Executive Summary

Tennessee Valley Authority
Reservoir Operations Study – Final Programmatic EIS

TVA

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ES.1 Introduction

The Tennessee Valley Authority (TVA) has conducted a comprehensive Reservoir Operations Study (ROS) to determine whether changes in how it operates the Tennessee River system would produce greater overall public value for the people of the Tennessee Valley. TVA, the U.S. Army Corps of Engineers (USACE), and the U.S. Fish and Wildlife Service (USFWS) have cooperated to prepare this Final Programmatic Environmental Impact Statement (FEIS) for the ROS. Representatives of other agencies and members of the public participated in this process by attending public meetings and providing comments on the scope of the document and the Draft Programmatic Environmental Impact Statement (DEIS). TVA also established two groups—a 17-member Interagency Team and a 13-member Public Review Group (IAT/PRG)—to ensure that agencies and members of the public were actively and continuously involved throughout the study. As the lead agency, TVA was primarily responsible for the preparation of this document.

Following public and agency review and comment on the DEIS, TVA has prepared a response to comments and a set of recommendations—the Preferred Alternative—which is included in this FEIS. After receiving comments on this FEIS, the TVA Board of Directors (Board) will decide whether TVA's reservoir operations policy will be changed and the nature of the change. In making its decision, the Board will consider the recommendations of TVA staff, this FEIS, public comments, and other factors. The Board will make a decision following the Notice of Availability of this FEIS and after consideration of public comments on the FEIS. The final decision will be documented in a Record of Decision and made available to the public. Decisions made by other federal agencies would be appropriately documented by the respective agency.

ES.2 Background

The Tennessee Valley Authority is a multi-purpose federal corporation responsible for managing a range of programs in the Tennessee River Valley (the Valley) for the use, conservation, and development of the water resources related to the Tennessee River. In carrying out this mission, TVA operates a system of dams and reservoirs with associated facilities—its water control system (Figure ES.2-01). As directed by the TVA Act, TVA uses this system to manage the water resources of the Tennessee River for the purposes of navigation, flood control, power production. Consistent with those purposes, TVA uses this system to improve water quality and water supply, and provide recreational opportunities and a wide range of other public benefits.

Public participation in the ROS EIS began in January 2002, when TVA mailed letters describing the ROS to over 60,000 stakeholders across the Valley and TVA Power Service Area, including representatives of agencies and Indian tribes that might be affected or interested. On February 25, 2002, TVA published a notice in the Federal Register, indicating the agency's intent to prepare a programmatic EIS on its reservoir operations policy and inviting interested parties to comment on its scope.

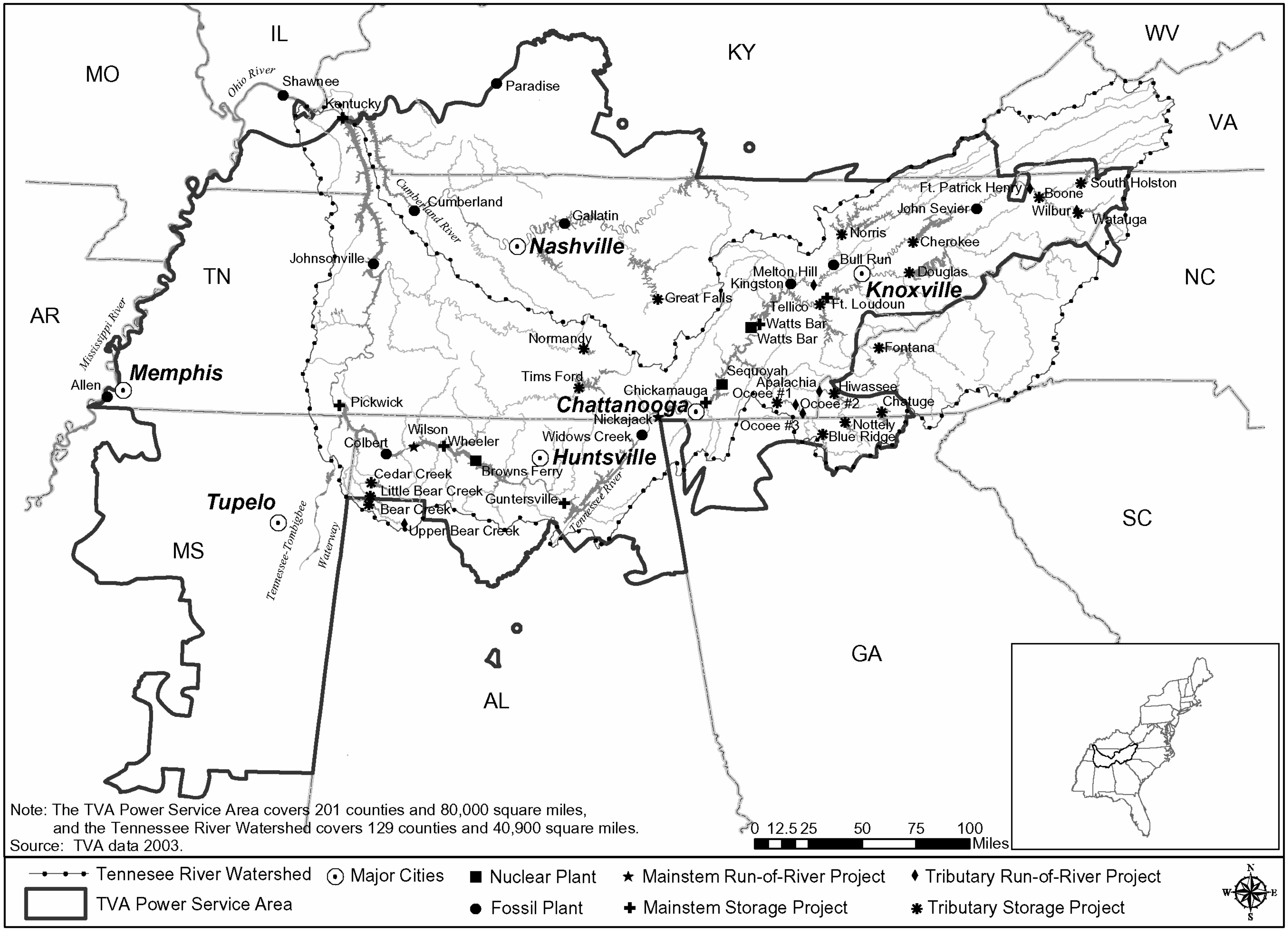

Figure ES.2-01 Tennessee River Watershed and TVA Power Service Area

During the 2-month comment period, more than 1,300 members of the public attended 21 community workshops held across the region; and several thousand wrote letters or submitted comments to TVA by mail, e-mail, fax, or telephone. When the comment period closed on April 26, 2002, TVA had received more than 6,000 individual comments, copies of form letters from approximately 4,200 individuals, and petitions signed by over 5,400 individuals. In addition, 3,600 residents in the TVA Power Service Area responded to a random telephone survey conducted by an independent research firm. The telephone survey was designed to sample a representative cross section of the populace served by TVA. TVA posted a copy of the DEIS on its web site and distributed approximately 1,500 copies to affected tribal governments, agencies, organizations, and individuals in July 2003. The Notice of Availability of the DEIS was published in the Federal Register on July 3, 2003. The comment period closed on September 4, 2003, but TVA continued to accept comments through mid-October from tribes and persons informing the agency that their comments would be late.

Including form letters and petitions, TVA received a total of 2,320 sets of comments on the DEIS. These sets of comments included input from almost 7,000 individuals, 7 federal agencies, 14 state agencies, 1 tribal government, and other groups and organizations. TVA has carefully reviewed and responded to all of the substantive comments on the DEIS, and used this input to improve the content of the FEIS.

ES.3 Purpose and Need

The purpose of the ROS is to enable TVA to review and evaluate its reservoir operations policy to determine whether changes in the policy would produce greater public value. TVA's reservoir operations policy guides the day-to-day operation of the Tennessee River system. It affects how much reservoir levels rise and fall, when changes in reservoir levels occur, and the amount of water flowing through the reservoir system at different times of the year. The policy sets the balance of trade-offs among competing uses of the water in the system.

Changing TVA's reservoir operations policy would modify the present balance among the various operating objectives for the system. These modifications would involve changing the existing reservoir system operating guidelines. In addition, because TVA receives no appropriations (money) from Congress, changes to its operations policy that require additional capital or operating expenditures would need to be funded by TVA or others.

TVA has periodically changed and adjusted its reservoir operations policy to achieve greater overall value for the public. Past policy changes reflected factors such as the public's changing needs and concerns, requests from citizens and regional groups, environmental quality issues, changes in the power industry, and TVA's own mission and planning needs. The reservoir operations policy also reflects a growing experience and understanding of the challenges and limitations imposed by annual variations in rainfall and runoff, especially during droughts and floods.

The last major evaluation of the environmental and socioeconomic impacts of TVA's reservoir operations policy was included in the Tennessee River and Reservoir System Operation and

Planning Review EIS, also known as the Lake Improvement Plan, which was completed in 1990. In 1991, the Board approved changes that included extending reservoir levels on 10 tributary reservoirs to August 1 in order to increase recreational opportunities. TVA also increased minimum flow requirements for many of its mainstem and tributary projects, and began a program to increase dissolved oxygen (DO) concentrations in the releases from 16 TVA dams. Following that evaluation, TVA continued to receive requests for changes to reservoir levels and other operations. As more and more users requested studies for their particular reservoir or tailwater, TVA decided that a piecemeal approach raised questions of fairness in how each reservoir would be treated. A comprehensive review was needed to examine the effects of changes in the reservoir operations policy on all of the operating objectives for the system across the entire TVA region.

ES.4 Scope of the ROS

TVA owns or operates 49 dams and reservoirs (called projects) in the Tennessee River and Cumberland River watersheds. The scope of the ROS EIS included evaluating the operations of 35 of these projects—projects for which TVA schedules water releases and reservoir levels in accordance with its reservoir operations policy. The remaining 14 projects not included in the ROS are one pumped storage project and several small water retention dams that are essentially self-regulating. These projects have little impact on the operation of TVA's water control system. In addition, physical removal of or major structural modifications to TVA dams and power plants was not included in the scope of the EIS.

The geographic area potentially affected by changes in the reservoir operations policy includes the Tennessee River watershed and the larger TVA Power Service Area. This area covers almost all of Tennessee and parts of Alabama, Kentucky, Georgia, Mississippi, North Carolina, and Virginia. The Tennessee River watershed includes 129 counties and encompasses 40,900 square miles; TVA's Power Service Area comprises 201 counties and covers approximately 80,000 square miles. Analyses of some resource areas (e.g., Navigation and Air Quality) included parts of the Ohio and Mississippi River systems and other areas outside the Valley and TVA Power Service Area to ensure a comprehensive analysis.

As is typical of water resource planning and management studies of this type, the ROS and this EIS used a long-range planning horizon (to the year 2030).

ES.5 Issues Considered

The scoping process for the EIS identified a broad range of issues and values to be addressed and alternatives to be evaluated in the ROS. Overall, the public placed a high value on recreation, a healthy environment, production of electricity, flood control, and water supply. After all public feedback was evaluated, TVA identified 11 major issues for evaluation in the EIS (Table ES-01). Other issues typically addressed in EISs were also incorporated into the analysis of each policy alternative.

Table ES-01 Public Feedback Provided during the Scoping Process

Major Issues	Concerns Expressed by the Public
Reservoir and downstream water quality	Dissolved oxygen concentrations, temperature, ammonia levels, wetted area (the area of river bottom covered by water), velocity, algae, and waste assimilation capacity
Environmental resources	Aquatic resources, shoreline erosion and sedimentation, visual resources, cultural resources, federal- and state-listed species, wetlands, vegetation, wildlife, and ecologically significant areas
Reservoir pool levels	Reservoir pool elevations and the annual timing of fill and drawdown, and their effects on reservoir recreation, property values, and aesthetics
Recreation flows	TVA's ability to schedule releases for tailwater recreation, including fishing, rafting, canoeing, and kayaking
Economic development	Recreation, property values, navigation, power supply, and water supply
Water supply	Reservoir and downstream intakes and potential inter-basin transfers
Navigation	Impacts on channel depth, speed of currents, and water levels
Flood risk on regulated waterways	Available reservoir space for storing floodwaters, how fast space can be recovered after a flood, and costs related to property damage and jobs lost or disrupted
Power reliability	Availability of cooling water at coal-fired and nuclear plants, fuel delivery by barges for coal-fired plants, and restrictions on hydropower production during critical power demands
Cost of power	Hydropower production, including total megawatt hours, seasonal availability, and value during high-cost periods
Capital costs	Changes to reservoir operations, including modifications and upgrades to—as well as additions to and removal of, various structures and equipment

ES.6 Objectives

To develop, screen, and select a range of policy alternatives for detailed evaluation, TVA established a set of objectives incorporating the issues that were identified by the public and interested parties during the scoping phase. TVA also considered other objectives, such as reducing the cost of treating water for municipal and assimilation-capacity uses, maintaining existing dam safety margins, and improving air quality.

OBJECTIVES IDENTIFIED DRING SCOPING FOR THE ROS EIS

- Supplying low-cost, reliable electricity
- Increasing revenue from recreation
- Reducing flood risk and flood-related damages
- Lowering the cost of transporting materials on the commercial waterway
- Providing enough water for municipal, agricultural, and industrial purposes
- Improving recreation on reservoirs and tailwaters
- Improving water quality in reservoirs and tailwaters
- Improving aquatic habitat in reservoirs and tailwaters
- Minimizing erosion of reservoir shoreline and tailwater riverbanks
- Increasing protection for threatened and endangered species
- Protecting and improving wetlands and other ecologically sensitive areas
- Protecting and improving the scenic beauty of the reservoirs

ES.7 Alternatives Considered

The National Environmental Policy Act (NEPA) requires that TVA evaluate a reasonable range of alternatives and the alternative of taking no action. For the purposes of the ROS EIS, a policy alternative refers to a set of system-wide operational changes that would re-balance the TVA reservoir system to emphasize certain operating objectives, such as increased opportunities for recreation, hydropower production, or navigation. To be considered reasonable, an alternative was required to be capable of adjusting the balance of operating objectives in response to expressed public values; continuing basic reservoir system benefits of flood control, navigation, and power production; and being environmentally, economically, and technically feasible.

Eight reservoir operations policy alternatives (seven policy alternatives and the Base Case) were selected for detailed evaluation in the DEIS. The Preferred Alternative was created after extensive public review of the DEIS and additional analyses. The goal was to enhance public value while minimizing impacts on the environment and other operating objectives. The Preferred Alternative combines and adjusts elements of the alternatives identified in the DEIS to preserve desirable characteristics and to avoid or reduce adverse impacts associated with those alternatives in order to create a more feasible, publicly responsive alternative. The following sections summarize the reservoir operations of each policy alternative. The alternative names reflect their primary emphasis, but each alternative was designed to achieve multiple objectives.

ES.7.1 Base Case

As required by NEPA, the Base Case (the No-Action Alternative) documents the existing reservoir operations policy against which the policy alternatives were compared. Under the Base Case, TVA would continue to fill tributary reservoirs to summer pool levels by June 1, restrict drawdown during June and July, and begin unrestricted drawdown on August 1. Fill and drawdown dates, and target elevations for mainstem reservoirs would not change. TVA would maintain the 2-foot normal winter operating range on mainstem reservoirs. Established minimum flows, including 13,000 cubic feet per second (cfs) bi-weekly average minimum flows at Chickamauga Reservoir from June to August, would continue. TVA would also continue recreation releases below Watauga/Wilbur, Apalachia, Tims Ford, Ocoee #2, and Ocoee #3 Reservoirs.

The Base Case also involves a number of other actions that would occur regardless of changes in the reservoir operations policy. These actions include existing water use patterns, taking into account increasing water supply demand in the future (through 2030); modernization and automation of TVA's hydro plants; operation of Browns Ferry Unit 1 and continued operation and uprate of Units 2 and 3; and operation of the Tennessee–Tombigbee Waterway at full capacity.

Process for Development of Alternatives

- Conducted public outreach to identify public's preferred reservoir operation priorities
- Compiled comments received during public scoping about suggested changes to the reservoir operations policy
- Identified major and minor issues
- Compiled operating options suggested by the public
- Developed, screened, and evaluated 65 preliminary policy alternatives
- Eliminated from further consideration those alternatives that did not meet operating objectives or were not practicable
- Formulated condensed set of 25 preliminary alternatives
- Obtained Interagency Team and Public Review Group review and comment on the condensed set of 25 preliminary alternatives
- Revised condensed set of 25 preliminary alternatives and developed a refined set of 25 alternatives
- Modeled the refined set of 25 alternatives to confirm technical and economic feasibility
- Screened and narrowed the number of alternatives to be considered by combining similar alternatives and bounding the range of possibilities
- Selected eight alternatives for further consideration (the Base Case and seven policy alternatives)
- Reexamined the eight alternatives to determine whether any additional operating objectives or policy elements should be included
- Analyzed and discussed the eight alternatives in the DEIS
- Compiled and reviewed comments on the DEIS
- Conducted additional analyses and developed a series of blended alternatives leading to the development of the Preferred Alternative, which is analyzed in this FEIS

ES.7.2 Reservoir Recreation Alternative A

Reservoir Recreation Alternative A would extend the summer pool period and delay unrestricted drawdown on 10 tributary reservoirs (Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Nottely, Norris, South Holston, and Watauga) until Labor Day (a month longer than under the Base Case). For Great Falls, the summer fill period would be completed by Memorial Day. On six mainstem reservoirs (Chickamauga, Guntersville, Kentucky/Barkley, Pickwick, Watts Bar, and Wheeler), the summer pool period would be extended to August 1 and then reduced by 1 foot from August 1 through Labor Day.

To maintain summer pool levels, reservoir releases during the summer pool period would be generally limited to those necessary to meet project and system minimum flow requirements[1] and to maintain flood storage allocation. However, the bi-weekly average releases from Chickamauga Reservoir would be increased and limited to 25,000 cfs weekly average from August 1 to Labor Day, providing sufficient flow throughout the reservoir system to minimize additional derating of nuclear and fossil power plants located on the reservoirs.

Under Reservoir Recreation Alternative A, the winter flood guide levels would be increased on 10 tributary reservoirs (Blue Ridge, Chatuge, Cherokee, Douglas, Hiwassee, Nottely, Norris, South Holston, Tims Ford, and Watauga) to the pool level targeted to be reached by March 15 under the Base Case. On five mainstem reservoirs (Fort Loudoun, Watts Bar, Chickamauga, Wheeler, and Pickwick), the minimum winter elevation would be raised by 2 feet, and the typical 2-foot winter fluctuating zone under the Base Case would be reduced to 1 foot for these five mainstem reservoirs under Reservoir Recreation Alternative A.

ES.7.3 Reservoir Recreation Alternative B

Reservoir Recreation Alternative B is similar to Reservoir Recreation Alternative A. Targeted summer pool levels would be extended to Labor Day on 10 tributary reservoirs (Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Nottely, Norris, South Holston, and Watauga) by delaying the beginning of unrestricted drawdown to Labor Day. On six mainstem reservoirs (Chickamauga, Fort Loudoun, Guntersville, Kentucky/Barkley, Pickwick, Wheeler, and Watts Bar), the summer pool elevations would be extended to Labor Day (as compared to August 1 under Reservoir Recreation Alternative A). In contrast to Reservoir Recreation Alternative A, Reservoir Recreation Alternative B would have no allowance for mainstem drawdown between August 1 and Labor Day.

For Reservoir Recreation Alternative B, the method of flood storage allocation would be changed to provide adequate storage for the 7-day, 500-year inflow[2]. Reservoir releases would be limited to only minimum flows from June 1 to Labor Day. Chickamauga Reservoir minimum releases would remain at 13,000 cfs (the Base Case).

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[1] System minimum flows are indicators of total flow through the system to meet specific system requirements for navigation, water supply, waste assimilation, and other benefits—including the assurance that adequate cooling water is provided to reduce derates at TVA's nuclear and coal-fired plants. System minimum flows are measured at the Chickamauga, Kentucky, and Pickwick Dams, and other locations. These flows include a bi-weekly average minimum flow in summer and a daily average minimum flow in winter. If the total of the project minimum flows plus any additional runoff from the watershed is insufficient to meet these system minimum flows, additional water must be released from upstream reservoirs to make up the difference.

[2] The 7-day, 500-year flood storage allocation for a given reservoir is the flood storage volume required to store the maximum 7-day average local inflow for a storm with a probability of occurrence in any given year of 0.002 (commonly referred to as the 500-year flood). The storage volume required for a specific reservoir assumes no releases from upstream projects.

In most cases, winter reservoir levels on tributary reservoirs would be higher, but by an amount that would vary among reservoirs depending on storage needed for the 7-day, 500-year inflow. On mainstem reservoirs, the minimum winter elevation would be raised 2 feet where possible. The typical 2-foot winter fluctuating zone under the Base Case would be reduced to 1 foot for these mainstem reservoirs under Reservoir Recreation Alternative B.

ES.7.4 Summer Hydropower Alternative

Under the Summer Hydropower Alternative, unrestricted drawdown would begin immediately after June 1 to increase power production and flood storage volume on both tributary and mainstem reservoirs.

Under the Summer Hydropower Alternative, the method of flood storage allocation would be revised to provide adequate storage for inflow for the 7-day, 500-year storm—allowing flood guides on tributary reservoirs to be raised in some cases. Weekly average releases from Chickamauga Reservoir would be increased to 35,000 cfs (compared to 13,000 cfs bi-weekly average under the Base Case). The only scheduled tailwater releases would occur at Ocoee #2 Reservoir.

ES.7.5 Equalized Summer/Winter Flood Risk Alternative

The principal changes to system operations under the Equalized Summer/Winter Flood Risk Alternative would involve establishing year-round flood guides for tributary and mainstem reservoirs that would vary by reservoir and month, depending on the anticipated runoff. These flood guides would be based on a reservoir's capacity to store inflow from the critical-period, 500-year storm[3] and would equalize the level of flood risk in all seasons. For tributary projects, a year-round flood guide would generally result in higher winter reservoir levels and lower summer reservoir levels, compared to the Base Case. For mainstem projects, the guide curves were modified to begin fill on April 1 and reach summer pool elevation by the end of May. A year-round flood guide would generally result in increased winter reservoir levels and reduced summer reservoir levels, in comparison to the Base Case.

Reservoir releases from June 1 to Labor Day would be limited to only those necessary to maintain minimum flows. Releases from Chickamauga Reservoir would be increased from the 13,000-cfs bi-weekly average under the Base Case to a 25,000-cfs weekly average from August 1 to Labor Day under the Equalized Summer/Winter Flood Risk Alternative.

ES.7.6 Commercial Navigation Alternative

Under the Commercial Navigation Alternative, changes to operations would primarily affect mainstem reservoirs. Raising the winter flood guides by 2 feet on mainstem reservoirs, where

[3] The critical-period, 500-year storage for a given reservoir is the maximum storage volume required to store the inflow from a storm, with a probability occurrence in any given year of 0.002 (commonly referred to as the 500-year storm). The storage volume required for a specific reservoir also takes into account the reservoir's natural inflow/discharge and inflows from upstream projects.

possible, would increase the navigation channel depth to 13 feet (providing an 11-foot navigation channel with a 2-foot overdraft). The mainstem winter operating range would be modified to allow only a 1-foot fluctuation on those mainstem reservoirs raised 2 feet in winter.

To further support navigation operations, minimum flows would be increased at several key projects with major navigation locks. Specific instantaneous minimum flows, would be provided at Kentucky, Pickwick, and Wilson Dams to reduce the difficulty of navigation at certain locations. At Pickwick and Wilson Dams, these flows would also be tied to pool elevation. A limitation on maximum flow (except in flood control situations) would be imposed at Barkley Reservoir, when practical, to reduce high-flow navigation hindrances.

ES.7.7 Tailwater Recreation Alternative

Under the Tailwater Recreation Alternative, tailwater recreation releases would have higher priority than maintaining water levels for reservoir recreation. This alternative would include extending the summer pool period to Labor Day; changing winter tributary flood guides to the 7-day, 500-year storm inflow; and raising winter mainstem reservoir levels by 2 feet, where possible. From June 1 to Labor Day, two types of reservoir releases would occur. Releases would be made to maintain minimum flows, and additional releases would be scheduled to increase tailwater recreational opportunities at a five projects (Apalachia, Norris, Ocoee #1, South Holston, and Watauga/Wilbur).

ES.7.8 Tailwater Habitat Alternative

Under the Tailwater Habitat Alternative, the principal change to system operations would involve releasing Base Case minimum flows or 25 percent of the inflow—whichever is greater—as a relatively continuous minimum flow with no turbine peaking. Hydroturbine pulsing would continue to be used to provide minimum flows. Minimum Operations Guides (MOGs) would be eliminated on tributary reservoirs. Tributary and mainstem reservoirs would use operating guide curves similar to the ones used under Reservoir Recreation Alternative A. Mainstem winter operating ranges would be limited to 1 foot for those projects raised 2 feet in winter.

Under this alternative, reservoir releases into tailwaters would produce flows, water depths, and velocities throughout the year that would be more similar to natural seasonal variability. Actual flows, limits, and changes would be determined by the inflow conditions. During high inflows, water would be released to keep elevations below the flood guides. During low inflows, existing project minimum flows would be met. In the intermediate inflow ranges, 25 percent of the inflow would be passed. Hydropower operations would occur when water is released from the dams.

ES.7.9 Preferred Alternative

Under the Preferred Alternative, each project would meet its own Base Case minimum flow requirements and share the responsibility for meeting increased system minimum flow requirements. After meeting those requirements, elevations on 10 tributary reservoirs (Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Nottely, Hiwassee, Norris, South Holston, and Watauga) would be maintained as close as possible to the summer flood guide from June 1 through Labor Day, resulting in restricted drawdown during this period. When rainfall and runoff are insufficient to meet system flow requirements, the needed water would be released from the upstream tributary reservoirs to augment the natural inflows, resulting in some drawdown of all of these projects. This would be expected to occur in about 90 percent of the years.

Reservoir balancing guides established for each tributary storage reservoir would be used under the Preferred Alternative to ensure that the proportional water releases for downstream system needs are drawn from the tributary reservoirs equitably. A balancing guide is a seasonal reservoir pool elevation that defines the relative drawdown at each tributary reservoir when downstream flow augmentation is required. Subject to variations in rainfall and runoff across the projects, and the necessity to ensure at least minimal hydropower capacity at each tributary project (up to a water equivalent of 17 hours of use per week at best turbine efficiency from July 1 through Labor Day), water would be drawn from each tributary reservoir so that elevation of each reservoir would be similar relative to its position between the flood guide and the balancing guide. Summer operating zones would be maintained through Labor Day at four additional mainstem projects (Chickamauga, Guntersville, Pickwick, and Wheeler). Base Case minimum flows, except for the increases noted below, and the DO targets adopted following completion of the 1990 Lake Improvement Plan would continue to be met.

Subject to flood control operations or extreme drought conditions, scheduled releases would be provided at five additional tributary projects (Ocoee #1, Apalachia, Norris, Watauga/Wilbur, and South Holston) to increase tailwater recreational opportunities. Under the Base Case, recreational releases are not formally scheduled at these five projects and are made only after other operating requirements have been met.

Under the Preferred Alternative, the weekly average system flow requirement from June 1 through Labor Day measured at Chickamauga Dam would be determined by the volume of water in storage at 10 upstream tributary reservoirs relative to a system Minimum Operations Guide (MOG). This guide is a seasonal storage guide that defines the combined storage volume for those 10 tributary reservoirs (Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Nottely, Hiwassee, Norris, South Holston, and Watauga). If the volume of water in storage is more than the system MOG, the weekly average system flow requirement would be increased each week from 14,000 cfs the first week of June to 25,000 cfs the last week of July. Beginning August 1 and continuing through Labor Day, the weekly average flow requirement would be 29,000 cfs. If the volume of water in storage is less than the system MOG, only 13,000 cfs weekly average flows would be released between June 1 and July 31, and only 25,000 cfs weekly average flows would be released from August 1 through Labor Day. During normal operations June through Labor Day, weekly average system flows would not be lower than the amounts specified to ensure adequate flow through the system. Also, they would not be higher than the specified amounts to maintain pool levels as close as possible to the flood guides on 10 tributary reservoirs. After periods of high inflow, higher flows would be released as necessary to recover allocated flood storage space. Continuous minimum flows would be provided in the Apalachia Bypass reach from June 1 through November 1.

The winter flood guide levels would be raised on 10 tributary reservoirs (Boone, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Norris, Nottely, South Holston, and Watauga) based on the results of the flood risk analysis. On Wheeler Reservoir, the minimum winter elevation would be raised by 0.5 foot to better ensure an 11-foot minimum depth in the navigation channel. Steady water releases up to 25,000 cfs of flow would be provided as necessary at Kentucky Dam to maintain a tailwater elevation of 301 feet. Great Falls Reservoir would be filled earlier to reach full summer pool by Memorial Day. On Fort Loudoun, Watts Bar, and Chickamauga Reservoirs, the fill period would follow the Base Case fill schedule during the first week in April. Then, the fill schedule would be delayed to reach summer operating zone by mid-May.

ES.8 Other Actions Considered

TVA considered a number of other possible actions during formulation of the policy alternatives. They included actions that exist or could be implemented independent of changes in reservoir operations policy, such as continuing operation of the Bear Creek and Normandy Projects under existing guide curves, changes in hydroturbine ramping rates, and operations to support fish spawning and improve habitat and biodiversity. TVA also considered but did not include a number of other actions, including major structural modifications to dams, levee construction, maintaining summer reservoir levels year-round, reducing minimum flows from tributary dams or filling tributary reservoirs by March 1, and delaying drawdown until after October. Other actions considered but not included in any of the policy alternatives were reducing the navigation channel to 9 feet or dredging the navigation channel, strengthening TVA's regulatory authority, and constructing or relying on new alternative energy sources and incentives for energy and water conservation. Some of these actions were not within the overall scope of the ROS, were not feasible, would clearly result in unacceptable environmental impacts, or have been considered in previous TVA studies.

ES.9 Potential Impacts and Comparison of Alternatives

Identifying and quantifying the trade-offs between competing reservoir operating objectives were essential to evaluating the policy alternatives. TVA performed a comprehensive environmental and economic evaluation of each of the policy alternatives. Three separate evaluations were performed—one with respect to the objectives identified during from the public scoping process (see Table ES-02), a second to evaluate impacts on each of the environmental resources (see Table ES-03), and a third to calculate regional economic benefits (see Table ES-04).

ES.9.1 Objectives Identified during Scoping

TVA conducted an extensive scoping process to obtain public input on future operations of the water control system. The 12 operating objectives identified during scoping are identified in Section ES.6. Table ES-02 shows the performance for each of the policy alternatives selected for evaluation in relation to those objectives. This table shows how well each policy alternative performed in relation to reservoir operating objectives important to the public. Changes in power costs and flood damage are predicted to be in the range of 1 percent or less. Other sectors, however, may experience greater changes. The one sector of direct economic effects that would increase for most alternatives is the change in recreation revenue. All of the alternatives that include increased recreation benefits would increase revenue approximately 20 percent. The Summer Hydropower Alternative and the Commercial Navigation Alternative would result in negative recreation revenues. In another category, shipper savings may be increased by 4 percent under the Commercial Navigation Alternative.

ES.9.2 Impacts on Resource Areas

At a more detailed level, TVA analyzed 24 resource areas that reflect a wide range of issues important to the residents of the Tennessee River basin. Table ES-03 (at the end of this summary) presents the effects of the policy alternatives on each of these resource areas.

This assessment of impact was made using seven impact levels, including No Change, Slightly Adverse/Slightly Beneficial, Adverse/Beneficial, and Substantially Adverse/Substantially Beneficial. The extent, duration, and intensity determined the level of impact. In some cases, the impact was listed as Variable for resources where impacts varied across the study area to a degree that they could not be classified within a single impact level.

DEFINITIONS OF IMPACT

Level of Impact	Description
No change	Impact on the resource area is negligibly positive or negative but is barely perceptible or not measurable, or confined to a small area; or the extent of the impact is limited to a very small portion of the resource.
Slightly adverse/slightly beneficial	Impact on the resource area is perceptible and measurable, and is localized; or its intensity is minor but over a broader area and would not have an appreciable effect on the resource. This also can refer to impacts with short duration and not recurring.
Adverse/beneficial	Impact is clearly detectable and could have an appreciable effect on the resource area. Moderate impacts can be caused by combinations of impacts, ranging from high-intensity impacts over a smaller area to small to moderate impacts over a larger area. This also can occur with minor to moderate impacts that are recurring over a period of years.
Substantially adverse/ substantially beneficial	Impact would result in a major, highly noticeable influence on the resource area—generally over a broader geographic extent and/or recurring for many years.

Table ES-02 Summary of Policy Alternative Performance by Objectives Identified during Public Scoping

Objective	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Low-cost/reliable electricity [1]	No change	$30 M increase in power costs	$67 M increase in power costs	$3 M increase in power costs	$108 M increase in power costs	$11 M decrease in power costs	$66 M increase in power costs	$295 M increase in power costs	$14 M increase in power costs
Revenue from recreation [2]	No change ($65.1 M existing revenue)	$11 M (17%) increase in revenue	$14 M (22%) increase in revenue	$10 M (15%) decrease in revenue	$1 M (2%) increase in revenue	$1M (2%) decrease in revenue	$14 M (22%) increase in revenue	$13 M (20%) increase in revenue	$9 M (14%) increase in revenue
Flood risk and flood-related damages	No change	Increase	Substantial increase	Increase	No change	Increase	Substantial increase	Substantial increase	No change
Cost of transporting materials on the commercial waterway [3]	No change ($426 M existing costs)	No change in shipper costs	No change in shipper costs	$12 M (3%) increase in shipper costs	$1 M (<1%) increase in shipper costs	$17 M (4%) decrease in shipper costs	No change in shipper costs	No change in shipper costs	$2.5 M (1%) decrease in shipper costs
Water for municipal, agricultural, and industrial purposes [4]	No change	No change	No change	$12.5 M increase in costs	No change	$3.4 M increase in costs	No change	No change	No change
Recreation on reservoirs and tailwaters [5]	No change (6.57 million base user days)	1.34 M (20%) increase in user days	1.54 M (24%) increase in user days	1.27 M (19%) decrease in user days	0.24 M (4%) increase in user days	0.12 M (1.9%) decrease in user days	1.55 M (23%) increase in user days	1.44 M (22%) increase in user days	1.17 M (18%) increase in user days
Water quality in reservoirs and tailwaters	No change (natural variability from year to year)	No change to adverse effects on water quality	No change to substantially adverse effects on water quality	Adverse to beneficial effects on water quality	No change to adverse effects on water quality	No change to slightly beneficial effects on water quality	No change to substantially adverse effects on water quality	Adverse effects on water quality	No change to slightly adverse effects on water quality

Table ES-02 Summary of Policy Alternative Performance by Objectives Identified during Public Scoping (continued)

Objective	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Aquatic habitat in reservoirs and tailwaters	No change	Slightly adverse to slightly beneficial effects on aquatic habitat	Slightly adverse to slightly beneficial effects on aquatic habitat	Slightly adverse to slightly beneficial effects on aquatic habitat	Slightly adverse to slightly beneficial effects on aquatic habitat	Slightly beneficial effects on aquatic habitat	Adverse to slightly beneficial effects on aquatic habitat	No change to adverse effects on aquatic habitat	Slightly adverse to slightly beneficial effects on aquatic habitat
Erosion of reservoir shoreline and tailwater riverbanks	No change	Slightly increased erosion	Slightly increased erosion	No change to slightly reduced erosion	No change to slightly reduced erosion	No change	Slightly increased erosion	Slightly increased to increased erosion	Slightly increased erosion
Threatened and endangered species	No change	No change to slightly adverse effects	No change to slightly adverse effects	Adverse effects	No change to slightly beneficial effects	No change to slightly beneficial effects	No change to slightly adverse effects	Beneficial to slightly adverse effects	Slightly adverse to slightly beneficial effects
Wetlands and other ecologically sensitive areas	No change	Slightly adverse to slightly beneficial effects	Adverse to slightly beneficial effects	Substan-tially adverse effects	Adverse to substantially adverse effects	No change	Slightly adverse to slightly beneficial effects	Slightly adverse to slightly beneficial effects	Slightly adverse to slightly beneficial effects
Scenic beauty of reservoirs	No change	Improved	Substantially improved	Reduced	Slightly reduced	Slightly improved	Substantially improved	Substantially improved	Improved

Notes:

1 Millions of dollars annually.

2 Changes in recreational expenditures from outside the TVA region in millions of dollars annually for the year 2010 in 2002 dollars (percent change from Base Case for 2010 in 2002 dollars).

3 Change in shipping costs in millions of dollars annually (percent change from Base Case for 2010 in 2002 dollars).

4 Cost in millions of dollars (2002 dollars) to modify intakes on reservoirs with pool levels below TVA-published minimum elevations.

5 Total recreation use in user days (percent change from Base Case in user days).

Tables ES-02 and ES-03 present different but closely related information. Table ES-02 focuses on the specific objectives identified by the public. Table ES-03 summarizes the results of technical analyses of the 24 resource areas by specialists, using more detailed metrics, modeling, and analysis. Table ES-02 is not derived directly from the more detailed results presented in Table ES-03.

Reservoir Recreation Alternative A—Reservoir Recreation Alternative B—Tailwater Recreation Alternative—Tailwater Habitat Alternative

These alternatives are similar in that they would produce benefits for recreational use of the reservoirs, substantially increased visual quality, and other beneficial resource improvements. However, these alternatives would also result in water quality impacts that would affect some aquatic resources, increase erosion and related impacts on cultural resources, and adversely affect the treatment of water supply. As a group, they represent a mixed set of impacts on environmental resources.

This group of alternatives would change, to various degrees, reservoir levels and flows through the reservoir system and their seasonal timing. These are the major factors driving the level of beneficial or adverse impacts on aquatic systems, wetland systems, and shoreline conditions, and the frequency and duration of thermal plant derates. Higher reservoir levels and reduced flows through the system would result in a suite of adverse and beneficial changes to the reservoir system. These would include some complex, inter-connected changes in the environment.

Holding summer pool levels higher later into summer and fall would result in increased thermal stratification in some reservoirs and in decreased water quality, low DO conditions, and anoxia—depending on the reservoir. Decreased water quality would adversely affect some aquatic resources and, at specific locations, threatened and endangered species. It would be costly to mitigate the water quality impacts resulting in low DO in project releases, and some impacts may be unavoidable.

Within this group of alternatives, Reservoir Recreation Alternative B, Tailwater Recreation Alternative, and the Tailwater Habitat Alternative would result in the most adverse impact on water quality because they would maintain summer pool levels longer and/or reduce flow through the system in summer to a greater extent. Reservoir Recreation Alternative A would achieve recreational and aesthetic benefits without the more substantial water quality impacts that accompany the other alternatives in this group. Maintaining summer pool levels longer would result in greater potential for shoreline erosion, with associated adverse effects on cultural resources and some shoreline habitats. Under all these alternatives, increased erosion would occur; erosion would be greatest under the Tailwater Habitat Alternative. Impacts on cultural resources under these alternatives would be slightly adverse to substantially adverse.

The alternatives in this group would result in variable and adverse impacts on wetlands overall because they would change the timing of inundation of various wetland, lowland, and shallow-water habitats.

Summer Hydropower Alternative and Equalized Summer/Winter Flood Risk Alternative

These alternatives are similar in the fact that they would produce few beneficial or substantially beneficial environmental resource impacts overall within the TVA reservoir system but would result in a number of substantially adverse environmental effects. The Equalized Summer/Winter Flood Risk Alternative would produce benefits for private recreational use of the reservoirs but little change is projected for public and commercial recreation use. It would have slightly adverse impacts on scenic integrity. The Summer Hydropower Alternative would produce substantially adverse impacts on private recreational use of the reservoirs and slightly adverse impacts on public and commercial recreation use. It would have adverse impacts on scenic integrity.

A suite of environmental resources would be adversely affected, especially under the Summer Hydropower Alternative. Both the Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative would result in substantial impacts on wetland resources. The Summer Hydropower Alternative would result in additional adverse environmental impacts on water quality in some tributary reservoirs, adverse impacts on several threatened and endangered species, and water supply withdrawal structures and pumping costs.

Base Case and Commercial Navigation Alternative

These alternatives are similar in the fact that they would produce few changes in the balance of beneficial or substantially beneficial impacts overall within the TVA system but also would result in fewer adverse environmental effects than the other alternatives. The Commercial Navigation Alternative would increase shipper savings, result in some slightly adverse impacts on wetland plant communities, terrestrial ecology (use of flats and some bottomland hardwood wetlands), and cultural resources. In general, the Commercial Navigation Alternative would not result in any adverse effects on protected species and would provide beneficial effects on summer water temperatures, minimum mainstem water levels, and increased stability of wetland habitats in comparison to the Base Case.

Preferred Alternative

After extensive public review of the DEIS and additional analyses, TVA developed a Preferred Alternative. This alternative combines and adjusts elements of the alternatives identified in the DEIS to preserve desirable characteristics and to avoid or reduce adverse impacts associated with those alternatives. The Preferred Alternative establishes a balance of reservoir system operating objectives that is more responsive to public values expressed during the ROS and consistent with the operating priorities established by the TVA Act. Adjusting project flood guides and delaying the complete filling of upper mainstem projects until May 15 would reduce potential flood damage compared to all other alternatives except the Base Case. Based on computer simulations, the Preferred Alternative would not result in increased flood damages associated with flood events up to a 500-year magnitude at any critical location within the Tennessee Valley, including Chattanooga. A flood event with a 500-year magnitude has a 1 in 500 chance of happening in any given year. Resolving flood risk issues was a central component in formulating the Preferred Alternative because reducing flood damage is one of the most valuable benefits provided by the system. Except for the Base Case, all of the alternatives evaluated in the DEIS would result in unacceptable increases in the risk of flooding at one or more critical locations. The Preferred Alternative would also provide a more equitable way of balancing pool levels among the tributary reservoirs, increase the minimum depth of the Tennessee River navigation channel at two locations, and maintain power system reliability while lessening impacts on delivered cost of power.

Under the Preferred Alternative, providing a longer duration of higher pool levels during summer (June 1 through Labor Day) would result in a beneficial increase in recreational opportunities and use of the reservoirs and tailwaters. Substantial beneficial increase in user days is anticipated for private access sites, with a slightly beneficial increase in public user days. It would also provide for more reliable recreational releases. Less fluctuation and longer duration of higher pool elevations on tributary reservoirs would substantially increase the scenic integrity of the reservoir system. The resulting reservoir pool elevations would produce slightly adverse impacts on shoreline erosion and associated slightly adverse effects on cultural resources.

Under the Preferred Alternative, reservoir pool levels would be maintained in a manner that continues to support wetlands extent, distribution, and habitat connectivity at levels similar to conditions under the Base Case. The Preferred Alternative would reduce some of the adverse impacts on flats, scrub/shrub, and forested wetlands that are associated with water levels being held too long during the growing season, and would ensure timely seasonal exposure of flats habitats important to migratory shorebirds and waterfowl at some of the more important mainstem reservoirs. However, it would result in slightly adverse impacts on certain wetland types and locations. In some cases, impacts may vary from year to year—depending on the reservoir, annual rainfall conditions, and other factors. The Preferred Alternative would result in slightly adverse effects on some protected species that occur in wetland habitats on most reservoirs, but would result in effects similar to the Base Case with regard to protected species on Kentucky Reservoir.

Compared to the Base Case, higher system flows would be required under the Preferred Alternative June through Labor Day when the volume of water in storage is above the system MOG. During normal operations in this period, weekly average system flows would not be higher than these minimum requirements to maintain pool levels as close as possible to the flood guides on 10 tributary reservoirs. Therefore, actual flows would be lower most of the time during this period. The Preferred Alternative would have little effect on water quality in tributary reservoirs. Effects would vary among mainstem reservoirs—some would have volumes of low DO water similar to the Base Case and others a substantially larger volume. Effects on water quality would be slightly adverse. The Preferred Alternative would maintain tailwater minimum flows and DO targets while reducing impacts on reservoir water quality, as compared to some of the other alternatives that hold summer pool levels longer, and would provide for more balanced tributary reservoir levels across the system.

ES.9.3 Regional Economic Effects

The geographic scope of this study consists of the 201-county area bounded by the TVA Power Service Area and the Tennessee River Watershed. In 2000, the ROS area population was 9.2 million, total employment was 5.4 million jobs, total personal income was $235 billion, and gross regional product (GRP) was $275 billion (2002 dollars). The region attained these levels after strong growth over the 1990s, outpacing national economic growth. Gross regional product, population, employment, and income in the region grew at a faster rate than their national counterparts during the same period.

Under the Base Case, regional economic growth is projected to continue to outpace national economic growth over the rest of the decade. Overall, the region is projected to experience a GRP increase of 3.2 percent per year, compared to 3.0 percent nationally, from 2000 to 2010. Total employment is forecasted to grow at 1.2 percent while increasing at 1.0 percent nationally. With this job growth and with the region remaining a desirable place to live, regional population is also expected to continue to outpace national growth, increasing at 1.1 percent per year versus 1.0 percent for the nation.

To determine the economic effects of an alternative reservoir operations policy as compared to the Base Case, TVA evaluated several economic parameters. This evaluation integrated changes to the cost of power, revenues from recreation, shipper savings from river transportation, cost of municipal water supplies, and changes in property values into a measure of overall effects on the regional economy. Table ES-04 shows the effect of each of the reservoir operations policy alternatives as measured by change (from the Base Case) in the GRP, which is the sum dollar value of all goods and services in the economy that is commonly used as a broad measure of economic activity. The GRP includes direct economic effects, such as changes in power costs, and also includes the ripple effect of changed power costs on other economic sectors.

As measured by the GRP, only the Commercial Navigation Alternative is expected to positively affect the regional economy. All other action alternatives are expected to result in a negative regional economic effect. The actual magnitude of these effects, either negative or positive, would be small as a percent of the GRP. Effects for 2010 are shown in Table ES-04. The impacts for 2010 represent the effects after changes to the operations policy have been absorbed into the regional economy.

Table ES-04 Annual Economic Effects of Policy Alternatives Based on Changes in Gross Regional Product (2010)

	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Change	[$13.6 million]	[$32.5 million]	[$43.2 million]	[$76.5 million]	$54.0 million	[$30.8 million]	[$160.8 million]	[$6.0 million]
Percent of gross regional product	-0.004	-0.01	-0.012	-0.02	0.02	-0.01	-0.043	-0.002

Note: Brackets indicate negative values.

ES.9.4 Cumulative Impacts

Relevant future trends and other reasonably foreseeable projects and actions were used in analyzing the cumulative impacts of changing TVA's reservoir operations policy. No material cumulative impacts are expected for Dam Safety, Invasive Plants and Animals, Aquatic Plants, Groundwater Resources, and Prime Farmland because changing TVA's system-wide operations policy is not expected to result in effects that would overlap or accumulate with them. The potential consequences of policy changes on Power and Navigation were determined to be primarily economic. The modeling of economic changes integrates cumulative effects and the results presented are cumulative in nature. Changes in TVA's reservoir system operations policy could affect Land Use, but these effects are also primarily economic and were captured by TVA's economic analyses. The cumulative effects of shoreline development were also presented in TVA's earlier programmatic EIS assessing shoreline development, the 1998 Shoreline Management Initiative.

Changing TVA's reservoir operations policy could have potential for cumulative impacts on Air and Climate, Water Quality, Water Supply, Aquatic Resources, Wetlands and Terrestrial Ecology, Vectors (mosquito breeding habitat), Threatened and Endangered Species, Managed Areas and Ecologically Significant Sites, Shoreline Erosion, Cultural Resources, Visual Resources, Flood Control, and Recreation. Compared to the other action alternatives, these potential cumulative effects would be avoided or substantially reduced under the Preferred Alternative. Through detailed analysis in this FEIS, TVA has determined that most changes under the Preferred Alternative would result in beneficial to slightly adverse impacts. Further, TVA has identified potential mitigation measures to address the few adverse and substantially adverse impacts associated with the Preferred Alternative.

ES.10 TVA's Preferred Alternative

Based on the evaluation included in this EIS, TVA staff will recommend that the TVA Board implement the ROS Preferred Alternative. This alternative would establish a balance of reservoir system operating objectives that is more responsive to values expressed by the public during the ROS and consistent with the operating priorities established by the TVA Act.

The Preferred Alternative would increase reservoir and tailwater recreation opportunities and visual quality. Based on computer simulations, the Preferred Alternative would not result in increased flood damage associated with flood events up to a 500-year magnitude at any critical location within the Tennessee Valley, including Chattanooga. A flood event with a 500-year magnitude has a 1 in 500 chance of happening in any given year. The Preferred Alternative would provide a more equitable way of balancing pool levels among tributary reservoirs. The Preferred Alternative would increase the minimum depth of the Tennessee River navigation channel at two locations and would maintain power system reliability while lessening impacts on the delivered cost of power compared to other alternatives.

The Preferred Alternative would maintain tailwater minimum flows and DO targets. Additionally, it would lessen impacts on reservoir water quality, as well as shoreline erosion and its associated adverse effects on cultural resources and some shoreline habitats—as compared to Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative. Responding to flood control, wetland, and wildlife concerns expressed by the USACE, the USFWS, state agencies, and some members of the public, no changes in seasonal water levels on Kentucky Reservoir were included in the Preferred Alternative.

Once the formulation of the Preferred Alternative was complete, TVA initiated consultations on this proposed action with the USFWS regarding the Endangered Species Act and with the seven State Historic Preservation Officers regarding the National Historic Preservation Act. Results of the Endangered Species Act consultation (presented in Appendix G) indicate that adoption of the Preferred Alternative would not jeopardize the continued existence of any listed or candidate federal threatened or endangered species. The National Historic Preservation Act consultations resulted in development of a Programmatic Agreement (presented in Appendix H) that covers the identification and protection or mitigation of historic properties that could be affected by adoption of the Preferred Alternative.

ES.11 Potential Mitigation Measures

A mix of monitoring and adaptive response is an important component of TVA's programmatic approach to mitigating potentially adverse to substantially adverse impacts under the Preferred Alternative. TVA would continue its existing monitoring activities under its Reservoir Release Improvement and Vital Signs Monitoring Programs to look for water quality and ecological changes; with additional DO and temperature sampling at selected tailwater locations as determined by Vital Signs monitoring. A Wetlands Monitoring Program would be established to determine whether shifts of wetland plant communities occur as a result of extended water levels. TVA would extend the existing Vector Monitoring Program to identify any increase in the number of days that reservoir mosquito breeding habitat exists due to the extended time the mainstem reservoirs are held up.

If analysis or monitoring indicates that DO concentrations are declining below DO target levels, TVA would upgrade aeration equipment and operations at appropriate locations as necessary to meet the DO target levels established by the Lake Improvement Plan. This could include increased oxygenation, upgrading existing equipment, or installing additional equipment. Such measures would be initiated and completed within 1 year at Watts Bar and within 3 years at other locations where established targets are not being met. If holding mainstem reservoir levels up longer increases the number of days that reservoir mosquito breeding habitat exists TVA would extend the duration of reservoir level fluctuations for mosquito control.

Table ES-03 Summary of Impacts by Policy Alternative

Resource Area	Alternative								
	Base Case	**Reservoir Recreation A**	**Reservoir Recreation B**	**Summer Hydropower**	**Equalized Summer/ Winter Flood Risk**	**Commercial Navigation**	**Tailwater Recreation**	**Tailwater Habitat**	**Preferred**
Air Resources									
Air emissions	No change in projected annual emissions (in tons) of about 469,000 SO_2, 202,000 NO_x, 13,000 particulates, 10,000 CO, 1,200 VOCs, and 1.6 Hg	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	No change	Slightly adverse	Beneficial (Due to non-emission generation)	No change to slightly adverse
Climate									
Greenhouse emissions	No change in projected annual emission of 106.5 million tons CO_2	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly adverse	Beneficial (Decrease of almost 2 million tons in annual CO_2 emissions)	Slightly beneficial
Water Quality									
Assimilative capacity – storage tributaries	No change in volume of water to assimilate oxygen-demanding waste	Slightly beneficial	Slightly beneficial	No change to slightly adverse	No change to slightly adverse	No change	Slightly beneficial	Slightly beneficial (Effects vary among reservoirs)	Slightly beneficial
Assimilative capacity – transitional tributaries [1]	No change in volume of water to assimilate oxygen-demanding waste	No change to slightly adverse	No change	No change to slightly adverse	Slightly adverse	No change	No change	No change to slightly adverse	No change

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Water Quality (continued)									
Assimilative capacity –mainstem reservoirs	No change in volume of water to assimilate oxygen-demanding waste	No change.	No change	No change to slightly adverse	No change	No change	No change	No change	No change
Anoxia – storage tributaries	No change in volume of water with DO concentration less than 1mg/L	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly beneficial (Effects vary among reservoirs)	No change	No change to adverse (Increase in volume of water with DO concentration less than 1mg/L)	Adverse (Increase in volume of water with DO concentration less than 1mg/L)	No change
Anoxia – transitional tributaries	No change in volume of water with DO concentration less than 1mg/L	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	No change to slightly adverse	Slightly adverse to slightly beneficial (Effects vary among reservoirs)	No change to slightly adverse (Effects vary among reservoirs)	Slightly adverse to slightly beneficial (Effects vary among reservoirs)
Anoxia – mainstem reservoirs	No change in volume of water with DO concentration less than 1mg/L	Adverse (Increase in volume of water with DO concentration less than 1mg/L)	Substantially adverse (Substantial increase in volume of water with DO concentration less than 1mg/L)	Substantially beneficial (Substantial decrease in volume of water with DO concentration less than 1mg/L)	Adverse to substantially adverse (Substantial increase in volume of water with DO concentration less than 1mg/L for some mainstem reservoirs)	Slightly beneficial	Substantially adverse (Substantial increase in volume of water with DO concentration less than 1mg/L for most mainstem reservoirs)	Adverse to substantially adverse (Substantial increase in volume of water with DO concentration less than 1mg/L for some mainstem reservoirs)	Slightly adverse

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Water Supply									
Water supply delivery (costs)	No change in parameters affecting cost of water supply pumping from reservoirs and intake modifications due to lower reservoir levels	Slightly beneficial (Savings of $1 million)	Slightly beneficial (Savings of $1.4 million)	Substantially adverse (Additional cost of $13 million)	Slightly beneficial (Savings of $0.2 million)	Adverse (Additional cost of $2.8 million)	Slightly beneficial (Savings of $1.4 million)	Slightly beneficial (Savings of $1.1 million)	Slightly beneficial (Savings of $0.5 million)
Water supply quality (treatment)	No change in parameters affecting cost of water treatment of water withdrawn from TVA reservoirs	Slightly adverse	Adverse (High potential for soluble iron and manganese formation based on increase in volume of water with DO less than 1 mg/L)	No change to adverse (Wide variability in potential for soluble iron and manganese formation, depending on reservoir and year)	Slightly adverse	No change	Adverse (High potential for soluble iron and manganese formation based on increase in volume of water with DO less than 1 mg/L)	Adverse (High potential for soluble iron and manganese formation based on increase in volume of water with DO less than 1 mg/L)	No change to slightly adverse
Groundwater Resources									
Groundwater levels – reservoirs	No change in existing groundwater use	Slightly beneficial	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly beneficial	Slightly beneficial

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	**Reservoir Recreation A**	**Reservoir Recreation B**	**Summer Hydropower**	**Equalized Summer/ Winter Flood Risk**	**Commercial Navigation**	**Tailwater Recreation**	**Tailwater Habitat**	**Preferred**
Aquatic Resources									
Biodiversity – tributary reservoirs	No change Benthic aquatic insect and mussel communities would still be affected by seasonal thermal stratification, low DO, and large water level fluctuations	No change	Slightly adverse	Adverse (Shoreline fluctuation would adversely affect shoreline habitat)	No change	No change	Slightly adverse	Slightly adverse	No change
Biodiversity – mainstem reservoirs	No change Aquatic insect communities would remain fair, status of mussels in flowing portions would remain poor for riverine species and favorable for pool-adapted species	Slightly adverse	Slightly adverse	Slightly beneficial	No change to slightly adverse	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse to slightly beneficial (Effects vary among reservoirs)
Biodiversity – warm-water tailwaters [2]	No change Biodiversity would continue to be limited due to the restraints of a regulated system	No change to slightly adverse	No change to slightly adverse	Adverse (Water quality and the stability of daily water elevations would decrease)	No change	No change	No change to slightly adverse	No change to slightly adverse	No change to slightly adverse

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Aquatic Resources (continued)									
Sport fish – tributary reservoirs	No change Conditions would continue to be stressful for cool-water species and favorable for warm-water species	No change to slightly beneficial	Slightly beneficial	Slightly adverse to slightly beneficial (Effects vary among reservoirs)	Slightly adverse	No change to slightly beneficial	Slightly beneficial	Slightly adverse	No change to slightly beneficial
Sport fish – mainstem reservoirs	No change Communities would continue to vary based on environmental conditions	No change to slightly adverse	No change to slightly adverse	No change to slightly beneficial	Slightly adverse	No change to slightly beneficial	No change to slightly adverse	Adverse (Lower DO, therefore less available habitat)	Slightly adverse
Sport fish – warm tailwaters	No change Communities would continue to vary based on environmental conditions	No change	No change to slightly beneficial	Slightly beneficial	Slightly adverse to slightly beneficial (Effects vary among reservoirs)	No change	No change to slightly beneficial	Slightly adverse to slightly beneficial (Effects vary among reservoirs)	Slightly adverse to slightly beneficial (Effects vary among reservoirs)
Sport fish – cool-to-warm tailwaters	No change Improvements would continue due to RRI initiatives; warm-water species would continue to be limited	Slightly beneficial to slightly adverse	Slightly beneficial to slightly adverse	Slightly beneficial	Slightly beneficial to slightly adverse	No change	Slightly beneficial to slightly adverse	Slightly beneficial to slightly adverse	Slightly beneficial to slightly adverse

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Aquatic Resources (continued)									
Sport fish – cool/cold tailwaters	No change Improvements would continue due to RRI initiatives	Slightly adverse	Slightly adverse	Adverse (Water temperatures would be higher in tributary reservoirs due to less cold water storage in late summer)	Slightly adverse	No change	Slightly adverse	Adverse (Increased hours with temperatures greater than 20°C)	Slightly beneficial
Commercial fisheries – reservoirs	No change Communities would continue to vary based on environmental conditions	Adverse (Increase in volume of water with poor water quality due to delayed summer drawdown)	Adverse (Increase in volume of water with poor water quality due to delayed summer drawdown)	Beneficial (Increase of flow through mainstem reservoirs, which would increase water quality)	Slightly adverse to adverse (Increase in yearly volumes of water with low DO)	No change	Adverse (Increase in volume of water with poor water quality due to delayed summer drawdown)	Adverse (Increased volume of water with low DO in mainstem reservoirs)	Slightly adverse to slightly beneficial (Effects vary among reservoirs)
Wetlands									
Location	No change Wetland extent and distribution are expected to follow existing trends	No change to slightly beneficial	Slightly beneficial	Substantially adverse (Less water would be available during the growing season for wetlands)	Substantially adverse (Less water would be available during the growing season for wetlands on tributary reservoirs)	No change	Slightly beneficial	No change to slightly beneficial	No change to slightly beneficial

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Wetlands (continued)									
Type	No change Shifts in wetland types are expected to follow existing trends	Slightly adverse	Adverse (Changes in the timing of the presence of water would adversely affect flats, scrub/shrub, and forested wetlands)	Substantially adverse (Changes in the timing of the presence of water would adversely affect all wetland types)	Substantially adverse (Changes in the timing of the presence of water would adversely affect all wetland types)	Slightly adverse	Adverse (Changes in the timing of the presence of water would adversely affect flats, scrub/shrub, and forested wetlands)	Slightly adverse	Slightly adverse
Function	No change Slow decline in wetland functions are expected to continue	Slightly adverse	Adverse (Changes in wetland types would cause a moderate decrease in wetland functions)	Substantially adverse (Changes in water regimes and wetland types would cause a major decrease in wetland functions)	Substantially adverse (Changes in water regimes and wetland types would cause a major decrease in wetland functions)	No change	Adverse (Changes in wetland types would cause a moderate decrease in wetland functions)	Slightly adverse	Slightly adverse
Aquatic Plants									
Tributary reservoirs	No change Aquatic plant coverage would continue to increase or decrease based on hydrologic and climatic events	Slight increase	Slight increase	Slight decrease	Slight increase to slight decrease (Effects vary slightly among reservoirs and years)	No change	Slight increase	Slight increase	Slight increase

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Aquatic Plants (continued)									
Mainstem reservoirs	No change Aquatic plant coverage would continue to increase or decrease based on hydrologic and climatic events	No change	No change	Substantial decrease (Large reduction of aquatic plants in upper portion of drawdown zone)	Slight decrease	No change	No change	No change	No change
Population abundance and spread of invasive emergent plants [3]	No change Emergent invasive plants would continue to increase or decrease based on natural fluctuation associated with hydrologic and climatic events	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly adverse	No change	Slightly adverse	Slightly adverse	Slightly adverse
Terrestrial Ecology									
Upland and lowland plant communities	No change Plant communities would continue to increase in biomass and biodiversity through natural succession	Adverse (Loss of bottomland hardwood communities from extended summer pool and higher winter pool)	Adverse (Loss of bottomland hardwood communities from extended summer pool and higher winter pool)	Substantially adverse (Loss of wetland plant communities due to early drawdown of summer pool and higher winter pool)	Adverse (Loss of lowland plant communities from extended summer pool and higher winter pool)	Adverse (Loss of bottomland hardwood communities from higher winter pool)	Adverse (Loss of bottomland hardwood communities from extended summer pool and higher winter pool)	Adverse (Loss of lowland plant communities from extended summer pool and higher winter pool)	Slightly adverse to adverse (Loss of bottomland hardwood communities from extended summer pool)

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Terrestrial Ecology (continued)									
Migratory shorebirds and waterfowl	No change Flats would continue to be exposed during late summer	Adverse (Flats not exposed during late summer, resulting in loss of feeding habitat)	Adverse (Flats not exposed during late summer, resulting in loss of feeding habitat)	Substantially adverse (Extent of flats would be altered throughout TVA system)	Adverse (Flats not exposed during late summer, resulting in loss of feeding habitat)	Slightly adverse	Adverse (Flats not exposed during late summer, resulting in loss of feeding habitat)	Adverse (Flats not exposed during late summer, resulting in loss of feeding habitat)	Slightly adverse
Wildlife	No change Areas used by wildlife would continue to be available	Slightly beneficial to adverse (Slight increases in aquatic beds would benefit wildlife; changes in wetland communities would adversely affect various species of wildlife)	Slightly beneficial to adverse (Slight increases in aquatic beds would benefit wildlife; changes in wetland communities would adversely affect various species of wildlife)	Adverse (Loss in variety of lowland habitats)	Slightly beneficial to adverse (Slight increases in aquatic beds would benefit wildlife; loss of flats would adversely affect waterfowl and other species of wildlife)	No change to slightly adverse	Slightly beneficial to adverse (Slight increases in aquatic beds would benefit wildlife; changes in wetland communities would adversely affect various species of wildlife)	Slightly beneficial to slightly adverse	Slightly beneficial to slightly adverse
Invasive Plants and Animals									
Population abundance and spread of invasive species [4]	No change Present trends relative to rate of establish-ment and spread would continue	No change	No change	Slightly adverse	No change	No change	No change	No change	No change

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Vector (Mosquito) Control									
Population abundance	No change to the number of days mosquito breeding habitat would be present	Adverse (Increase in the number of days mosquito breeding habitat would be present)	Adverse (Increase in the number of days mosquito breeding habitat would be present)	Beneficial (Reduction in mosquito breeding habitat)	Slightly adverse	No change	Adverse (Increase in the number of days mosquito breeding habitat would be present)	Adverse (Increase in the number of days mosquito breeding habitat would be present)	Adverse (Increase in the number of days mosquito breeding habitat would be present)
Threatened and Endangered Species									
Flowing-water mainstem reservoirs and tailwaters	No change Continuation of existing trends could lead to eventual loss of some mussel species	Slightly beneficial	Slightly beneficial	Beneficial (Probably higher flows and DO levels)	No change	Beneficial (Higher minimum water levels on most tailwaters)	Beneficial (Higher minimum water levels on tailwaters)	Variable (Higher minimum water levels on tailwaters, larger volume of low DO water, longer time of low DO dis-charges at one dam)	No change

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Threatened and Endangered Species (continued)									
Flowing-water tributary reservoirs and tailwaters	No change Continuation of existing trends would include increasing diversity and reintroduction of protected species	Variable (Less natural water temperatures in some tailwaters, more natural in others, less late summer temperature variation in some tailwaters)	Variable (Less natural water temperatures in some tailwaters, more natural in others, less late summer temperature variation in some tailwaters)	Adverse (Probably more variable summer flows and water temperatures)	Beneficial (Less variation in June flow rates and less late summer temperature variation in some tailwaters, more natural summer water temperatures in most tailwaters)	Slightly beneficial	Variable (Less natural water temperatures in some tailwaters, more natural in others; less late summer temperature variation in some tailwaters)	Beneficial (Less variation in June flow rates and less late summer temperature variation in some tailwaters, more natural summer water temperatures in most tailwaters)	Few changes from Base Case (Less natural water temperatures in some tailwaters, more natural in others)
Shorelines and lowland habitats	No change Continuation of existing trends would include the gradual loss of habitats and species populations	Slightly adverse	Slightly adverse	Adverse (Unreplaced loss of wetland habitats due to shorter duration of summer pool levels)	Adverse (Unreplaced loss of wetland habitats due to frequent changes in pool levels)	Slightly beneficial	Slightly adverse	Adverse (Unreplaced loss of scrub/shrub habitats due to higher summer pool levels)	Slightly adverse
Upland habitats	No change Existing trends would continue	No change	No change	No change	No change	No change	No change	No change	No change
Apalachia Bypass reach	No change Existing trends would continue	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Threatened and Endangered Species (continued)									
Wide-ranging species	No change Existing trends would continue	Slightly beneficial	Slightly beneficial	Adverse (Potential adverse effects to gray bats)	No change	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Reservoir inflow areas	No change Existing trends would continue	No change	No change	No change	No change	No change	No change	No change	No change
Cave aquifers	No change Existing trends would continue	No change	No change	No change	No change	No change	No change	No change	No change
Managed Areas and Ecologically Significant Sites									
Integrity of sites	No change Continued difficulty in protecting integrity of bottomland hardwoods and some aquatic endangered species sites	Slightly adverse to slightly beneficial	Slightly adverse	Adverse (Shifts or losses in wetlands type and function)	Adverse (Shifts or losses in waterfowl subimpound-ments, flats, scrub/shrub, and forested wet-lands, and some asso-ciated wildlife; slight benefits to some wildlife on tributary reservoirs)	Slightly adverse to slightly beneficial	Slightly adverse	Slightly adverse to slightly beneficial	Slightly adverse to slightly beneficial
Land Use									
Indirect effect on natural condition	No change Projected rate of shoreline residential development would continue	Slightly adverse	Slightly adverse	Slightly beneficial	No change to slightly beneficial	No change	Slightly adverse	No change to slightly adverse	Slightly adverse

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Shoreline Erosion									
Reservoir effects	No change Shoreline erosion would continue at existing rates	Adverse (Longer reservoir pool durations at summer levels and increased recreational boating would increase reservoir shoreline erosion)	Adverse (Longer reservoir pool durations at summer levels and increased recreational boating would increase existing erosion)	Beneficial (Shorter reservoir pool durations at summer levels and decreased recreational boating would decrease existing erosion)	Beneficial (Shorter reservoir pool durations at summer levels and higher winter pools would reduce reservoir shoreline erosion)	No change	Adverse (Longer reservoir pool durations at summer levels and increased recreational boating would increase reservoir shoreline erosion)	Substantially adverse (Substantially longer reservoir pool durations at summer levels and increased recreational boating would increase existing erosion)	Slightly adverse
Tailwater effects	No change Bank erosion would continue at existing rates	No change	No change	No change	No change	No change	No change	No change	No change
Prime Farmland									
Conversion of prime farmland	No change Current conversion rates would continue	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly beneficial	No change	Slightly adverse	Slightly adverse	Slightly adverse

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Cultural Resources									
Indirect effects	No change Impacts would continue at existing rates due to land development	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly beneficial	No change	Slightly adverse	Slightly adverse	Slightly adverse
Direct effects	No change Impacts would continue at existing rates due mainly to erosion	Adverse (Increase in shoreline erosion)	Adverse (Increase in shoreline erosion)	Beneficial (Decrease in shoreline erosion)	Beneficial (Decrease in shoreline erosion)	No change	Adverse (Increase in shoreline erosion)	Substantially adverse (Substantial increase in shoreline erosion)	Slightly adverse
Visual Resources									
Scenic integrity	No change Scenic integrity would remain as presently exists	Beneficial (Overall, less fluctuation and longer duration at higher pool elevations)	Substantially beneficial (Overall, longer duration of higher pool elevations and less fluctuation compared to Reservoir Recreation A)	Adverse (Overall reduction in duration of higher pool elevations)	Slightly adverse	Slightly beneficial	Substantially beneficial (Overall, longer duration of higher pool elevations and less fluctuation compared to Reservoir Recreation A)	Substantially beneficial (Overall, longest duration of higher pool elevations and less fluctuation in pool levels)	Substantially beneficial (Overall, tributary reservoirs would have less fluctuation and longer duration at higher pool elevations)
Dam Safety									
Reservoir-induced seismicity	No change in existing conditions	No change	No change	No change	No change	No change	No change	No change	No change
Leakage	No change in existing conditions	No change	No change	No change	No change	No change	No change	No change	No change
Design flood maximum reservoir levels	No change in existing conditions	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	No change	Slightly adverse	Slightly adverse	Slightly adverse

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Navigation									
Change in annual shipper savings [5]	No change Regional shipper savings of approximately $378 million are expected to increase to $597 million by 2030	No change $0	No change $0	Slightly adverse (Losses range from $11 million in 2004 to over $17 million in 2030)	Slightly adverse (Losses range from $1 million in 2004 to $1.9 million in 2030)	Slightly beneficial (Savings of $15 million in 2004 to $24 million in 2030)	No change $0	No change $0	Slightly beneficial (Savings of $2.4 million in 2004 to $3.8 million in 2030)
Flood Control									
Peak discharge–historical inflows	No change in existing conditions	Adverse (Increase in peak discharge)	Substantially adverse (Substantial increase in peak discharge)	Adverse (Increase in peak discharge)	No change	Adverse (Increase in peak discharge)	Substantially adverse (Substantial increase in peak discharge)	Substantially adverse (Substantial increase in peak discharge)	No change
Peak discharge–design storms	No change in existing conditions	Adverse (Increase in peak discharge)	Substantially adverse (Substantial increase in peak discharge)	Adverse (Increase in peak discharge)	No change	Adverse (Increase in peak discharge)	Substantially adverse (Substantial increase in peak discharge)	Substantially adverse (Substantial increase in peak discharge)	No change
Potential damage	No change in average annual flood related damages of approximately $1,460,000	Adverse (29% increase in total average annual damages)	Substantially adverse (49% increase in total average annual damages)	Adverse (Approximately 25% increase in total average annual damages)	No change (3% increase in total average annual damages)	Adverse (37% increase in total average annual damages)	Substantially adverse (Approximately 40% increase in total average annual damages)	Substantially adverse (44% increase in total average annual damages)	No change (6% decrease in total average annual damages)

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Power									
Change in annual power cost [5]	No change Annual power supply costs would continue as projected in the 2003 forecast	Slightly adverse Increase cost of $30 million	Slightly adverse Increase cost of $67 million	No change to slightly adverse Increase cost of $3 million	Slightly adverse Increase cost of $108 million	Slightly beneficial Decrease cost of $11 million	Slightly adverse Increase cost of $66 million	Adverse Increase cost of $295 million	Slightly adverse Increase cost of $14 million
Recreation [5, 6]									
Change in annual recreation spending	No change Expenditure of $65 million	Slightly beneficial Increase of $11 million	Slightly beneficial Increase of $14 million	Slightly adverse Decrease of $10 million	Slightly beneficial Increase of $1 million	Slightly adverse Decrease of $1 million	Slightly beneficial Increase of $14 million	Slightly beneficial Increase of $13 million	Slightly beneficial Increase of $9 million
Public access site use in reservoirs	No change Total use August through October is 670,000 user days	Slightly beneficial (Increase of ~21,000 user days [3%])	Slightly beneficial (Increase of ~40,000 user days [6%])	Slightly adverse (Decrease of ~15,000 user days [-2%])	No change (Decrease of 3,000 user days [-0.5%])	No change (Decrease of 1,000 user days [-0.1%])	Slightly beneficial (Increase of ~40,000 user days [5.9%])	Slightly beneficial (Increase of ~40,000 user days [5.9%])	Slightly beneficial (increase of 19,000 user days [2.8%])
Public access site use in tailwaters	No change Total use August through October is 200,000 user days	No change (Increase of approximately 1,000 user days [0.5%])	Slightly beneficial (increase of approximately 5,000 user days [3.0%])	Slightly adverse (Decrease of approximately 10,000 user days [-5.0%])	Slightly adverse (Decrease of approximately 11,000 user days [-5.5%])	No change (Decrease of less than 300 user days [-0.1%])	Slightly beneficial (Increase of ~5,000 user days [2.5%])	No change (Increase of 300 user days [-0.1])	No change Increase of 1,000 user days [0.6%])
Commercial site use [7]	No change Total use August through October is 3,800,000 user days	Slightly beneficial (Increase of ~150,000 user days [4.0%])	Slightly beneficial (Increase of ~250,000 user days [7.0%])	Slightly adverse (Decrease of ~120,000 user days [-3.0%])	Slightly beneficial Increase of 47,000 user days [1.2%])	No change (Increase of 3,000 user days [0.1%])	Slightly beneficial (Increase of ~250,000 user days [7.0%])	Slightly beneficial (Increase of ~250,000 user days [7.0%])	Slightly beneficial (Increase of 110,000 user days [2.8%])

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Recreation (continued)									
Private access site use	No change Total use August through October is 1,850,000 user days	Substantially beneficial (Increase of ~1,100,000 user days [63%])	Substantially beneficial (Increase of ~1,200,000 user days [67%])	Substantially adverse (Decrease of ~1,100,000 user days [-61%])	Beneficial (Increase of 210,000 user days [11%])	Slightly adverse (Decrease of 120,000 user days [-6%])	Substantially beneficial (Increase of ~1,200,000 user days [67%])	Substantially beneficial (Increase of ~1,100,000 user days [61%])	Substantially beneficial (Increase of 1,040,000 user days [56%])
Social and Economic Resources									
Gross regional product	No change in forecasted GRP	Slightly adverse ($13.6 million decrease in GRP)	Slightly adverse ($32.5 million decrease in GRP)	Slightly adverse ($43.2 million decrease in GRP)	Slightly adverse ($76.5 million decrease in GRP)	Slightly beneficial ($54.0 million increase in GRP)	Slightly adverse ($30.8 million decrease in GRP)	Adverse ($160.8 million decrease in GRP)	Slightly adverse ($6.0 million decrease in GRP)
Personal income	No change in forecasted personal income	Slightly adverse ($4.4 million decrease in PI)	Slightly adverse ($11.5 million decrease in PI)	Slightly adverse ($14.6 million decrease in PI)	Slightly adverse ($31.1 million decrease in PI)	Slightly beneficial ($15.8 million increase in PI)	Slightly adverse ($10.9 million decrease in PI)	Adverse ($63.7 million decrease in PI)	Slightly adverse ($1.9 million decrease in PI)
Employment	No change in forecasted regional employment	Slightly adverse (Decrease of 43 workers)	Slightly adverse (Decrease of 220 workers)	Slightly adverse (Decrease of 413 workers)	Slightly adverse (Decrease of 745 workers)	Slightly beneficial (Increase of 408 workers)	Slightly adverse (Decrease of 201 workers)	Adverse (Decrease of 1,522 workers)	No change (Estimated increase of 2 workers)
Population	No change in forecasted regional population	Slightly adverse (408 residents leaving the region)	Slightly adverse (769 residents leaving the region)	Slightly adverse (372 residents leaving the region)	Slightly adverse (1,571 residents leaving the region)	Slightly beneficial (In-migration of 405 residents)	Slightly adverse (745 residents leaving the region)	Adverse (3,518 residents leaving the region)	Slightly adverse (191 residents leaving the region)

Table ES-03 Summary of Impacts by Policy Alternative (continued)

Notes:

Brackets indicate negative values.

CO = Carbon monoxide
CO_2 = Carbon dioxide.
DO = Dissolved oxygen.
GRP = Gross regional product.
Hg = Mercury.
HPA = Habitat protection area.
mg/L = Milligrams per liter.
NOx = Nitrogen oxides
NWR = National wildlife refuge.
PI = Personal income.
RRI = Reservoir Release Improvement Program.
SO2 = Sulfur dioxide.
VOCs = Volatile organic compounds.

[1] Transitional reservoirs are so categorized because they are unique cases that do not include all of the general characteristics of mainstem or tributary reservoirs described in Section 3.5. They include Boone, Fort Patrick Henry, Tellico, Apalachia, and Melton Hill Reservoirs.

[2] Cold-water tailwaters are not included because resident communities are minimal due to the cold-water releases, and no alternative would change this general condition.

[3] A change in coverage includes either an increase or a decrease in the number of plant acres. Changes can be seen as adverse or beneficial, depending on the reader's perspective.

[4] Terrestrial plants and animals and aquatic animals.

[5] Projected costs in 2010 stated in 2002 dollars; indicative of trends.

[6] Impacts are reported for the months of August, September, and October—the months for which the recreation analysis was completed.

[7] Commercial whitewater rafting activity on Ocoee # 2 and Ocoee # 3 is considered in this summary. Under the Summer Hydropower Alternatives and the Tailwater Habitat Alternative, commercial whitewater releases would be suspended on Ocoee # 3. For purposes of this summary, it was assumed that this would result in the closure of commercial whitewater activities on Ocoee #3

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List of Acronyms

AHPA	Archaeological and Historic Preservation Act
ALIS	Automated Land Information Systems
AQRV	air quality-related values
APE	area of potential effect
ARPA	Archeological Resources Protection Act
BIBI	Benthic Index of Biotic Integrity
BMPs	best management practices
Board	TVA Board of Directors
CAA	Clean Air Act
CEQ	Council on Environmental Quality
cfs	cubic feet per second
CO	carbon monoxide
CO_2	carbon dioxide
CWA	Clean Water Act
CWIS	cooling water intake structures
DBPs	disinfection by-products
DEIS	Draft Environmental Impact Statement
DO	dissolved oxygen
DOM	dissolved organic matter
EA	Environmental Assessment
EIS	Environmental Impact Statement
ELCP	Emergency Load Curtailment Plan
ESA	Endangered Species Act
FEIS	Final Programmatic Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FPPA	Farmland Protection and Policy Act
GDP	gross domestic product
GIS	geographic information system
GRP	gross regional product
ha	hectares
HAP	hazardous air pollutant
HMOD	hydro modernization
HPA	habitat protection area
IAT	Interagency Team
IAT/PRG	Interagency Team and Public Review Group
IBI	Index of Biotic Integrity
IBT	inter-basin transfer

List of Acronyms (continued)

IDF	inflow design flood
LMP	Land Management Plan
LOLP	loss of load probability
m	meter
Mg/L	milligrams per liter
mgd	million gallons per day
MOG	Minimum Operations Guide
MPF	maximum probable flood
MW	megawatt
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Council
NFIP	National Flood Insurance Program
NFMA	National Forest Management Act
NHPA	National Historic Preservation Act
NO_2	nitrogen dioxide
NOM	natural organic material
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
NWR	national wildlife refuge
NWS	National Weather Service
O_3	ozone
Pb	lead
PCBs	polychlorinated biphenyls
PI	personal income
$PM_{2.5}$	particulate matter whose particles are $\leq$ 2.5 micrometers
PM_{10}	particulate matter whose particles are $\leq$ 10 micrometers
PMF	probable maximum flood
PPS	Population Protection Planning Site
PRG	Public Review Group
RED	Regional Economic Development
REITS	real estate investment trusts
REMI	Regional Economic Model, Inc
RFAI	Reservoir Fisheries Assemblage Index
ROS	Reservoir Operations Study

List of Acronyms (continued)

RRI	Reservoir Release Improvement
RTS	reservoir-triggered seismicity
SAHI	Shoreline Aquatic Habitat Index
SAMI	Southern Appalachian Mountains Initiative
SERC	Southeastern Electric Reliability Council
SFI	Sport Fish Index
SFRA	Southern Forest Resource Assessment
SHPO	State Historic Preservation Officer
SIP	state implementation plan
SMI	Shoreline Management Initiative
SMP	Shoreline Management Policy
SMS	Scenery Management System
SO_2	sulfur dioxide
TDEC	Tennessee Department of Environment and Conservation
The Board	TVA Board of Directors
Valley	Tennessee River Valley
TMDL	total maximum daily load
TOC	total organic carbon
TRI	Toxics Release Inventory
TRM	Tennessee River Mile
TSP	total suspended particulates
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compound
WMA	wildlife management area
WSM	Weekly Scheduling Model

Metric Conversion Chart

Metric to U.S. Customary

Multiply	By	To Obtain
Millimeters (mm)	0.03937	Inches
Centimeters (cm)	0.3937	Inches
Meters (m)	3.281	Feet
Kilometers (km)	0.6214	Miles
Square meters (m^2)	10.76	Square feet
Square kilometers (km^2)	0.3861	Square miles
Hectares (ha)	2.471	Acres
Liters (l)	0.2642	Gallons
Cubic meters (m^3)	35.31	Cubic feet
Cubic meters	0.0008110	Acre-feet
Milligrams (mg)	0.00003527	Ounces
Grams (g)	0.03527	Ounces
Kilograms (kg)	2.205	Pounds
Metric tons (t)	2205.0	Pounds
Metric tons	1.102	Short tons
Kilocalories (kcal)	3.968	BTU
Celsius degrees	1.8(°C) +32	Fahrenheit degrees

U.S. Customary to Metric

Multiply	By	To Obtain
Inches	25.40	Millimeters
Inches	2.54	Centimeters
Feet (ft)	0.3048	Meters
Fathoms	1.829	Meters
Miles (mi)	1.609	Kilometers
Nautical miles (nmi)	1.852	Kilometers
Square feet (ft^2)	0.0929	Square meters
Acres	0.4047	Hectares
Square miles (mi^2)	2.590	Square kilometers
Gallons (gal)	3.785	Liters
Cubic feet (ft^3)	0.02831	Cubic meters
Acre-feet	1233.0	Cubic meters
Ounces (oz)	28.35	Grams
Pounds (lb)	0.4536	Kilograms
Short tons (ton)	0.9072	Metric tons
British thermal units (BTU)	0.2520	Kilocalories
Fahrenheit degrees	0.5556 (°F –32)	Celsius degrees

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Chapter 1

Introduction

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1.1 Introduction

The Tennessee Valley Authority (TVA) is a multipurpose federal corporation responsible for managing a range of programs in the Tennessee River Valley (the Valley) for the use, conservation, and development of the water resources related to the Tennessee River. In carrying out this mission, TVA operates a system of dams and reservoirs with associated facilities—its water control system (Figure 1.1-01). As directed by the TVA Act, TVA uses this system to manage the water resources of the Tennessee River for the purposes of navigation, flood control, power production and, consistent with those purposes, for a wide range of other public benefits.

TVA RESERVOIR SYSTEM OPERATING OBJECTIVES

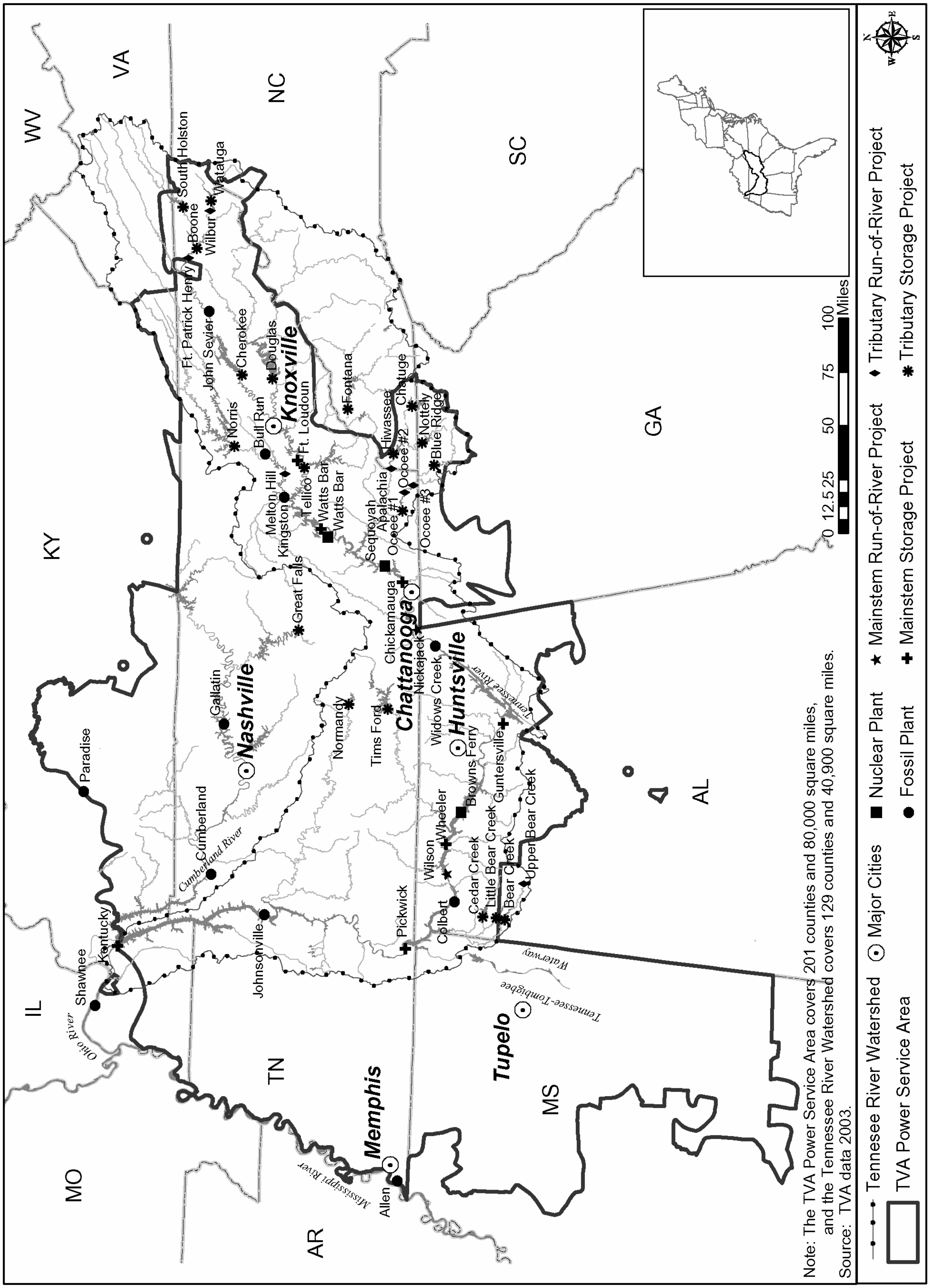
- Navigation
- Flood control
- Power production
- Water supply
- Water quality
- Recreation
- Other objectives

TVA generates and distributes electric power to customers within its Power Service Area. The water control system has hydroelectric generators and provides the cooling water supply for TVA's coal-fired and nuclear power plants located adjacent to TVA reservoirs. TVA's power system and its management of water resources are central components of sustainable economic development in the Valley and TVA Power Service Area.

TVA also has custody of and manages approximately 293,000 acres of land in the Valley, most of which is along the shorelines of TVA reservoirs. TVA has established policies for the development of reservoir shorelines and adjacent TVA lands (see Section 1.8). Development and management of these lands and activities are influenced by reservoir levels and river flows.

TVA's reservoir operations policy guides the day-to-day operation of its water control system. The reservoir operations policy sets the balance of trade-offs among competing uses of the water in the system.

TVA has periodically evaluated the reservoir operations policy to respond to the values expressed by the public. The last examination of the policy culminated in the issuance of TVA's Lake Improvement Plan in December 1990 (the Tennessee River and Reservoir System Operation and Planning Review). TVA now is completing a comprehensive study of its reservoir operations policy, the Reservoir Operations Study (ROS), to determine whether changes in the policy could produce greater overall public value. With considerable involvement and advice from the public and interested federal and state agencies, TVA staff analyzed and reviewed a wide range of policy alternatives for its water control system. Staff is recommending appropriate changes in the reservoir operations policy to the TVA Board of Directors (the Board). A decision by the Board to change the reservoir operations policy would affect the operation of TVA's water control system and would modify the present balance among the various operating objectives.



Note: The TVA Power Service Area covers 201 counties and 80,000 square miles, and the Tennessee River Watershed covers 129 counties and 40,900 square miles.
Source: TVA data 2003.

Figure 1.1-01 Tennessee River Watershed and TVA Power Service Area

TVA prepared this Final Programmatic Environmental Impact Statement (FEIS) in accordance with the Council on Environmental Quality (CEQ) regulations and TVA's own procedures for implementing the National Environmental Policy Act (NEPA). The U.S. Army Corps of Engineers (USACE) and the U.S. Fish and Wildlife Service (USFWS) were cooperating agencies in the preparation of this EIS. As the lead agency in this effort, TVA was primarily responsible for ensuring opportunities for stakeholder participation, EIS content, and compliance with all aspects of NEPA and other applicable statutes and implementing regulations.

According to the CEQ, a programmatic EIS is appropriate when a decision involves a policy or program, or a series of related actions by an agency over a broad geographic area. This programmatic EIS summarizes the results of the ROS, the public involvement process, the development and evaluation of policy alternatives, and the potential impacts of those alterations on the natural and human environment. The ROS is integrated into this FEIS and is not a separate report. Distribution of the Draft EIS (DEIS) afforded the public, governmental agencies, and non-governmental organizations opportunity for review and comment prior to TVA staff making a recommendation to the Board.

1.2 Purpose and Need

The specific purpose of the ROS is to enable TVA to review and evaluate its reservoir operations policy to determine whether changes in the policy would produce greater public value. TVA's reservoir operations policy affects how much reservoir levels rise and fall, when changes in reservoir levels occur, and the amount of water flowing through the reservoir system at different times of the year.

Changes in TVA's reservoir operations policy would modify the present balance among the various operating objectives for the system in response to changing public values. The final result of the ROS is a set of recommendations developed by TVA staff in this FEIS and a subsequent decision by the Board, possibly establishing a new reservoir operations policy. Implementing a new reservoir operations policy would involve changing the existing reservoir system operating guidelines. The Board's decision will be documented in a Record of Decision. In addition, because TVA receives no appropriations (money) from Congress, changes to operations that require additional capital or operating expenditures would need to be funded by either TVA or others.

1.3 Scope of the ROS

TVA owns or operates 49 dams and reservoirs (called projects) within the Tennessee River and Cumberland River watersheds. The scope of the ROS included evaluating the operations of 35 of these projects—projects for which TVA schedules water releases and reservoir levels in accordance with its reservoir operations policy (Figure 1.1-01). The projects not included in the ROS are one pumped storage project and several small water retention dams that are essentially self-regulating. These projects have little impact on the operation of TVA's water control system.

In addition, physical removal of or major structural modifications to TVA dams and power plants is not included in the scope of this EIS.

The geographic area potentially affected by changes in the reservoir operations policy includes the Tennessee River watershed and the larger TVA Power Service Area (Figure 1.1-01). This area covers almost all of Tennessee and parts of Alabama, Kentucky, Georgia, Mississippi, North Carolina, and Virginia. The Tennessee River watershed includes 129 counties and encompasses 40,900 square miles; TVA's Power Service Area comprises 201 counties and covers approximately 80,000 square miles. Analyses of some resource areas (e.g., navigation) included parts of the Ohio and Mississippi River systems that are outside the Valley. Other resource evaluations (e.g., air quality) included areas outside the TVA Power Service Area to ensure a comprehensive analysis.

KEY TERMS

The System—The TVA water control system (also referred to as the reservoir system) is a series of interconnected dams and reservoirs on the Tennessee River and its tributaries. Many of the dams include hydropower generation facilities and locks for navigation.

Operation of the System—TVA controls water storage in each reservoir and the flow of water from one reservoir to another, in response to changing rainfall and runoff.

Reservoir Operations Policy—This policy balances the benefits of operating objectives and is implemented through a set of operating guidelines for all reservoirs in the system.

Operating Objectives—These objectives include navigation, flood control, power production, recreation, water supply, water quality, and other benefits.

Operating Guidelines—Operation of the system is governed by a set of operating guidelines that include guide curves, minimum flow requirements, water release requirements, and other requirements to meet system operating objectives.

Policy Alternative—A reservoir operations policy alternative is a set of operational changes that would adjust the present balance among the various operating objectives for the system. A policy alternative may emphasize several operating objectives at the same time.

As is typical of water resource planning and management studies of this type, the ROS and this EIS used a long-range planning horizon (to the year 2030).

1.4 Decisions To Be Made

The Board will decide whether TVA's reservoir operations policy will be changed and the nature of the change, based on the recommendations of TVA staff. In addition to staff recommendations, the Board will consider this FEIS, public comments, and other factors. The Board will make a decision following the Notice of Availability of this FEIS and after public comments on the FEIS are considered. The final decision will be documented in a Record of Decision and made available to the public. Decisions made by other federal agencies would be appropriately documented by the respective agency.

1.5 History of Policy Changes

TVA has periodically made changes and adjustments to its reservoir operations policy in order to achieve greater overall value for the public. Past policy changes reflected factors such as the public's changing needs and concerns, requests from citizens and regional groups, environmental quality issues, changes in the power industry, and TVA's own mission and planning needs. The reservoir operations policy also reflects a growing experience and understanding of the challenges and limitations imposed by annual variations in rainfall and runoff, especially during droughts and floods.

- **1970s—Improved Reservoir System Benefits.** In the early 1970s, TVA began looking for ways to improve long-term power supply, water quality in tailwaters, aquatic habitat, and recreational opportunities without sacrificing navigation, flood control, and power production. A multiple-reservoir study completed in 1971 found that TVA could meet some of these objectives by raising minimum winter water levels at nine tributary reservoirs.

- **1980s—Reservoir Resource Reevaluation Program.** TVA began its Reservoir Resource Reevaluation Program in the early 1980s, bringing together a team of TVA specialists to review its operations and evaluate suggested changes. This was the beginning of a more formal evaluation process that involved public input. Although the program did not create broad policy changes for TVA reservoir operations, it provided a forum for external groups (e.g., state organizations and reservoir user groups) to voice their concerns and to understand the impacts of requested changes on individual reservoirs, as well as the entire TVA system.

- **1980s—Reservoir Release Improvement Evaluations.** The low availability of water during the extended drought of the 1980s affected water quantity and quality in river segments below dams. In response, TVA experimented with minimum flows to improve aquatic habitat, water quality, and waste assimilation (the process by which a river accepts wastewater). TVA developed methods to provide higher minimum flows, including turbine pulsing, reregulation weirs, and continuous releases through small turbines. TVA also began the process of evaluating and implementing methods to increase dissolved oxygen (DO) concentrations in the water released from the dams.

- **1990s—Lake Improvement Plan.** By the late 1980s, there was growing recognition that benefits beyond the operating objectives of navigation, flood control, and power production had become increasingly important to residents of the Valley. In response to public input through the NEPA process, TVA completed the Tennessee River and Reservoir System Operation and Planning Review EIS, also known as the Lake Improvement Plan (TVA 1990). In 1991, the Board approved changes to the reservoir operations policy. These changes included extending summer reservoir levels on 10 tributary reservoirs to August 1 in order to increase recreational opportunities. Consistent with the Reservoir Release Improvement (RRI) evaluations, TVA also increased minimum flow requirements for many of its mainstem and tributary projects, and began a program to increase DO concentrations in the releases from 16 TVA dams.

TVA continued to receive requests for changes to reservoir levels and other operations during implementation of the Lake Improvement Plan. As more and more users requested studies for their particular reservoir or tailwater, TVA decided that a piecemeal approach raised questions of fairness in how each reservoir would be treated. A comprehensive review was needed to examine the effects of changes in the reservoir operations policy on system performance (in terms of benefits produced) and on system-wide costs.

In March 1997, TVA established a 4-year moratorium on making any new changes in reservoir operations. This action was taken to allow the agency time to deal with the uncertainty of deregulation of electric utilities and to develop the analytical tools and methodologies for evaluating and explaining the benefits ascribed to reservoir operations changes, particularly in the area of flood risk in the Tennessee River watershed. In July 1998, an internal TVA task force report recommended that TVA continue its moratorium and, in the next 2 to 4 years, begin a system-wide evaluation of policies that would affect reservoir levels. The task force also noted the complexities involved in carrying out such a study and identified several areas requiring further attention, including a proactive communication plan with the public and better evaluation methodologies for costs and benefits. This EIS fully addresses those recommendations.

1.6 Scoping Process

NEPA regulations require an early and open process for deciding what should be discussed in the EIS document—known as the scope of the evaluation. The scoping process involves requesting and using comments from the public and interested agencies to help identify the issues and alternatives that should be addressed in the EIS, and the temporal and geographic coverage of the study.

Consistent with NEPA requirements, the ROS process and this EIS were designed to be responsive to the values, comments, and input of the public and other governmental and non-governmental organizations. The objectives of the ROS and this EIS included, but were not limited to:

- Identifying public issues, concerns, and values regarding the reservoir system;
- Using public input to shape reservoir operations policy alternatives;
- Identifying key objectives and options for formulating and evaluating reservoir operations policy alternatives;
- Identifying the social, economic, and environmental factors to be considered in formulating policy alternatives;
- Developing and analyzing policy alternatives;
- Explaining the potential environmental and socioeconomic effects of the policy alternatives to the year 2030; and,
- Providing opportunities for the public to actively participate in this process.

In July 2002, TVA issued a report entitled Reservoir Operations Study Environmental Impact Statement Scoping Document, which is summarized in the following sections.

1.6.1 Public Involvement

At the beginning of the NEPA process, citizens were asked to help TVA define the scope of the planned evaluation. Scoping began in January 2002, when TVA mailed letters describing the ROS to more than 60,000 stakeholders across the Tennessee River Valley and Power Service Area, including representatives of agencies and Indian tribes that might be affected or interested. On February 25, 2002, TVA published a Notice of Intent in the Federal Register that described the agency's plans to prepare a programmatic EIS and invited interested parties to comment on its scope.

TVA also established two groups—an Interagency Team (IAT) and a 13-member Public Review Group (PRG) —to ensure that other agencies and members of the public were actively and continuously involved throughout the study. The IAT included representatives from 11 federal agencies and six Valley states. Members of the PRG represented reservoir user groups, white–water interests, local governments, local utilities and utility districts, industry, river advocates, fishery interest groups, academia, and other special interests. Several meetings were held with members of the joint IAT/PRG groups during the scoping process. Additional meetings with the joint IAT/PRG groups were held throughout the course of the study and preparation of this EIS.

TVA reviewed input from technical experts and management staff, and from groups such as the Regional Resource Stewardship Council and individuals of the IAT/PRG. TVA then held 21 community workshops between March 21 and April 18 that were attended by more than 1,300 people (Table 1.6-01). During each workshop, TVA staff distributed informational brochures and other materials, and answered questions about the ROS, the EIS process, and related environmental and operational issues.

TVA also sought feedback by mail, e-mail, fax, telephone, and computer polling. The agency received more than 6,000 individual comments, approximately 4,200 form letters, and petitions signed by more than 5,400 people. In addition, 3,600 residents in the Power Service Area answered a random telephone survey conducted by an independent research firm. The latter survey was designed to sample a representative cross section of the populace served by TVA.

1.6.2 Results of the Scoping Process

The scoping process identified a broad range of issues and values to be addressed and alternatives to be evaluated in the ROS. Overall, the public placed a high value on recreation, a healthy environment, production of electricity, flood control, and water supply. People were also concerned with a number of other topics. After all public feedback was evaluated, TVA identified 11 major issues for evaluation (Table 1.6-02). Other issues typically addressed in NEPA reviews were also incorporated into the analysis of each policy alternative (for example, air quality, climate, groundwater resources, and other resource topics).

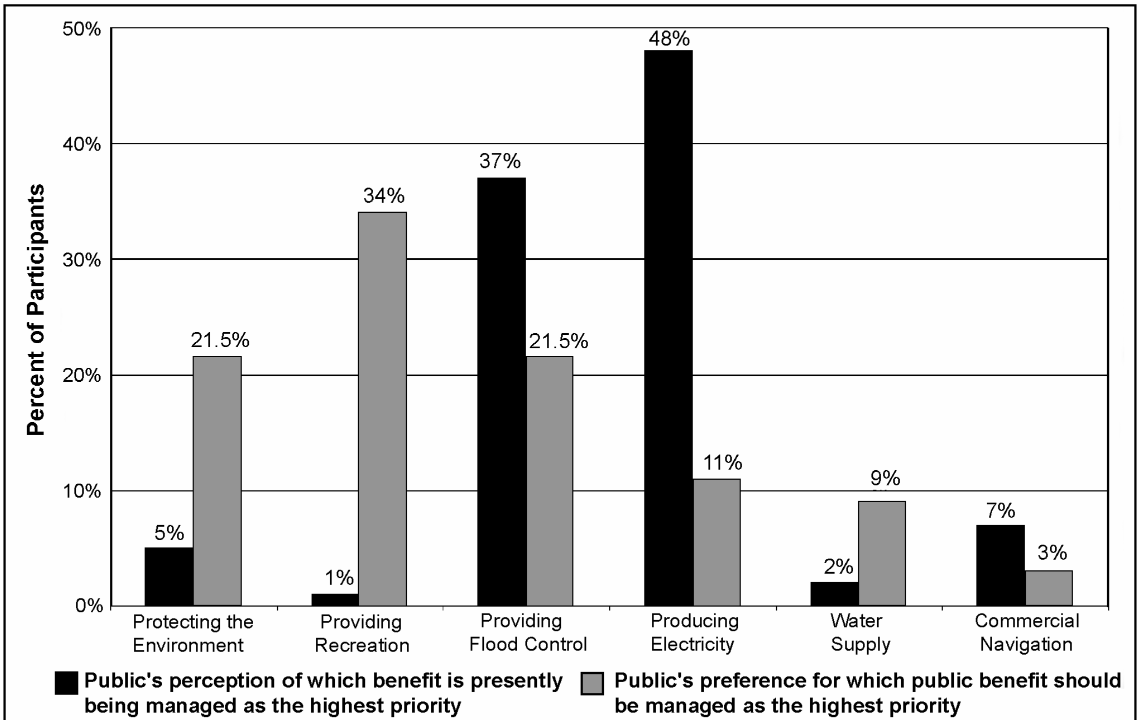
Table 1.6-01 Community Workshops Held during the Scoping Process

Date	Location	Participants Registered
Thursday, March 21, 2002	Catoosa/Walker County, Georgia	61
	Tupelo, Mississippi	13
Saturday, March 23, 2002	Murphy, North Carolina	74
	Guntersville, Alabama	45
Tuesday, April 2, 2002	Decatur, Alabama	100
	Starkville, Mississippi	7
Thursday, April 4, 2002	Paris, Tennessee	47
	Nashville, Tennessee	45
Saturday, April 6, 2002	Morristown, Tennessee	108
	Muscle Shoals, Alabama	36
Tuesday, April 9, 2002	Knoxville/Loudon County, Tennessee	28
	Chattanooga, Tennessee	96
Thursday, April 11, 2002	Blountville, Tennessee	128
	Gilbertsville, Kentucky	225
Saturday, April 13, 2002	Norris, Tennessee	28
	Savannah, Tennessee	22
Tuesday, April 16, 2002	Blairsville, Georgia	272
	Bowling Green, Kentucky	14
Thursday, April 18, 2002	Bryson City, North Carolina	57
	Memphis, Tennessee	9
	Tullahoma, Tennessee	37

Table 1.6-02 Public Feedback Provided during the Scoping Process

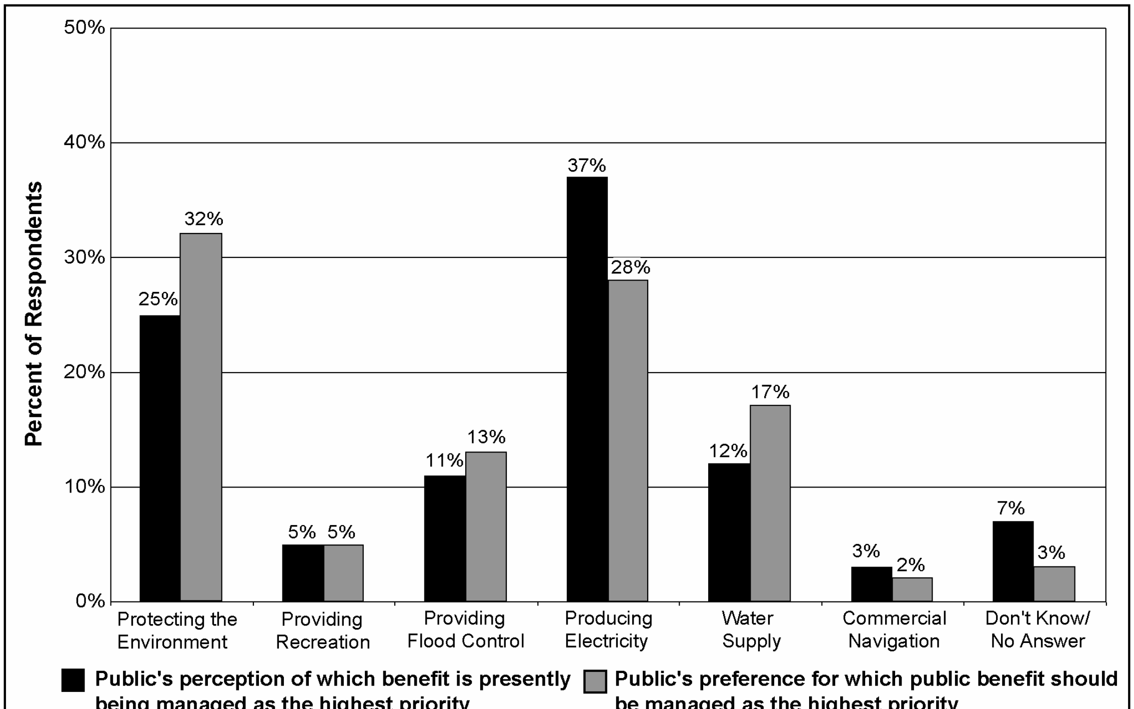
Major Issues	Concerns Expressed by the Public
Reservoir and downstream water quality	Dissolved oxygen concentrations, temperature, ammonia levels, wetted area (the area of river bottom covered by water), velocity, algae, and waste assimilation capacity
Environmental resources	Aquatic resources, erosion and sedimentation, visual resources, cultural resources, federally and state-listed species, wetlands, and ecologically significant areas
Reservoir pool levels	Reservoir pool elevations and the annual timing of fill and drawdown, and their effects on reservoir recreation, property values, and aesthetics
Recreation flows	TVA's ability to schedule releases for tailwater recreation, including fishing, rafting, canoeing, and kayaking
Economic development	Recreation, property values, navigation, power supply, and water supply
Water supply	Reservoir and downstream intakes and potential inter-basin transfers
Navigation	Impacts on channel depth, speed of currents, and water levels
Flood risk on regulated waterways	Available reservoir space for storing floodwaters, how fast space can be recovered after a flood, and costs related to property damage and jobs lost or disrupted
Power reliability	Availability of cooling water at coal-fired and nuclear plants, fuel delivery by barges for coal-fired plants, and restrictions on hydropower production during critical power demands
Cost of power	Hydropower production, including total megawatt hours, seasonal availability, and value during high-cost periods
Capital costs	Changes to reservoir operations, including modifications and upgrades to, as well as additions to and removal of, various structures and equipment

When asked to respond to the keypad question "Which of TVA's public benefits should be managed as the highest priority?" workshop participants said providing recreation (34 percent), protecting the environment (21.5 percent), and providing flood control (21.5 percent) should be the top three priorities (Figure 1.6-01). The results of the same question asked in the telephone survey are illustrated in Figure 1.6-02. Unlike the results from the workshops, the telephone survey participants said protecting the environment (32 percent), producing electricity (28 percent), and water supply (17 percent) should be the top three priorities.



Source: TVA data 2002.

Figure 1.6-01 Community Workshop Keypad Results--Comparison of the Public's Perceptions of and Preferences for TVA Management Priorities



Source: TVA data 2002.

Figure 1.6-02 Telephone Survey Results--Comparison of the Public's Perceptions of and Preferences for TVA Management Priorities

Many of those commenting, including the 5,400 individuals who signed petitions, expressed the desire for TVA to increase recreational opportunities in a variety of ways, such as:

- Holding reservoir water levels stable;
- Delaying the date at which summer reservoir water levels are lowered;
- Filling reservoirs earlier to improve fish spawning and subsequent fishing opportunities; and,
- Increasing the amount of water released from some dams for wade fishing, boat fishing, and recreational boating.

Nearly 4,000 of those commenting requested that TVA change its reservoir operations policy to protect the diversity of aquatic life and, specifically, to protect endangered, threatened, and other at-risk species. Less than 1 percent of those submitting comments expressed support for TVA to continue its existing reservoir operations policy.

OBJECTIVES IDENTIFIED DURING SCOPING FOR THE ROS EIS

- Supplying low-cost, reliable electricity
- Increasing revenue from recreation
- Reducing flood risk and flood-related damages
- Lowering the cost of transporting materials on the commercial waterway
- Providing enough water for municipal, agricultural, and industrial purposes
- Improving recreation on reservoirs and tailwaters
- Improving water quality in reservoirs and tailwaters
- Improving aquatic habitat in reservoirs and tailwaters
- Minimizing erosion of reservoir shoreline and tailwater riverbanks
- Increasing protection for threatened and endangered species
- Protecting and improving wetlands and other ecologically significant areas
- Protecting and improving the scenic beauty of the reservoirs

Objectives

To define and evaluate policy alternatives, TVA established a set of objectives that incorporates the issues that were identified by the public and interested parties during the scoping phase (Table 1.6-03). TVA also considered other objectives, such as reducing the cost of treating water for municipal and assimilation-capacity uses, maintaining existing dam safety margins, and improving air quality.

Preliminary Alternatives

On the basis of the objectives identified during scoping, 65 possible changes to the reservoir operations policy were identified and proposed. TVA technical experts worked with individuals in the IAT/PRG to refine this list into a set of operations options—specific changes to reservoir operations that could be considered in formulating alternative reservoir operations policies (Table 1.6-04). Various combinations of these options were then evaluated to develop specific policy alternatives. Chapter 3 further describes the process TVA used to develop, screen, and select a range of policy alternatives for detailed evaluation.

Table 1.6-03 Description of Objectives Identified during the Scoping Process

Objective	Summary Definition[1]
Supplying low-cost, reliable electricity	Supplying low cost, reliable electricity from the TVA system involves efficiently managing the water within the TVA reservoir system to release water as necessary to assure adequate cooling water for TVA's coal-fired and nuclear power plants that provide the majority of TVA's generation. This water management lessens the need to reduce generation at these plants during the summer and fall to maintain water quality. Reservoir releases for cooling water and other purposes are dispatched through hydropower units when it is most valuable, reducing reliance on higher cost fuels during high demand periods. Also, although hydropower provides only 10 to 15 percent of TVA's annual energy generation, the operational flexibility afforded by the hydropower units to adjust the system generation to changes in demand is critical to maintaining the stability of the power system at a low cost. Reservoir operations that enhance the ability to meet these factors result in lower cost of electricity and increased system reliability.
Increasing revenue from recreation and tourism	Reservoir levels and river flows affect the level of use and desirability for recreational uses. Managing the reservoir system for longer periods at levels more suitable and desirable for recreation—especially during high-use periods—can increase recreational use and the expenditures of users, increasing recreation and tourism revenues within the Valley economy.
Reducing flood risk and flood-related damages	Flood risk and flood-related damages within the Valley are closely related to the amount of flood storage space available within the TVA reservoir system—which is controlled by reservoir levels—especially during winter. The timing and rate of filling the mainstem reservoirs in spring can also be of particular importance. Reservoir operations that increase the available flood storage throughout the year and maintain more flood storage space through spring decrease flood risk and flood-related damage.
Lowering the cost of transporting materials on the commercial waterway	Reservoir levels and flows within the commercial waterway of the TVA system influence the depths and velocities in the navigation channel, which influence the navigability, size of barges that can used, barge travel times, and a number of factors that influence shipper costs. Reservoir operations that improve the suitability of the commercial waterway result in reduced shipper costs.
Providing enough water for municipal, agricultural, and industrial purposes	The TVA reservoir system provides the source of water for a variety of municipal, agricultural, and industrial uses. Reservoir levels and flows are important components affecting the availability of sufficient water supplies. Water levels in reservoirs and flow rates can affect conditions at the intake structures, the cost of pumping water, and other factors that affect the use of water. Reservoir operations that ensure adequate flow and reduce pumping costs result in a greater reliable supply of water.
Improving recreation on reservoirs and tailwaters	Reservoir levels and river flows affect the level of use, desirability, and quality of experience for recreational uses. Managing the reservoir system to provide longer periods at reservoir levels more suitable and desirable for recreation, especially during high-use periods, and providing flows to support greater and more desirable conditions for water-based recreation improve the quality and diversity of recreation opportunities.

Table 1.6-03 Description of Objectives Identified during the Scoping Process (continued)

Objective	Summary Definition[1]
Improving water quality in reservoirs and tailwaters	Water quality throughout the TVA system is strongly affected by reservoir system operations. Indicators of water quality include temperature, dissolved oxygen levels, and the occurrence of water quality constituents. Changes in system operation affect flows in tailwaters and the length of time that water stays in the reservoirs, affecting the probability and occurrence of unsuitable water quality conditions and overall system water quality. Management of the reservoir levels and dam releases can either improve or degrade these conditions.
Improving aquatic habitat in reservoirs and tailwaters	A variety of factors, including water quality, temperature, reservoir levels, flows, and hydraulic-habitat conditions in tailwaters, determine the quantity, quality, and diversity of aquatic habitat within the TVA reservoir system. Other important factors include the timing of changes in reservoir levels, flows during critical spawning or migration periods, severity of low oxygen conditions, and the abundance of aquatic plants. Reservoir operations that improve water quality, improve tailwater flow-habitat conditions (e.g., increased minimum flows, reduced daily flow fluctuation), or lead to improved spawning and rearing conditions result in improved aquatic habitat and an enhancement of aquatic resources.
Minimizing erosion of reservoir shoreline and tailwater riverbanks	The length of time that reservoir or tailwater shorelines are exposed to wave action or sustained high flow affect the rate of shoreline erosion. A number of resource areas are affected by shoreline erosion, including visual and cultural resources, wetlands and shoreline habitats, and water quality. Reservoir operations that reduce shoreline erosion positively affect shoreline conditions and a number of other related resource areas.
Increasing protection for threatened and endangered species	Most threatened and endangered species in the TVA system occur in aquatic habitats along the stream sections least modified by construction of the TVA reservoir system. Reservoir operations that improve water quality conditions result in greater protection for these species.
Protecting and improving wetlands and other ecologically significant areas	Wetlands and other ecologically significant areas along the TVA reservoir system are dependent on how often and for how long they are inundated or saturated. Over time, changes in the timing and duration of surface water and soil saturation can affect the location, types, and functions of wetlands. In addition, a number of important or ecologically significant areas depend on certain reservoir levels (e.g., reservoir levels at waterfowl management areas) to maintain their operational integrity.
Protecting and improving the scenic beauty of the reservoirs	The scenic beauty of the TVA reservoirs can be affected by reservoir levels, especially during the fall foliage viewing period. Lower reservoir levels expose reservoir bottoms and a "shoreline ring." In general, reservoir operations that maintain higher levels and reduce the exposure and visibility of the shoreline serve to protect and improve the scenic beauty.

[1] See Chapter 2 for more detailed descriptions of the relationships between reservoir operations and operating objectives.

Table 1.6-04 Operating Options Developed during the Scoping Process

Options for Mainstem Reservoirs	Raise or lower winter and/or summer pool elevations
	Fill reservoirs to summer levels earlier
	Delay summer drawdown until later in the year
Options for Tributary Reservoirs	Raise or lower maximum and/or minimum summer pool elevations
	Raise winter pool elevations
	Fill reservoirs to summer levels earlier
	Delay unrestricted drawdown until later in the year
	Replace unrestricted drawdown with a restricted (stepped) drawdown
	Provide tailwater flows to support fishing and boating
	Modify the rate of flood-storage recovery by slowing drawdown
Options for All Reservoirs	Increase minimum flows to improve water quality and biodiversity

1.7 DEIS Public Review Process

The DEIS on TVA's ROS was distributed in July 2003. Approximately 1,530 copies of the DEIS were sent to affected tribal governments, agencies, organizations, and members of the public. The Notice of Availability of the DEIS was published in the Federal Register on July 3, 2003. The comment period closed on September 4, 2003, but TVA continued to accept comments through mid-October from tribes and persons informing the agency that their comments would be late.

Comments were provided by members of the public, organizations, and interested agencies at 12 interactive workshops held around the Tennessee Valley region after the DEIS was released. Approximately 1,700 individuals registered at the workshops (Table 1.7-01). During these workshops, comments could be made in writing using comment cards, given to court reporters, or entered on computer terminals through an interactive software program that was specially designed to assist the public in providing comments. TVA also posted a copy of the DEIS on its official agency internet web site, and comments could be made through this web site. In addition, TVA accepted comments through surface or electronic mail, by phone, and by facsimile.

While the ROS proceeded, TVA continued to meet with its cooperating agencies and with members of the IAT/PRG to receive their input on the DEIS. TVA conducted special briefings with resource agency staffs, including the U.S. Environmental Protection Agency (USEPA), to apprise them of ROS analyses and progress. These briefings provided interested agencies multiple opportunities to help direct and influence the scope and substance of the study, the EIS process, and associated analyses. TVA also held briefings with about 200 community leaders and representatives of interest groups to share information and to receive their input on the DEIS (see Appendix F, Table F1-02).

Including form letters and petitions, TVA received a total of 2,320 sets of comments on the DEIS (Appendix F, Table F1-03). These sets of comments included input from almost 7,000 individuals, 7 federal agencies, 14 state agencies, one tribal government, 8 county and local government agencies, and 42 other organizations. TVA has carefully reviewed and responded to all of the comments on the DEIS (see Appendix F).

Table 1.7-01 DEIS Community Workshops

Date	Location	Attendance
July 21, 2003	Murfreesboro, TN	30
July 22, 2003	Knoxville, TN	58
July 24, 2003	Bristol, TN	299
July 28, 2003	Morristown, TN	479
July 29, 2003	Murphy, NC	53
July 31, 2003	Blairsville, GA	407
August 5, 2003	Chattanooga, TN	53
August 7, 2003	Decatur, AL	106
August 12, 2003	Gilbertsville, KY	105
August 14, 2003	Pickwick, TN	70
August 19, 2003	Muscle Shoals, TN	54
August 21, 2003	Columbus, MS	10
Total workshop attendance		**1,724**

1.8 Statutory Overview

A number of federal statutes and executive orders are relevant to the formulation and evaluation of reservoir operations policy alternatives. Compliance with applicable regulations may affect the environmental consequences of an alternative or measures needed during its implementation.

Chapter 4, Description of Affected Environment, describes the regulatory setting for each resource; Chapter 5, Environmental Consequences of the Alternatives, discusses applicable laws and their relevance to this analysis. Specific analyses and EIS sections or content that are required by these statutes are included in this EIS (for example, a prime farmland report and analysis of threatened and endangered species).

The key authorities that relate to this EIS are summarized in the following sections.

1.8.1 Tennessee Valley Authority Act

The TVA Act charges TVA to promote the social and economic welfare of the citizens of the region through wise use and conservation of the area's natural resources (*United States ex rel. TVA v. Welch, 327 U.S. 546 [1946]*). Two sections of the TVA Act are especially important to TVA's management of the Tennessee River system. Section 9a authorizes the Board to regulate the river system—primarily for the purposes of navigation and flood control and, when consistent with these purposes, to provide and operate facilities for the generation of electric energy. Section 26a requires TVA approval before any obstruction affecting navigation, flood control, or public lands can be constructed, operated, or maintained along or in the Tennessee River system. Under the authority of the TVA Act, TVA manages the Tennessee River system to advance the economic and social well being of the citizens of the Tennessee Valley region.

1.8.2 National Environmental Policy Act

NEPA established a process by which federal agencies must study the effects of their actions. Whenever a federal agency proposes an action, grants a permit, or agrees to fund or authorize an action that could affect the natural or human environment, the agency must consider the potential adverse and beneficial effects of the action. NEPA requires that an EIS be prepared for major federal actions. This process must include public involvement and analysis of a reasonable range of alternatives. TVA prepared this FEIS to comply with the requirements of NEPA.

1.8.3 Protection of Water Quality

The Clean Water Act (CWA) was passed in 1972 to protect the Nation's water quality. The CWA is the primary law for regulating discharges of pollutants into the waters of the United States by enforcing water quality standards that are defined in Section 301 of the Act. Two categories of pollutants enter streams, rivers, and lakes or reservoirs: nonpoint sources (runoff from the landscape) and point sources (direct discharge via a pipe or ditch into the water). Section 402, the National Pollutant Discharge Elimination System (NPDES) Program, regulates point source discharges; states have been mandated to grant and enforce permits under this program. When stream segments are listed under Section 303(d) as impaired by a pollutant(s), a total maximum daily load (TMDL) must be developed for pollutant(s) for the listed stream segment. This TMDL determines the load of the pollutant(s) that a waterbody can receive without compromising its biological and chemical integrity. Both nonpoint and point sources are targeted for reductions under a TMDL. Many streams in the Tennessee River watershed are listed on the Section 303(d) lists for parameters such as flow alterations; low DO; sediment accumulation; contamination with polychlorinated biphenyls (PCBs), other organic compounds or metals, and pathogens (bacteria or microorganisms); high fecal coliform; and poor biological health. TMDLs for these listed waters are in various stages of development.

Certain actions that affect waters of the United States are coordinated with the applicable state to receive approval under Section 401, water quality certification. This certification is received by showing that the project or discharge will not adversely affect the water quality of the receiving stream, as defined by its designated uses. The designated use is determined by the primary uses of the water, such as recreation, water supply, and aquatic life.

1.8.4 Protection of Wetlands and Floodplains

Disturbance of many wetlands or any other waters of the United States by the discharge of any dredge or fill material requires a permit from the USACE under Section 404 of the CWA. Under Executive Order 11990—Protection of Wetlands, federal agencies are required to avoid construction in wetlands to the extent practicable and to mitigate potential impacts as appropriate. State programs for protection of wetlands also exist. For example, the Tennessee Aquatic Resource Alteration Permit Program controls alteration of streams and wetlands for actions within the state of Tennessee.

Under Executive Order 11988—Floodplain Management, federal agency actions must, to the extent practicable, avoid siting in floodplain zones in order to reduce the risk of flood loss; minimize impacts of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values of floodplains. The Federal Emergency Management Agency (FEMA) has identified where floodplains occur, and many local governments have adopted regulations to control the development of these defined floodplains.

1.8.5 Flood Control Act of 1944

The Flood Control Act of 1944 generally exempts TVA from USACE regulations governing the operation of federal dams, except when there is danger of flooding on the lower Ohio and Mississippi Rivers. In such a situation, USACE can direct TVA how to release water from the Tennessee River system into the Ohio River system.

1.8.6 Protection of Air Quality

Under the Clean Air Act (CAA), proposed new air pollutant sources must be permitted and must demonstrate that they will not violate the National Ambient Air Quality Standards (NAAQS). State Implementation Plans (SIPs) are developed by each state; these plans outline how the state will protect air quality. SIPs are based on the NAAQS, which are set by the USEPA for pollutants such as sulfur and nitrogen-based air emissions, with margins of safety to protect human health and welfare. Sources of air emissions are controlled based on the size of the emission, its location, and the type of pollutant. For new sources, best available control technology must be used to control emissions, and offsets (reducing emissions from existing sources) are required in some areas.

1.8.7 Protection of Threatened and Endangered Species

Under the Endangered Species Act (ESA), federal agencies must ensure that their actions will not jeopardize the existence of species federally listed as threatened or endangered, or affect the critical habitat of those species. Under provisions of Section 7(a)(2) of the ESA, a federal agency that permits, licenses, funds, or otherwise authorizes activities must consult with the

USFWS as appropriate, to ensure that its actions will not jeopardize the continued existence of any listed species. In addition, Section 9 makes it unlawful to take or harm any listed species. The states within the Tennessee Valley also have programs that protect state-listed threatened and endangered species.

1.8.8 Protection of Cultural Resources

The National Historic Preservation Act (NHPA) and Archaeological Resource Protection Act were enacted to protect cultural and archaeological resources. Before disturbing any cultural or archaeological resources with historical significance, the State Historic Preservation Office must be consulted. In some circumstances, the Federal Advisory Council on Historic Preservation must also be consulted. The Valley states have additional requirements for protection of excavation of the remains of Native Americans on lands under state or local control. Some of these lands border TVA managed reservoirs, and TVA actively works with the states to protect these resources.

1.8.9 Protection of Farmland

Under the Farmland Protection and Policy Act (FPPA), federal agencies are required to identify and consider the potential adverse effects of a proposed action on prime farmland. The FPPA ensures, to the maximum extent practicable, that federal programs are administered in a manner that is compatible with state and local government and private programs to protect farmland. In addition, the State of Tennessee has enacted the Agricultural District and Farmland Preservation Act, which provides limited protection of farmlands that have been specially designated under the Act.

1.8.10 Environmental Justice

Executive Order 12898—Environmental Justice requires some federal agencies to identify and address the adverse human health or environmental effects of federal programs, policies, and activities that may be disproportionately greater for minority and low-income populations. Federal agencies must ensure that federal programs or activities do not directly or indirectly result in disparate impacts on minorities or low-income populations. Federal agencies must provide opportunities for input into the NEPA process by affected communities and must evaluate the potentially significant and adverse environmental effects of proposed actions on minority and low-income communities during preparation of environmental documents. TVA is not subject to this executive order but evaluates environmental justice impacts as a matter of policy.

1.8.11 Homeland Security Act

The primary mission of the Homeland Security Act is to prevent terrorist attacks in the United States, reduce the vulnerability of the United States to terrorism, and minimize damage and assist with recovery if attacks do occur. All federal, state, and local agencies, including TVA, must follow this Act by ensuring that any public service is protected, emergency plans are developed, and communities are protected from potential terrorist attacks.

1.8.12 Other Regulations and Executive Orders

Other statutes and executive orders may be relevant, depending on the type of specific projects or operating changes that occur as a consequence of this EIS, including:

- Executive Order 13112—Invasive Species;
- Section 10 of the River and Harbors Act;
- Migratory Bird Treaty Act;
- Executive Order 13186—Responsibilities of Federal Agencies to Protect Migratory Birds;
- The Safe Drinking Water Act and Tennessee drinking water regulations;
- The Toxic Substances Control Act;
- The Federal Insecticide, Fungicide, and Rodenticide Act;
- The Resource Conservation and Recovery Act and other solid waste disposal regulations; and,
- The Comprehensive Environmental Response, Compensation, and Liability Act.

1.9 Relationship with Other NEPA Reviews

This EIS builds on other EISs and NEPA reviews. The following completed environmental reviews are relevant to this EIS because they may affect or be affected by related TVA policies, or were included in and used as a basis for the analyses presented herein:

- **Tennessee River and Reservoir System Operation and Planning Review Final Environmental Impact Statement.** Published in December 1990, this EIS was the basis for TVA’s present reservoir operations policy. The Lake Improvement Plan is the starting point for the evaluation of the reservoir operations policy, and this ROS EIS relies on relevant information from that document.
- **Shoreline Management Initiative Final Environmental Impact Statement.** In November 1998, TVA issued a final EIS on its policy regulating permitting activities and allowable residential uses for TVA-owned lands and easement properties along 11,000 miles of shoreland in the Tennessee River system. Many of these shorelands are included in the scope of the ROS EIS. The SMI established a management and environmental planning and review process, including individual reservoir Land Management Plans (LMPs) and procedures for implementing the Section 26a permitting program that affect and are affected by the reservoir operations policy. The SMI is the source of some of the basic land use and shoreline development projections used in this ROS EIS, and some of the management

measures resulting from the SMI are relevant to the conclusions about environmental consequences.

- **Energy Vision 2020 Final Environmental Impact Statement.** In December 1995, TVA completed an Integrated Resource Plan identifying and selecting a long-range strategy that would enable TVA to meet the additional electricity needs of its customers from 1996 to 2020. TVA prepared an EIS on the portfolio of energy resource options (including hydropower) that best met TVA's evaluation criteria regarding costs, rates, environmental impacts, debt, and economic development. The plan was designed to aid TVA and its customers in addressing the uncertainty that the electric utility industry would face in a deregulated environment. The power analyses presented in this document are consistent with the analysis in the Energy Vision 2020 EIS.
- **Final Supplemental Environmental Impact Statement for Browns Ferry Nuclear Plant Operating License Renewal, Athens, Alabama.** In March 2002, TVA prepared a Final Supplemental EIS for renewing the operating licenses and extending operation of all three units at its Browns Ferry Nuclear Plant located in Limestone County, Alabama. The Final Supplemental EIS tiered from the 1972 Final EIS and included refurbishment and restart of Unit 1, with extended operation of all three units as its preferred alternative, which was subsequently adopted by TVA. These actions are considered in this ROS EIS as part of the Base Case and all of the policy alternatives.
- **Environmental Assessments for Hydro Modernization Projects.** Various Environmental Assessments (EAs) have been prepared during the implementation of individual elements of TVA's Hydro Modernization (HMOD) projects. EAs have been completed for modernization and rehabilitation of the following TVA hydropower plants: Douglas (March 1995), Cherokee (July 1995), Raccoon Mountain (July 1999), Fort Loudoun (February 2000), Hiwassee (February 2001), Chatuge (April 2001), Watts Bar (December 2001), Apalachia (February 2002), and Boone (October 2002). HMOD projects that were designed and funded, implemented, or completed on or before October 2001 are considered in this ROS EIS as part of the Base Case (see Appendix A, Table A-09); the projects yet to be designed or implemented as of October 2001 are considered in the cumulative impacts analysis.
- **Environmental Assessments and Environmental Impact Statements for Land Management Plans.** Environmental Assessments and EISs were completed for LMPs at the following TVA reservoirs: Melton Hill, Boone, Tellico, Tims Ford, Guntersville, Cherokee, Bear Creek, Norris, and Pickwick. These LMPs were developed in a manner consistent with the implementation of TVA's land management policy as established in the SMI.
- **Final Chickamauga Dam Navigation Lock Project Environmental Impact Statement.** In May 1996, this EIS evaluated the proposed construction of a new 110– by 600–foot navigation lock at Chickamauga Dam. The Final EIS addressed the economic, social, and environmental impacts of various alternative plans and the proposed plan. The USACE prepared a final supplement to the EIS in February 2002. In fiscal

year 2003, Congress authorized construction of a 110– by 600–foot replacement lock.

- **Final and Supplemental Environmental Impact Statements, Lower Cumberland and Tennessee Rivers Kentucky Lock Addition Project.** These Final EISs evaluated the potential impact of constructing a 110– by 1,200–foot navigation lock at the Kentucky Dam.

1.10 EIS Overview

Volume I of this FEIS consists of 10 chapters (Figure 1.10-01) as outlined below. Volume II includes eight appendices, with more detail on technical analyses and supporting data.

- **Chapter 1—**describes the purpose and need for the ROS EIS, scope of the ROS, decision to be made, history of policy changes, reservoir operations policy scoping process, public review and agency consultation requirements, relationship to other NEPA reviews, and EIS overview.
- **Chapter 2**—provides a background and water control system overview, a description of how the water control system is operated to achieve public benefits, and the existing water control system operations.
- **Chapter 3—**includes a description of the process of developing, evaluating, and winnowing the list of reservoir operations policy alternatives; a summary of analyses of policy alternatives; and a summary of the environmental consequences of the policy alternatives considered. It also identifies TVA's Preferred Alternative.
- **Chapter 4—**discusses the affected environment of the reservoir system.
- **Chapter 5—**identifies the environmental consequences of each policy alternative.
- **Chapter 6—**addresses the cumulative impacts of alternatives identified in this EIS, in consideration of other major actions in the region of influence.
- **Chapter 7—**describes a range of potential mitigation measures to offset potential adverse impacts of the Preferred Alternative.
- **Chapters 8–10—**contain a list of preparers, an FEIS distribution list, and supporting information (including an index, a glossary, and the literature cited).
- **Appendix A—**contains tables describing the characteristics of the water control system and its individual projects.
- **Appendix B—**contains detailed descriptions of the Base Case, the preliminary operations policy alternatives, and the Preferred Alternative.
- **Appendix C—**contains information on models used to analyze the alternatives: reservoir level, water availability, and hydropower modeling; energy cost modeling; water quality modeling; flood flow modeling; the hedonic valuation model; and the economic model. Appendix C also contains elevation and flow results from the

Weekly Scheduling Model for key reservoirs and probability plots of the Preferred Alternative.

- **Appendix D—**contains additional information on water quality, groundwater resources, aquatic resources, wetlands, terrestrial ecology, threatened and endangered species, cultural resources, recreation, inter-basin transfers, and social and economic resources.
- **Appendix E—**contains the Prime Farmland Technical Report.
- **Appendix F—**contains the responses to comments on the DEIS.
- **Appendix G—**contains the results of consultations required under Section 7 of the ESA.
- **Appendix H—**contains the results of consultations required under Section 106 of the NHPA.

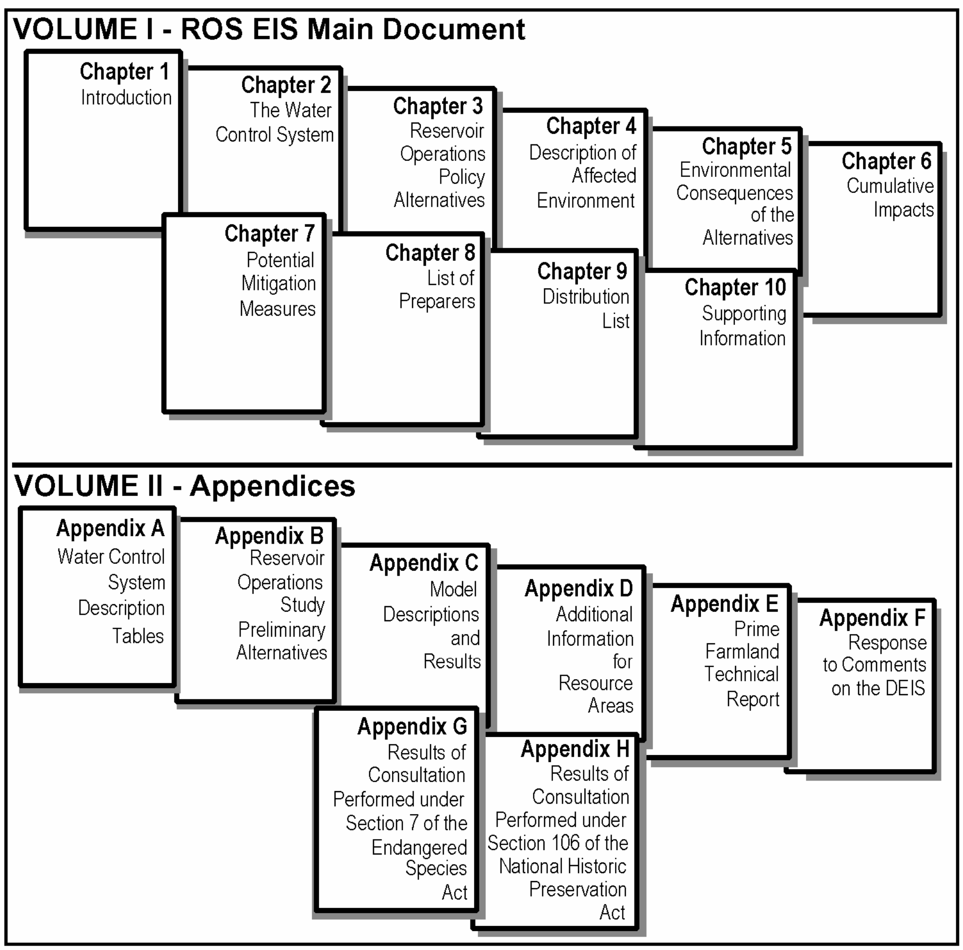


Figure 1.10-01 Contents of the ROS EIS

Chapter 2

The Water Control System

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2.1 Background and Water Control System Overview

This chapter describes the seasonal patterns of rainfall and runoff in the Tennessee Valley watershed and the specific components of the TVA water control system.

2.1.1 Rainfall and Runoff

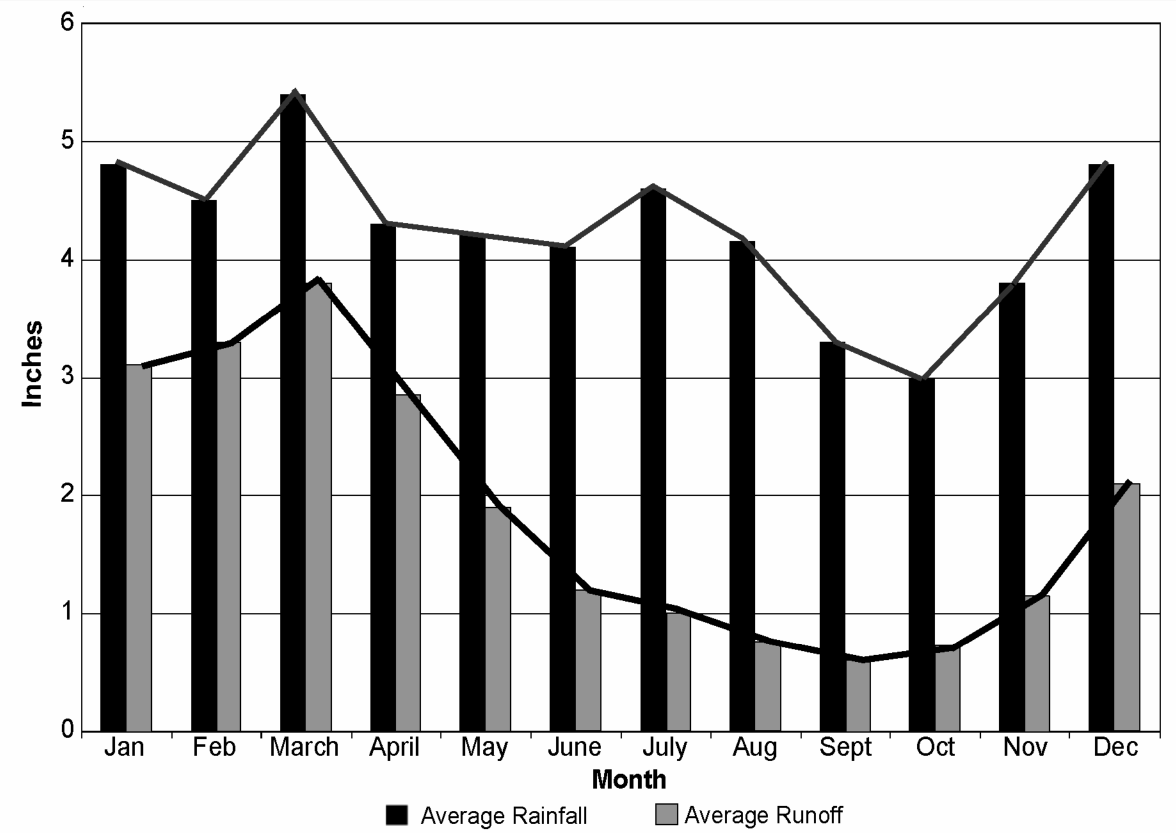
Rainfall, runoff, and topography in the Tennessee Valley watershed strongly influenced the original location, design, and operating characteristics of TVA reservoirs and the water control system. The locations and storage volumes of reservoirs reflect the variation in rainfall and runoff in the region. Rainfall and runoff continue to control when and where water flows into the reservoirs; and runoff exerts a strong influence on the annual, seasonal, and weekly patterns of reservoir operations.

Mean total annual rainfall is 52 inches per year throughout the TVA system, but rainfall varies considerably from year to year and at different locations in the system. During the past 100 years, mean annual rainfall has varied between a low of 36 inches in 1985 and a high of 65 inches in 1973. Rainfall is greatest in certain mountainous regions of the watershed—where rainfall totals over 90 inches per year. In contrast, mean annual rainfall in some portions of the Valley is as low as 40 inches. Although the months with the highest or lowest rainfall may differ each year, rainfall is typically highest from December through March and lowest from September through November (Figure 2.1-01).

More important to reservoir operations than rainfall is the seasonal variation in runoff. Runoff is rainfall that flows into streams and reservoirs. About 40 percent of rainfall in the drainage area of the Tennessee River system becomes runoff; the remainder evaporates, is used by plants, or drains into the soil and becomes part of the groundwater.

Although average rainfall varies somewhat, runoff patterns vary considerably more through the seasons due to changes in ground conditions, plant growth and cover, and storm and rainfall patterns (Figure 2.1-01). During late spring, summer, and fall, soils are generally drier, and dense ground cover helps to intercept and reduce rapid runoff from rainfall. In winter, as plants turn dormant and the ground becomes wetter, runoff increases. As shown in Figure 2.1-01, the greatest total runoff occurs from January through March, which is the major flood season in the Tennessee Valley. Storms tend to be larger during this period, and winter storms can cover the entire Valley for several days—sometimes with one storm followed by another storm 3 to 5 days later.

In contrast, runoff in summer and fall is much lower than in winter and spring. Summer storms generally affect only a portion of the basin. Although the total runoff in a summer storm is a fraction of that for a winter storm, flooding is still a concern—especially on a local scale—because reservoir levels are usually higher and less flood storage space is available.



Note: Rainfall amounts are monthly averages for the whole TVA Region. Runoff is rainfall that flows into streams and reservoirs.
Source: TVA data 2003.

Figure 2.1-01 Monthly Average Rainfall and Runoff (1903 to 2001)

Substantial variation in the annual amount of rainfall affects the degree to which objectives of the water control system can be achieved. For example, lack of rainfall and severe droughts in the 1980s and 1990s limited the amount of water in the system, which in turn reduced hydropower production, caused water quality problems, and reduced recreational use of reservoirs. During such low rainfall periods, achieving reservoir system objectives is difficult because of lower reservoir levels. At other times, excessive amounts of rainfall can rapidly exhaust flood storage space and necessitate frequent spills through sluiceways and spillways.

2.1.2 Structure of the Water Control System

The water control system is composed of dams and reservoirs, tailwaters, navigation locks, and hydropower generation facilities, as described in the following sections.

Dams and Reservoirs (Projects)

The 35 projects that comprise the water control system evaluated in the ROS include nine mainstem reservoirs and 26 tributary reservoirs (Table 2.1-01). Mainstem projects are those on the Tennessee River from Fort Loudoun Reservoir to Kentucky Reservoir (Figure 1.1-01).

Each TVA project typically falls into one of four general categories that are closely related to its characteristics (e.g., location and size), primary function (e.g., navigation, storage for flood control, or power generation), and operation. These categories include mainstem storage projects, mainstem run-of-river projects, tributary storage projects, and tributary run-of-river projects, as described below and listed in Table 2.1-01.

> **RESERVOIR CLASSIFICATION TERMS**
>
> **Mainstem Projects—**TVA mainstem projects are located on the Tennessee River as opposed to tributary streams and smaller rivers that feed into it.
>
> **Tributary Projects—**TVA tributary projects are located on the smaller rivers and streams that feed into the mainstem.
>
> **Storage Projects—**Storage projects have volume available for retaining floodwaters. These projects are operated on an annual fill and drawdown cycle. They are operated with higher pool levels during the summer recreation period and lower pool levels during the winter flood period.
>
> **Run-of-River Projects—**Run-of-river projects have limited storage volume and generally release the same amount of water that flows into the reservoir on an hourly, daily, or weekly basis; therefore, these projects are operated based on streamflow, with limited seasonal change in storage.

- **Mainstem Storage Projects.** Projects located on the mainstem of the Tennessee River, the lowest part of the TVA water control system (Figure 1.1-01), are managed for navigation, flood control, power production, recreation, and other uses. Seven mainstem storage projects and their associated locks comprise the majority of the 800-mile Tennessee River commercial navigation channel. Their pool elevations (or reservoir levels) and flow releases are essential to maintaining a viable commercial waterway. Mainstem storage projects are operated on a seasonal basis for flood control. Mainstem project pool elevations typically fluctuate from approximately 2 to 6 feet on an annual basis—much less than tributary projects.

- **Mainstem Run-of-River Projects.** The two mainstem run-of-river projects serve the same general functions as the mainstem storage projects. Because they have limited storage volume, these projects generally release water on an inflow-equals-outflow basis (reflecting operations of the larger upstream projects). Run-of-river projects provide navigation, hydropower production, recreation, and a range of other benefits.

Table 2.1-01 Characteristics of TVA Reservoirs

Project and Location	Operating Mode	Length of Reservoir (miles)[1]	Navigation Facilities	Flood Storage (1,000 acre-feet)[5]	Turbine Units and Generating Capacity (MW)[7]
Mainstem Projects					
Kentucky, KY	Storage	184.3	2 Locks, canal[2]	4,008	5 (223)
Pickwick, TN	Storage	52.7	2 Locks, canal[3]	493 [6]	6 (240)
Wilson, AL	Run-of-river	15.5	2 Locks	0	21 (675)
Wheeler, AL	Storage	74.1	2 Locks	349	11 (412)
Guntersville, AL	Storage	75.7	2 Locks	162	4 (135)
Nickajack, TN	Run-of-river	46.3	Lock	0	4 (104)
Chickamauga, TN	Storage	58.9	Lock	345	4 (160)
Watts Bar, TN	Storage	95.5*	Lock	379	5 (192)
Fort Loudoun, TN	Storage	60.8*	Lock	111	4 (155)
Total mainstem		**663.8**	**14 Locks**	**5,847**	**64 (2,296)**
Tributary Projects					
Norris, TN	Storage	129.0	-	1,473	2 (131)
Melton Hill, TN	Run-of-river	44.0	Lock	0	2 (72)
Douglas, TN	Storage	43.1	–	1,251	4 (156)
South Holston, TN	Storage	23.7	–	290	1 (39)
Boone, TN	Storage	32.7*	–	92	3 (92)
Fort Patrick Henry, TN	Run-of-river	10.4	–	0	2 (59)
Cherokee, TN	Storage	54.0	–	1,012	4 (160)
Watauga, TN	Storage	16.3	–	223	2 (58)
Wilbur, TN	Run-of-river	1.8	–	0	4 (11)
Fontana, NC	Storage	29.0	–	580	3 (294)
Tellico, TN	Storage	33.2	Canal[4]	120	0 [8]
Chatuge, NC	Storage	13.0	–	93	1 (11)
Nottely, GA	Storage	20.2	–	100	1 (15)
Hiwassee, NC	Storage	22.2	–	270	2 (176)
Apalachia, NC	Run-of-river	9.8	–	0	2 (100)

Table 2.1-01 Characteristics of TVA Reservoirs (continued)

Project and Locations	Operating Mode	Length of Reservoir (miles)[1]	Navigation Facilities	Flood Storage (1,000 acre-feet)[5]	Turbine Units and Generating Capacity (MW)[7]
Tributary Projects (continued)					
Blue Ridge, GA	Storage	11.0	–	69	1 (22)
Ocoee #1, TN	Storage	7.5	–	0	5 (19)
Ocoee #2, TN	Run-of-river	–	–	0	2 (23)
Ocoee #3, TN	Run-of-river	7.0	–	0	1 (29)
Tims Ford, TN	Storage	34.2	–	220	1 (45)
Normandy, TN	Storage	17.0	–	48	0[8]
Great Falls, TN	Storage	22.0	–	0	2 (34)
Upper Bear Creek, AL	Run-of-river	14.0	–	0	0[8]
Bear Creek, AL	Storage	12.0	–	37	0[8]
Little Bear Creek, AL	Storage	6.0	–	25	0[8]
Cedar Creek, AL	Storage	9.0	–	76	0[8]
Total tributary		**622.1**	**1 Lock**	**5,979**	**45 (1,546)**
Total projects		**1,285.9**	**15 Locks**	**11,826**	**109 (3,842)**

Notes:

1 Full summer pool. *Fort Loudoun—49.9 miles on the Tennessee River, 6.5 miles on the French Broad River and 4.4 miles on the Holston River; Watts Bar—72.4 miles on the Tennessee River and 23.1 miles on the Clinch River; Norris—73 miles on the Clinch River and 56 miles on the Powell River; Boone—17.4 miles on the South Fork Holston River and 15.3 miles on the Watauga River.

2 Includes new main lock chamber (110 feet wide and 1,200 feet long) and the Barkley Canal.

3 Tennessee–Tombigbee Waterway; Bay Springs Reservoir is connected to Pickwick Reservoir by a navigation canal.

4 River diversion through a canal increases energy generation at Fort Loudoun.

5 Numbers reflect allocated flood storage. The observed flood storage varies, depending on rainfall and runoff.

6 Includes additional storage volume from Bay Springs Reservoir.

7 Actual megawatt generating capacity at any time depends on several factors, including operating head, turbine capability, generator cooling, water temperature, and power factor. Generating capacities include rehabilitation and modernization of turbine units already performed, as well as those in the design, construction, or authorization phase.

8 Project design does not include power generation capacity.

- **Tributary Storage Projects.** Eighteen tributary storage projects are located on the tributaries of the Tennessee River and one, Great Falls Reservoir, is located on a tributary of the Cumberland River (Figure 1.1-01). These projects store water to provide flood control, recreational benefits, and water supply. They release water over time to generate power and support downstream flows for navigation and power generation lower in the system—at downstream tributary and mainstem projects. Historically, water in tributary projects was held in storage and released to maximize hydropower production during summer. Presently, water is released not only to generate hydropower but also to provide minimum flows (water releases necessary to help maintain downstream water quality and protect aquatic habitat) and to maintain summer pool elevations longer into the summer. Reservoir levels for tributary storage projects fluctuate considerably on a seasonal basis; levels can fluctuate up to 90 feet.

- **Tributary Run-of-River Projects.** The seven tributary run-of-river projects are operated as part of the tributary project group. Because they are located between much larger reservoirs (Figure 1.1-01) and have limited storage volume, tributary run-of-river projects generally release water on an inflow-equals-outflow basis, reflecting operations of the larger upstream projects. Daily fluctuations in pool elevations are common but limited to a few feet. Although tributary run-of river projects are operated for similar objectives as tributary storage projects, they are generally operated as pass-through projects and provide little storage for flood reduction or minimum flows.

Tailwaters

Tailwater is a widely used term that generally refers to the portion of a river below a dam that extends downstream to the upper portion of the next reservoir pool in the system. The term tailwater can also refer to the upper portion of a reservoir pool immediately below an upstream dam with river-like characteristics, but which is also influenced at times by the elevation of the downstream pool. In these tailwater areas, the water is nearly always moving but the rate of flow, temperature, and other water quality characteristics are controlled or at least strongly affected by releases from the upstream dam.

In this EIS, several resource areas define or identify various lengths of tailwaters. These differences reflect the many types of tailwater characteristics and uses that occur in the study area and demonstrate that there is no single, well-defined definition of tailwater or, in many cases, a clearly defined transition point between a tailwater and the downstream reservoir pool. Section 4.1 provides further information on waterbody types in the TVA reservoir system.

Navigation Locks

The TVA reservoir system also includes 15 navigation locks located at 10 dams. Operated by the USACE, the locks provide an 800-mile commercial navigation channel from the mouth of the Tennessee River at Paducah, Kentucky; upstream past Knoxville, Tennessee; and into parts of the Hiwassee, Clinch, and Little Tennessee Rivers. TVA operates the reservoir system to maintain a minimum 11-foot depth in the navigation channel along this navigable waterway.

Hydropower Generation Facilities

Hydropower generation facilities are incorporated into 29 of the project dams. Although these facilities initially provided base load power (operating almost continuously), they now generate electricity primarily during periods of peak power demand. Fossil and nuclear power generation facilities with much greater generation capacities have been added to the TVA power system to provide base load power. Operation of the reservoir system has changed over time to meet peak power demands, improve overall power system reliability, and to ensure that an adequate supply of cooling water is made available to the coal and nuclear power plants. Depending on annual runoff, the hydropower facilities provide from 10 to 15 percent of TVA's average power requirements.

TVA is in the midst of an Hydro Automation Program, which will automate the control of TVA's hydro generating units. When completed in 2004, the Hydro Automation Program will greatly improve TVA's flexibility to control its conventional hydro generating units (turbines). This flexibility will enable TVA to reduce overall operating expenses and to increase operating efficiencies. TVA will be able to produce the maximum amount of power with the available minimum amount of water and to provide rapid, automatic, real-time dispatching of the generating units.

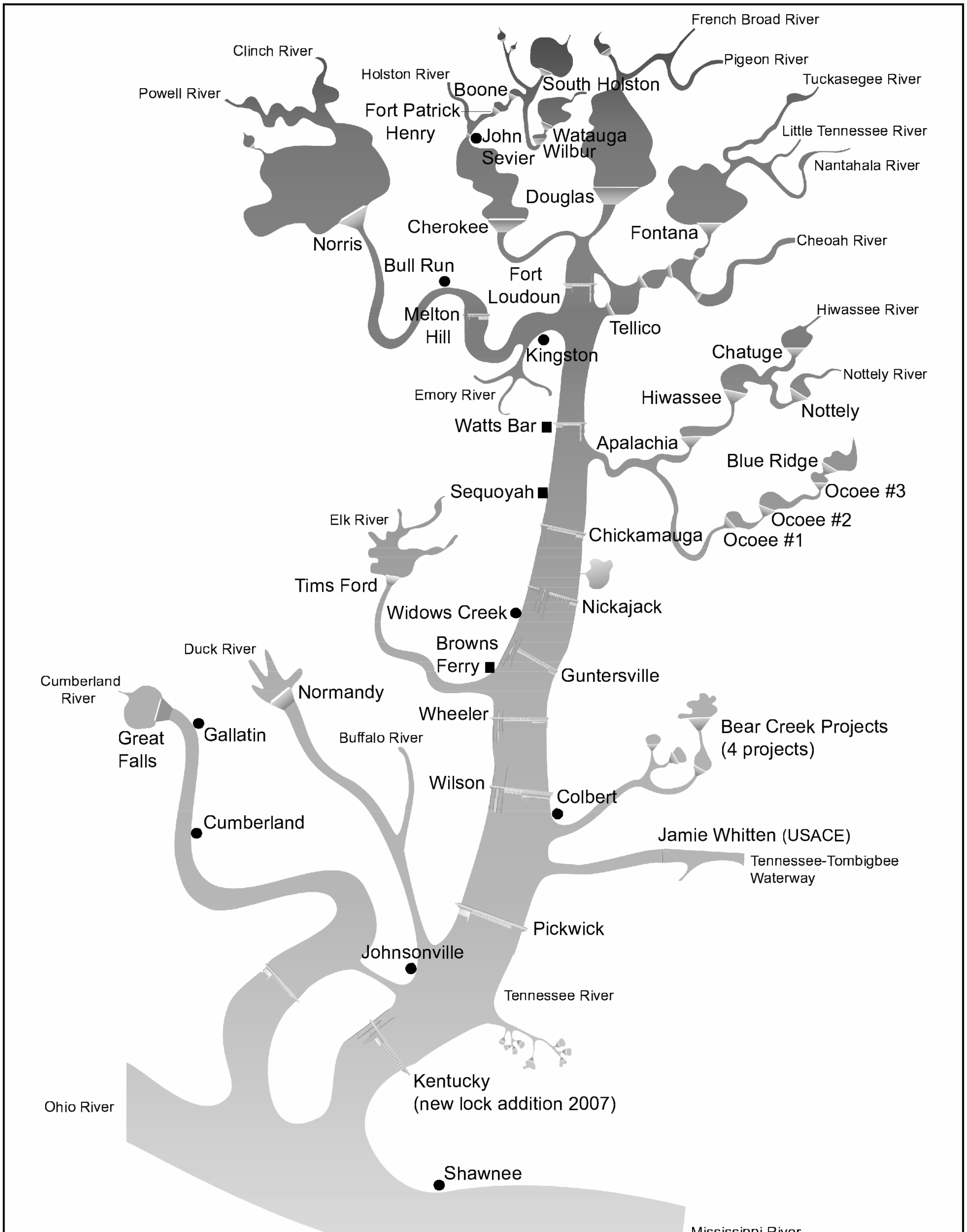
In addition, TVA began to rehabilitate and upgrade its aging hydropower generation facilities in 1991. Eventually, as many as 92 hydro turbine units at 26 plant sites (including Raccoon Mountain Pumped Storage Project) may be rehabilitated and modernized. The goal of TVA's HMOD projects is to provide for a safer and more reliable hydropower system, improved operational efficiency, and increases in system capacity at an acceptable economical cost and return to TVA. HMOD projects that were designed and funded, implemented, or completed on or before October 2001 are considered in this EIS as part of the Base Case (see Appendix A, Table A-09). The projects yet to be designed or implemented as of October 2001 are considered in the cumulative impacts analysis.

2.2 Water Control System

This section describes how the water control system is operated to optimize public benefits while observing physical, operational, and other constraints.

2.2.1 Flows through the Water Control System

Figure 2.2-01 depicts a schematic of the water control system. Water stored in the tributary reservoirs is released downstream to the larger Tennessee River mainstem projects (shown on the center of the schematic) and eventually flows into the Ohio River. Water is released from the projects to provide flows to maintain minimum navigational depth, reestablish flood storage volume in the reservoirs, generate power as it passes through the system, supply cooling water to the coal and nuclear power plants, and maintain water quality and aquatic habitat.



Note: The scope of the ROS EIS includes the 35 projects and power facilities shown here. (Paradise and Allen Fossil plants are outside the bounds of this schematic. See Figure 1.1-02 for their locations. The other 14 TVA projects not labeled on this figure are outside the scope of this study.)

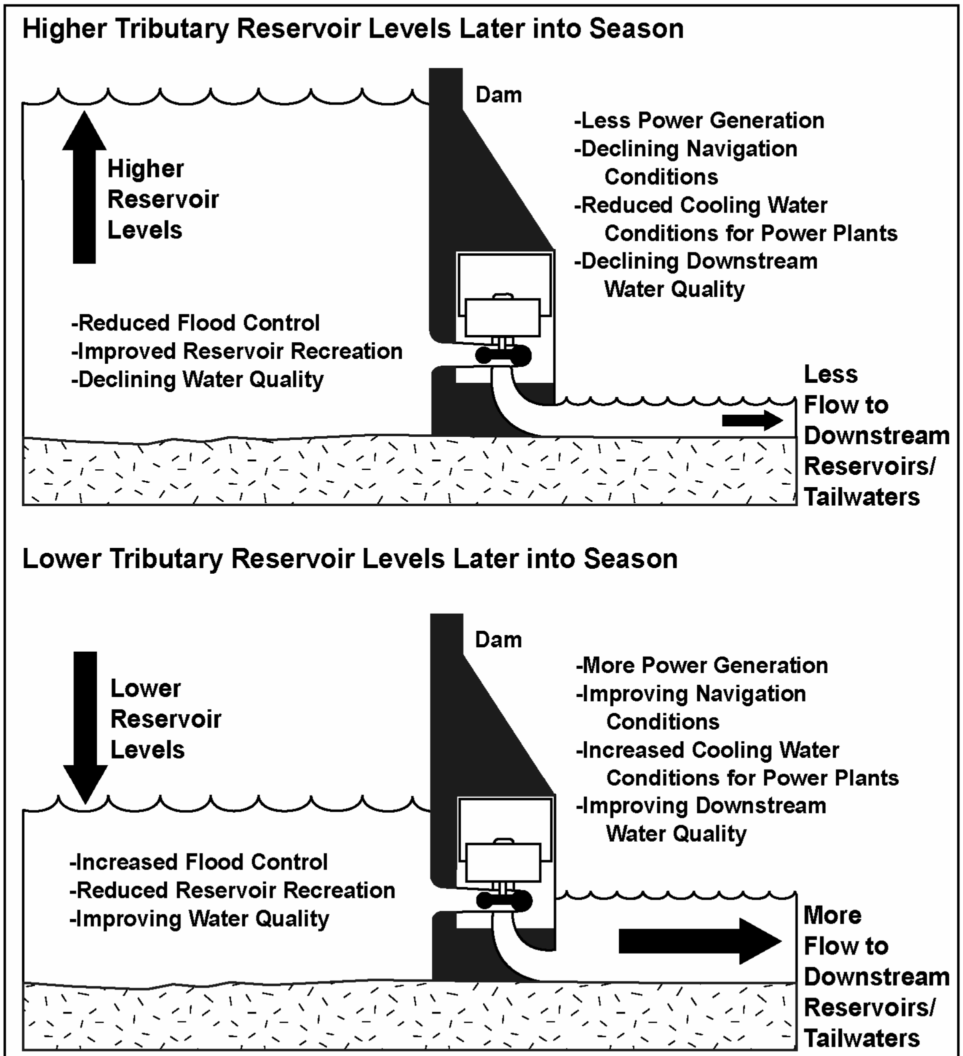
Source: TVA data 2003.

Figure 2.2-01 Schematic Diagram of the TVA Water Control System

Throughout the year, TVA manages the distribution of flows through the system in response to changing rainfall and runoff levels and other operating factors. Higher reservoir levels during some months of the year increase recreational opportunities and other benefits. During other months of the year, lower reservoir levels (especially at storage projects) provide flood storage volume during high-runoff periods.

2.2.2 Balancing Operating Objectives

The TVA reservoir system is not operated to maximize a single benefit to the exclusion of others. The system is operated to achieve a number of objectives and to provide multiple public benefits. Some operating objectives are complementary; others require trade-offs, especially in periods of limited water (Figure 2.2 -02).



Source: TVA data 2003.

Figure 2.2-02 Achieving a Balance of Reservoir System Operating Objectives (Summer/Fall)

During the late summer and fall drawdown period, water released to increase winter flood storage also supports navigation, power production, water quality, and tailwater recreation, creating complementary benefits.

A clear example of a trade-off during operation of the reservoir system is the lower reservoir levels needed for flood control and the higher reservoir levels desired for recreation. To manage flood risk, TVA lowers reservoir levels before the high runoff period, thus providing storage volume. Lowering reservoir levels affects the amount of water surface available for reservoir recreational activities and detracts from the recreational experience. In certain seasons, there is an unavoidable trade-off between flood control and reservoir recreational opportunities. Just as the trade-offs affect the benefits created, they often involve different beneficiaries.

2.2.3 Reservoir Operations Policy

TVA's reservoir operations policy establishes a balance of operating objectives. It guides system-wide decisions about how much water is stored in specific reservoirs, how the water is released, and the timing of those releases. The policy helps TVA in managing its reservoir system to fulfill its statutorily prescribed operating objectives (navigation, flood control, and power production) and to provide other benefits to the region—such as recreational opportunities and improved water quality.

The reservoir operations policy is composed of guidelines that describe how the reservoirs should be operated given the rainfall and runoff and the operating objectives. To be effective over the wide range of rainfall and runoff patterns within the 40,000-square-mile watershed, these guidelines must be flexible. This flexibility also allows the water control system to provide multiple uses of the water.

Reservoir operating guidelines establish pool level parameters for daily operations. One of the most important factors that determines where the actual pool levels are relative to these guidelines is the year-to-year variation in rainfall and runoff. Reservoir operations may temporarily deviate from normal operating guidelines to meet critical power system situations and meet other reservoir system needs to the extent practicable. Temporary deviations above and below these guidelines occur frequently due to floods and droughts.

Elements of TVA's reservoir operations policy include:

- **Reservoir Operating Guidelines—**control the amount of water in each reservoir, the reservoir pool elevations, and the flow of water from one reservoir to another; these guidelines are implemented through guide curves for each reservoir.
- **Water Release Guidelines—**control the release of water needed for reservoir system and project minimum flows, including flows for special operations.
- **Other Guidelines and Operational Constraints—**include procedures and limitations set for hydropower generation, response to drought conditions, scheduled maintenance

for power generation facilities, power system alerts, dam safety, security threats, and environmental emergencies (e.g., spills).

The manner in which these guidelines are implemented under the present reservoir operations policy is described in the following section and in Section 2.3, Existing Water Control System Operations.

Reservoir Operating Guidelines

Reservoir operating guidelines are implemented as planned operating ranges of reservoir levels throughout the year. TVA represents these guidelines in graphs called guide curves, which show the planned reservoir levels for navigation, flood control, recreation, and other operating objectives. Guide curves also depict the volume of water available to TVA for hydropower generation and other beneficial uses.

> **RESERVOIR GUIDE CURVES**
>
> Guide curves are line graphs showing the planned reservoir levels throughout the year. They also depict the storage allocated for flood control, operating zones and, in some reservoirs, the volume of water available for discretionary uses.
>
> (See Figures 2.2-03 and 2.2-04.)

Guide curves for mainstem and tributary reservoirs have different characteristics. Mainstem guide curves typically allow for a much smaller range of reservoir elevation change. Tributary guide curves include a larger change in reservoir elevations over the annual cycle and usually include a discretionary operating zone (the area between the flood guide and Minimum Operations Guide [MOG]). Because guide curves specify certain periods for raising or lowering the reservoirs, they substantially affect seasonal releases in project tailwaters. Each project has its own guide curve.

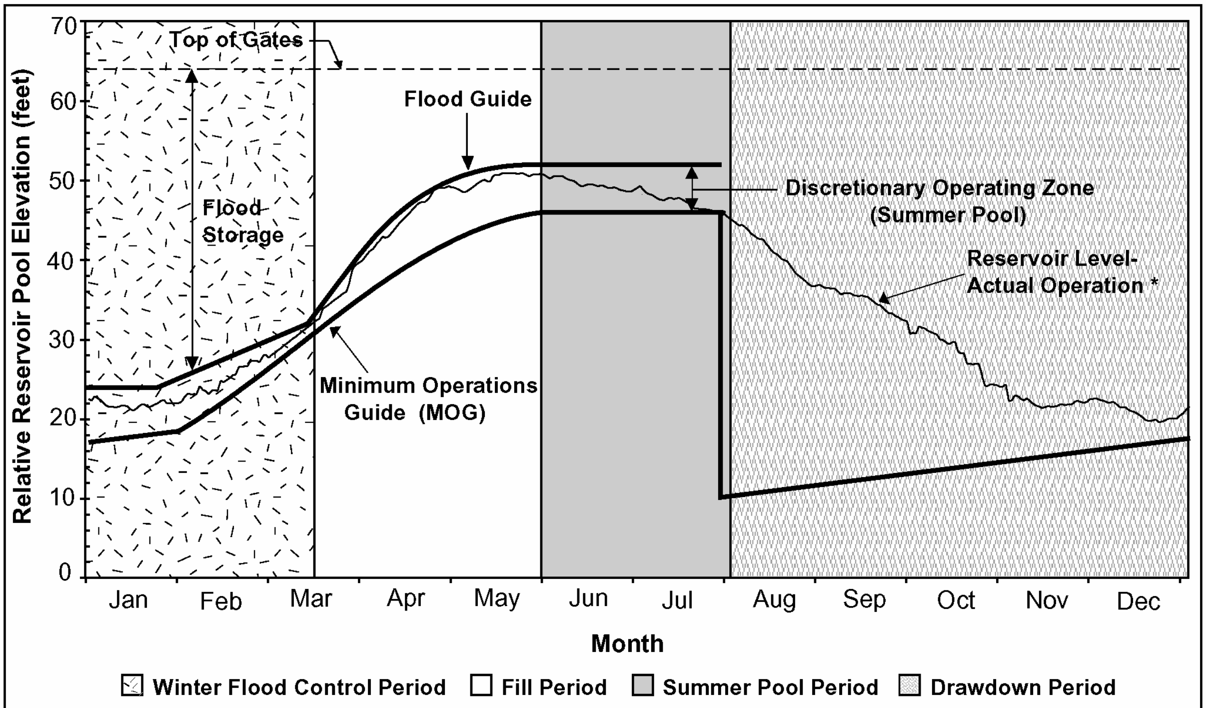
These project-specific guide curves are based on original project allocations and subsequent modifications, many years of historical flows, flood season conditions, and experience with project and reservoir system operations. Reservoir operations per the guide curves maintain project storage volume available for flood control within the watershed at any given time of year, as well as the amount of stored water needed to meet other purposes such as year-round navigation, power generation, reservoir recreation, water quality, waste assimilation, and other environmental resource considerations.

> **RESERVOIR OPERATING PERIODS**
>
> **Winter Flood Control Period—**Reservoir elevations are held at lower levels during periods of higher runoff to provide more flood storage.
>
> **Fill Period—**During the spring period of diminishing runoff, reservoirs are filled at a rate designed to maintain flood storage and reach summer pool elevations.
>
> **Recreation/Summer Pool Period—**Reservoir levels are maintained at or above minimum operations guide levels to the extent possible during this time of lower flood risk. Drawdown rates are restricted during this period in tributary reservoirs.
>
> **Drawdown Period—**Reservoirs are drawn down to or below winter flood guide levels (for tributary reservoirs) or within operating zone levels (for mainstem reservoirs) in anticipation of higher runoff; this is the unrestricted drawdown period.
>
> (See Figures 2.2-03 and 2.2-04.)

TVA operating guidelines must be flexible enough to respond to unusual or extreme circumstances in the system that are beyond TVA's control. The most important of these is variation in rainfall and runoff, at times resulting in low inflow conditions (droughts) or high inflow conditions (floods) that substantially increase the difficulty in meeting the multiple needs of the system. Other extreme circumstances include extreme temperatures and sudden loss of generating units, requiring a quick response that may be available only from TVA's hydropower electric units.

Tributary Reservoir Guide Curves

Figure 2.2-03 shows a generic guide curve for a tributary storage reservoir. Because tributary reservoirs provide a significant portion of the system's flood storage, their reservoir pool may vary substantially over the annual cycle.



* Varies from year to year
Source: TVA data 2003

Figure 2.2-03 Generic Tributary Reservoir Guide Curve

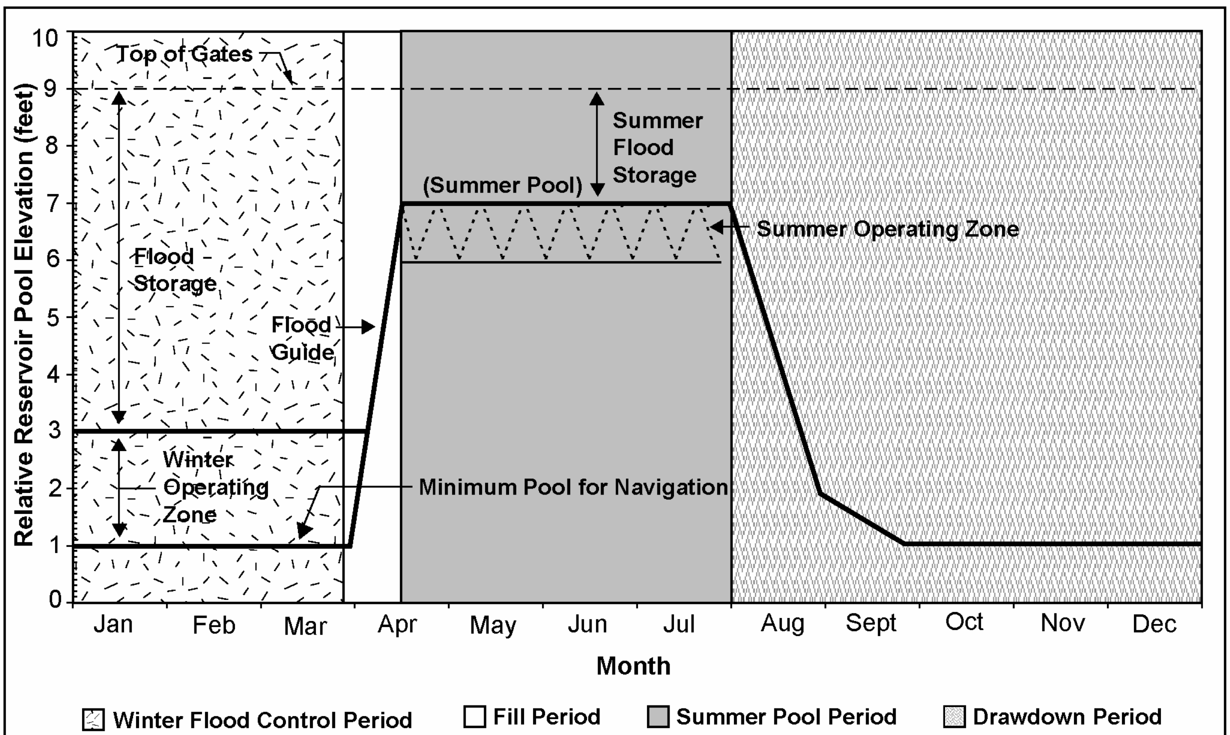
To achieve multiple reservoir system elevations, the guide curve must include operational flexibility. Managing the tributary reservoir levels within a discretionary operating zone creates this flexibility. The lower limit of this zone is the MOG. When a reservoir is at or below its MOG, only minimum flows are released.

The upper limit of the discretionary operating zone is the flood guide. Reservoir levels generally are not allowed to exceed this limit because the flood guide controls the minimum amount of flood storage available in a reservoir. By limiting reservoir elevations to a level equal to or lower than the flood guide, TVA is assured that flood storage necessary to minimize flood risk is available for use. Occasionally, temporary fills to higher levels occur when high flows are regulated, and lower levels may occur for power generation emergencies.

Under typical conditions, the water level in a tributary storage reservoir fluctuates within its discretionary operating zone. The reservoir can be drawn down to generate hydropower and to meet downstream water requirements, such as providing cooling water for nuclear and coal power plants, process water for industry, or flow for navigation.

Mainstem Reservoir Guide Curves

The generic guide curve for a mainstem reservoir (Figure 2.2-04) shows that the schedules for drawdown and fill are somewhat similar to those for a tributary reservoir, but the drawdown is generally much smaller than for a tributary reservoir because of the difference in reservoir characteristics. All mainstem projects have a seasonal fluctuation zone, which is followed to the extent practicable (Appendix A, Table A–02).



Source: TVA data 2003.

Figure 2.2-04 Generic Mainstem Reservoir Guide Curve

- **January–March.** Reservoir elevations are lowest from January to March, the period of highest runoff and flood risk, as shown in Figure 2.2-04. Pools are maintained within a 1- to 2-foot winter operating zone to the extent possible, except when regulating high flows. The bottom of this winter regulating zone is the lowest elevation to which the reservoir is drawn while still meeting minimum navigation depth requirements.

- **April.** From late March through the middle of April, reservoir elevations are raised to the summer pool level as runoff and system demands allow.

- **Mid-April through Late Summer.** Reservoirs are maintained at summer operating levels until seasonal drawdown begins. Normal operation includes a band of reservoir fluctuations, called the summer operating zone. Fluctuations of reservoir levels in this zone are used for power generation; and for mosquito control operations at Chickamauga, Guntersville, Wheeler, and Pickwick Reservoirs.

  Occasionally, temporary fills to higher levels occur when high flows are regulated, and lower levels may occur for power generation emergencies.

RESERVOIR POOL LEVELS AND OPERATING ZONES

Top of Gates—Top of Gates represents the maximum controlled elevation at a project; typically, the top of a spillway gate in a closed position or crest elevation of an uncontrolled outlet structure.

Flood Guide*—This seasonal elevation guide depicts the amount of storage allocated in a reservoir for flood reduction.

Flood Storage—Flood storage is the volume of runoff that can be stored in a reservoir to reduce downstream flooding.

Minimum Operations Guide (MOG)*—This seasonal guideline for reservoir elevation for some tributary projects depicts the elevation below which only minimum flows are usually released, except during emergencies.

Minimum Flow—A minimum flow is a release from one or more dams to meet downstream water needs (e.g., navigation, water supply, aquatic habitat, and waste assimilation). A minimum flow does not represent the lowest flow rate that TVA can pass from a dam or dams.

Discretionary Operating Zone*—This range of reservoir elevations between the MOG and the flood guide enables flexible operation of the system to achieve multiple benefits.

Summer Pool*—The range between the flood guide and the MOG during June and July. Full summer pool is the targeted reservoir elevation to be achieved by the beginning of the summer recreation season, and is also the summer flood guide. Minimum summer pool is the level for tributary storage projects equal to the MOG for June and July.

Restricted Drawdown*—This allowable lowering of tributary storage pool levels from June 1 to July 31 is limited to maintaining at least minimum summer pools, if possible.

Unrestricted Drawdown*—Reservoir pool elevations are lowered in late summer (usually August 1) to meet the January 1 flood guide. The release rate depends on the economical use of hydropower and design considerations, and is not restricted to maintaining minimum reservoir levels.

Summer Operating Zone—**This zone allows for fluctuations in reservoir levels for power production, flood control, and mosquito control.

Winter Operating Zone—**This zone includes fluctuations in reservoir levels between the winter flood guide and the minimum pool for navigation.

* Applies only to some tributary reservoirs.

** Applies only to mainstem reservoirs.

(See Figures 2.2-03 and 2.2-04.)

- **Fall Drawdown.** Reservoir elevations are lowered to the winter operating level beginning at various dates through summer and fall (Appendix A, Table A–08).

Water Release Guidelines

TVA manages the rate of flow and water levels through the system by selective releases from the dams. These releases affect water quality conditions in the tailwaters and reservoirs, water supply to the lower reservoirs, and the temperature of cooling water for coal and nuclear power plants located on mainstem reservoirs. TVA also manages flows in the tailwaters to maintain water quality and aquatic habitat. At times, TVA releases water to provide flows for special operations, as described in a following section.

To meet flow needs in the tailwaters and flow-through needs in the downstream reservoirs, TVA has adopted two broadly defined reservoir release policy elements: project minimum flows and system minimum flows. A minimum flow is a release from one or more dams to meet downstream water needs (e.g., navigation, water supply, aquatic habitat, and waste assimilation); a minimum flow does not represent the lowest flow rate that TVA can pass from a dam or dams.

Project Minimum Flows

Project minimum flows are flows released at a specific reservoir (Appendix A, Table A–03). TVA implements project minimum flows to achieve specific operating objectives, including water supply and water quality improvements, and benefits for aquatic habitat and fisheries. Project minimum flows are provided below seven mainstem (these are also the system minimum flows discussed below) and 20 tributary reservoirs in a variety of ways, including instantaneous flows (continuous via small turbine operation or sluice outlet setting), pulsing flows (use of a generating unit at various hourly intervals), and daily average releases.

Minimum flows at 10 tributary projects were developed on the basis of techniques used by the USFWS to enhance aquatic life in streams in other regions of the country (see discussion of the Lake Improvement Plan in Chapter 1). These minimum flows are intended to afford greater protection for aquatic life from environmental stresses than would occur under average dry conditions.

System Minimum Flows

System minimum flows are indicators of total flow to meet requirements for navigation, water supply, cooling water for coal and nuclear plants, water quality, and aquatic habitat. System minimum flows are measured at the Chickamauga, Kentucky, and Pickwick Dams and other locations (Appendix A, Table A–03). These flows include a bi-weekly average minimum flow in summer and a daily average minimum flow in winter. If the total of the project minimum flows discussed above plus any natural runoff from the watershed is insufficient to meet these system minimum flows, additional water must be released from upstream reservoirs to supply the difference.

TVA uses a number of guidelines for system minimum flows as described in Section 2.3, Existing Water Control System Operations. These system minimum flows include:

- **Flows for Navigation—**to maintain minimum channel depths in the Tennessee River navigation channel.
- **Flows for Water Quality—**to minimize the water residence time (the amount of time it takes for water to pass through the reservoir) in mainstem reservoirs, thereby limiting periods of low DO in mainstem dam releases and reducing water quality degradation.
- **Flows for Cooling Water—**to meet the water temperature requirements of the cooling system discharges for TVA's nuclear and coal power plants.

Flows for Special Operations

Flows for special operations occur when reservoir levels are held steady or release schedules are modified to accommodate specific requests. In 2002, TVA responded to over 200 requests to support special events and activities across the Valley. Special operations have included boat parades, regattas, rowing competitions, and fishing tournaments throughout the Valley. Special operations have been scheduled to assist clean-ups, aid in stocking trout, free stranded barges, dilute runoff from fire-fighting, and recover drowning victims. They have also been used to support surveys of endangered plants, help control mosquito populations, and conduct fisheries research. Special operations may also be scheduled to facilitate boat ramp and pier construction, installation of water intake pipes, and shoreline stabilization projects.

Other Guidelines and Operational Constraints

Ramping Rates

Reservoir releases are normally made through a project's hydropower turbines, and these releases determine the rate of flow and depth in the project tailwater. The number of turbines in use and their size control the rate of flow. Project design features (e.g., the types and sizes of turbines) and the rate at which turbines are turned on and off—or ramped up or down—also govern the rate of flow. For purposes of this EIS, ramping rates refer to how many hydro turbine units are simultaneously brought online or taken offline at a hydropower plant. The term ramping rate can also indicate an increase or decrease in generation by an individual hydro turbine unit.

Restrictions are placed on ramping rates for environmental or safety concerns, or to limit upstream generation to balance a downstream project's storage volume. Existing ramping restrictions for TVA dams are outlined in Appendix A, Table A–04.

Response to Drought Conditions

Based on the 100 years of water flow data compiled by TVA, severe system-wide drought conditions are rare. When drought conditions occur, it becomes more difficult to meet competing demands for the use of water.

The system operating guidelines for the larger tributary storage projects include some measures that respond to drought conditions. For example, releasing only minimum flows when reservoirs are below their MOGs helps conserve water while still protecting aquatic life. When drought conditions persist for an extended period of time, operating decisions must be made based on the best available information. For example, during the hot, dry summer of 1999, operations at Normandy Reservoir were adjusted to enhance municipal water supply and Tims Ford Reservoir was operated to alleviate problems with inadequate water depth at the intake for a downstream public utility.

Scheduled Maintenance Periods for Hydropower Generation Facilities and Power Plants

TVA must plan and conduct periodic shutdowns of its hydropower facilities for maintenance activities. Special operations for this purpose usually require restrictions on reservoir levels or releases. These restrictions sometimes extend to upstream hydropower plants, because their flows can affect the special operations or maintenance outages at downstream projects. When hydropower units are out of service, they are unavailable for reservoir releases; therefore, such shutdowns are scheduled in consideration of projected release schedules.

TVA also schedules and performs periodic maintenance on its nuclear and fossil power plants. Scheduling of these outages may influence the timing of reservoir level changes or downstream flows.

Critical Power System Situations

During critical power system situations, including but not limited to Power System Alerts or implementation of the Emergency Load Curtailment Plan (ELCP), reservoir operations may temporarily deviate from normal system operating guidelines to meet power system needs. In such situations, water stored in the reservoirs may be used to the extent practicable to preserve the reliability of the TVA power system. Power system alerts are issued when situations such as an unexpected shutdown of a large generating unit, extreme temperatures, or an interchange curtailment (which limits TVA's ability to import power due to overloads on the bulk transmission grid) would reduce power supply reserves below TVA/North American Electric Reliability Council requirements.

The ELCP was developed to provide arrangements and contingency plans to meet power system emergencies. Emergency situations involving a sudden loss in power generation do not always allow a sequential implementation of the steps contained in the power system alert and ELCP processes. Further, issuance of a power system alert or ELCP does not necessarily mean that MOGs are no longer followed. The specific type of power emergency determines the type of operational responses required.

Dam Safety

TVA follows federal regulatory guidelines to ensure that operation of its reservoir system does not jeopardize the structural integrity of the dams. Dams and adjacent features, such as embankments and shoreline structures, are designed to be stable under a set of operating conditions, both normal and unusual, that might occur during the life of the structure. Drawdown limits for dam safety (Appendix A, Table A–07) ensure that the structures and systems are not exposed to conditions that are outside those design or safety limits. Relative to the reservoir operations policy, the pertinent limits include a maximum allowable reservoir elevation and a maximum rate of reservoir drawdown. The maximum allowable reservoir elevation is an unusual condition that would occur during a major flood. Reservoir drawdown occurs as a part of normal operations, and TVA must limit the rate of drawdown to maintain structural stability.

2.3 Existing Water Control System Operations

The previous section described the reservoir guide curves and other operational guidelines that are used to manage day-to-day operation of the water control system. The guide curves and guidelines were developed to achieve, to the extent possible, public benefits from the operating objectives established for the water control system. The following sections discuss how the system is operated to meet these objectives.

The operating objectives include:

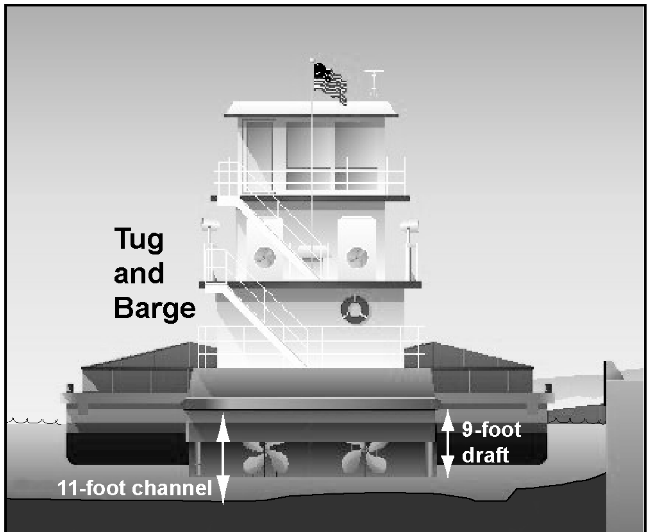
- Navigation
- Flood control
- Power production
- Water supply
- Water quality
- Recreation
- Other objectives

2.3.1 Operations for Navigation

Navigation is one of TVA's primary objectives. The Tennessee River is a key element of regional commerce because it provides a waterborne transportation route for movement of bulk commodities and materials into and out of the region. Commodities transported by barge include coal, aggregates, grains, and chemicals. Because most bulk commodities are needed on a year-round basis, maintaining navigation on the reservoir system is an important operating objective. This objective is met by maintaining adequate river depths, rate of flow, and controlling flood flows during times of high runoff.

Maintaining Adequate River Depths for Navigation

The existing reservoir operations policy prescribes that the reservoir system be operated to provide a minimum depth of 11 feet in the navigation channel within the reservoirs on the mainstem between Paducah, Kentucky (where the Tennessee River joins the Ohio River), and Knoxville, Tennessee. The 11-foot channel allows for passage of commercial barges with a 9-foot draft (the depth below the water surface that a towboat and barge extend when fully loaded). The additional 2 feet of channel depth allow for such operational factors as squat, trim, and wave action (factors that affect the draft of the boat), as well as sufficient channel width for safe navigation (Figure 2.3-01).



Note: A minimum channel depth of 11 feet allows standard commercial barge traffic to move through the system with a 2-foot overdraft (extra space between bottom of boat and river bottom).
Source: TVA data 2003.

Figure 2.3-01 Illustration of Minimum Channel Depth for Navigation

During normal flow conditions, operation of the reservoir system for flood control and power generation provides adequate water flow through the system to maintain minimum channel depths, making these operating objectives complementary uses of the water. To maintain adequate river depths for navigation, TVA must:

- Hold pool levels at all nine mainstem reservoirs high enough to provide an 11-foot depth at the shallowest points along the channel; and,
- Release enough water to create a depth of flow sufficient to provide an 11-foot channel at Kentucky and Pickwick tailwaters.

At times during summer and fall, when runoff is lowest, flows may be insufficient to maintain an 11-foot depth for the entire navigation channel. The channel depth at shoals, sandbars, and other shallows may cease to meet the 11-foot minimum and may impede navigation operations. During these periods, barge operators may reduce barge loads (and the draft needed for passage) or cease operations altogether. In response to low flows and shallow navigation channels, TVA may release water from storage in the tributary reservoirs to increase flows in the mainstem reservoirs and tailwaters in order to maintain the 11-foot minimum channel depth for navigation.

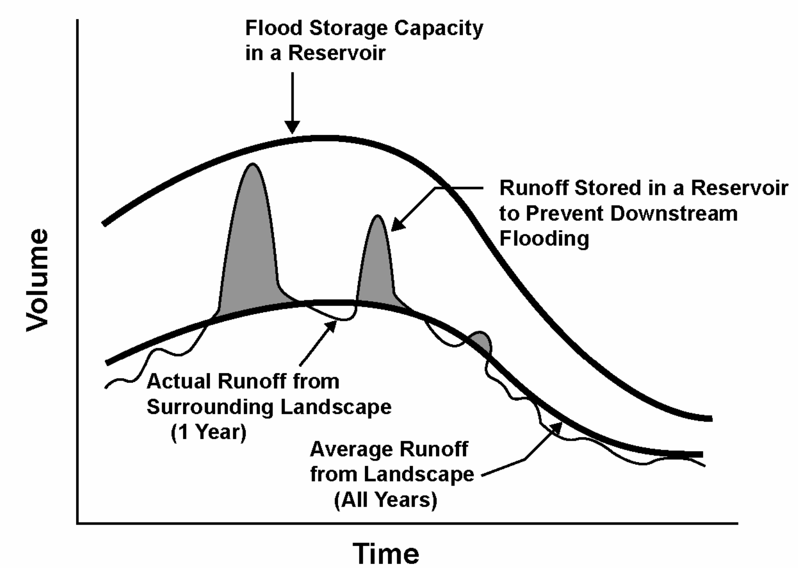
Controlling Flood Flows for Navigation

During periods of high flow (during and after major storms and high runoff), flow velocity and turbulence in the navigation channel, especially at the entrance and exit of locks and in shoal areas, may become dangerous to barge operations. For safety in these circumstances, navigation is suspended and barge movement is stopped until flows are reduced to a safe level and navigation can be resumed. When the reservoir system stores flood flows, disruption of navigation from dangerous high flows is minimized. To the extent that navigational operations are not interrupted by insufficient water depths or high river flows, the reliability and cost effectiveness of river transportation are achieved by operation of the reservoir system.

2.3.2 Operations for Flood Control

Reducing flood damage at critical locations is the second primary objective of the reservoir system. The greatest potential for flood damage is in and around Chattanooga, which is located just upstream from the point where the Tennessee River passes through the Cumberland Mountains. This mountain pass constricts higher river flows, backing water up onto adjacent floodplains.

During periods of high flow, flood risk can be significantly reduced by storing runoff in both tributary and mainstem storage reservoirs (Figure 2.3-02).



Note: On average, there is more storage capacity than is needed. However, the full capacity is needed during high runoff years.
Source: TVA data 2003.

Figure 2.3-02 Storage of Increased Runoff to Prevent Flooding

To reduce the risk of flooding, TVA implements the following actions:

- A portion of each reservoir's storage volume is set aside specifically for floodwater storage (Table 2.1-01). This storage is reserved so that it is available when increased runoff occurs.

- During a flood event, the reservoir operations policy permits storage reservoirs to rise above their flood guides, storing the excess runoff and reducing downstream flood crests that may otherwise inundate flood-prone areas.

- After the peak flow of the storm has passed, the stored floodwaters are released at a controlled rate to recover flood storage. This controlled release protects against downstream flooding and reclaims the reservoir's flood storage volume in preparation for the next storm.

Each reservoir's flood guide curve reflects the amount of storage reserved for flood control and how it varies by season of the year. These allocations were determined in the original project design, and some have been modified based on subsequent analysis of rainfall and runoff characteristics of the drainage basin and the physical limitations of the reservoir system. As noted in the discussion of reservoir guide curves (Section 2.2, Water Control System), the amount of flood storage for most tributary storage reservoirs is greatest in winter and early spring. As runoff volumes decline in late spring or summer, reservoir levels are allowed to increase, thus reducing flood storage volume (Figures 2.2-03 and 2.2-04).

Water releases during flood control operations may differ from normal releases. Most often, water is released through the hydro turbines. The flood control reservoir operations policy prescribes the amount of water to be released and the method of its release to reestablish flood storage. This drawdown is usually accomplished by operating the hydro turbines at maximum capacity until the necessary quantity of water has been discharged from the reservoirs. At other times, additional water must be released through sluiceways or spillways to lower the reservoir levels more quickly and regain the storage space needed for future storms.

Although the general flood protection procedure is the same for all storms, which reservoirs are filled and the timing of the store-and-release operation varies from storm to storm depending on where and how much rainfall occurs, and how much flood storage is allocated. System operations in response to an isolated thunderstorm might involve store and release at a single reservoir. In contrast, flood control operations for a major storm that spans the majority of the Tennessee Valley would necessitate the integrated operation of all the reservoirs in the system and may require coordination with the USACE on the lower Ohio and Mississippi Rivers.

2.3.3 Operations for Power Production

A third primary objective of the TVA water control system is the production of power for energy users in the TVA Power Service Area (Figure 1.1-02). TVA's power system includes 3,842 megawatts (MW) of conventional hydropower generating capacity, 1,645 MW of pumped storage capacity, and over 25,000 MW of fossil and nuclear generation facilities.

Most of TVA's fossil and nuclear generation plants are located along the reservoir system. Thus, the reservoir system is used directly to generate electrical energy (hydropower) and supports energy generation by providing cooling water to coal and nuclear plants, and transport of coal to its power plants. TVA operates all of its power plants together to meet regional power demands at the lowest possible cost to consumers.

Hydropower Generation

Energy generation from TVA's hydropower facilities is an important component of TVA's power supply system. Hydropower facilities provide reliable, low-cost energy. In the TVA system, these facilities primarily provide peaking power (power needed during periods of highest energy demand). The TVA Power Service Area typically has one period of high demand in summer and a second high-demand period in winter; the summer peak period is longer than the winter peak period. In an average year, more than 55 percent of the annual hydropower generation occurs during these two peak periods.

Hydropower is generally produced whenever reservoir releases are made, regardless of the purpose of the release. When a reservoir is within its discretionary operating zone (Section 2.2, Water Control System), additional water may be released for the sole purpose of generating hydropower. Releases are scheduled so that hydropower turbines are operated to maximize their value to the power supply system—by operating during the peak demand hours of each day and typically more on weekdays than on weekends.

The primary limit on generation of hydropower within the reservoir system is the availability of water, which may be constrained by low rainfall or other system operating priorities. For example, when TVA maintains higher summer pool levels by restricting drawdown, less water is available for hydropower generation.

Under normal streamflow conditions, releases from upstream reservoirs are scheduled to avoid releasing more flow into the mainstem reservoirs than TVA's hydropower units can use. During high-flow periods, excess water must be discharged through spillways or sluiceways, but using this option means losing the opportunity to use the water to generate electricity and diminishing the potential energy value of the water.

Coal and Nuclear Power Generation

Operation of the reservoir system also provides cooling water for TVA's coal and nuclear power plants. TVA coal and nuclear plants provide 80 percent of the energy needed for the TVA Power Service Area and depend on reservoir operations. Because their availability is essential to TVA's ability to provide reliable, affordable electricity, support of coal and nuclear plant operations by the reservoir system is an important operating objective.

The coal and nuclear plants require large quantities of cooling water to operate. Return of the cooling water to the reservoir system is regulated (by permit) and includes limitations on the increase in reservoir water temperatures that can result from the power plant discharge. These limitations are established to maintain water quality and protect aquatic life. System minimum flows in the Tennessee River are governed in part by the cooling water needs of these plants.

If cooling water discharges from any of TVA's power plants are predicted to exceed permit limits, power plant operations must be curtailed or river flows must be modified. The options available to TVA include reducing generation output (referred to as derating a power plant), which reduces the amount of discharged heat; or, at some facilities, switching to more expensive backup cooling systems (cooling towers). Both options increase TVA's cost of power generation. TVA may also modify reservoir releases to provide more flow or create steady flow. When possible, TVA selects the option that minimizes power costs.

Reductions in coal and nuclear power generation (derates) typically occur during summer months. When flows in the reservoir system are reduced, reservoir water temperatures increase—providing less power plant cooling capacity. If the river flow is too low to provide adequate cooling water, flows may be supplemented by releases from tributary storage reservoirs. Historically, modification of some plant operations for some portion of the summer period has been necessary to maintain thermal limit compliance.

Any reduction in energy output from the coal and nuclear plants typically must be replaced by obtaining the electricity from other generating sources. Because generation output reductions due to thermal limits generally occur on hot summer days when the demands on TVA's generating resources are the greatest and when all of TVA's plants are already operating, replacement energy often must be obtained from non-TVA energy resources at higher costs. Although replacement energy may be available from outside sources, overloading can occur on the bulk transmission grid, resulting in insufficient transmission capacity to bring it into TVA's Power Service Area. Recently, circumstances have occurred when energy was available only from other sources and the costs of the available energy were very high compared to TVA's power system costs.

2.3.4 Operations for Water Supply

The TVA reservoir system supports a variety of instream and offstream water uses, including power production (cooling water for coal and nuclear power plants), industrial production, public supply, and irrigation. Water is withdrawn at over 700 points along the Tennessee River and its tributaries to benefit approximately 4 million citizens. According to the U.S. Geological Survey, about 12 billion gallons of water are withdrawn from the river system each day (Hutson et al. 2003). TVA's reservoir operations provide the reservoir levels and system flows necessary to support water supply withdrawals and allow pumping mechanisms to function properly.

Water in the TVA system is some of the most intensively used in the United States as measured by water use per area or population (Hutson et al. 2003). At the same time, the basin has one of the lowest rates of consumptive use. Basin-wide consumptive use is presently about 5 percent of the water withdrawn; 95 percent of the water withdrawn is returned to surface water or groundwater for reuse. Increase in consumptive uses through 2030 is not expected to exceed 14 percent of the total water withdrawn (Hutson et al. 2003).

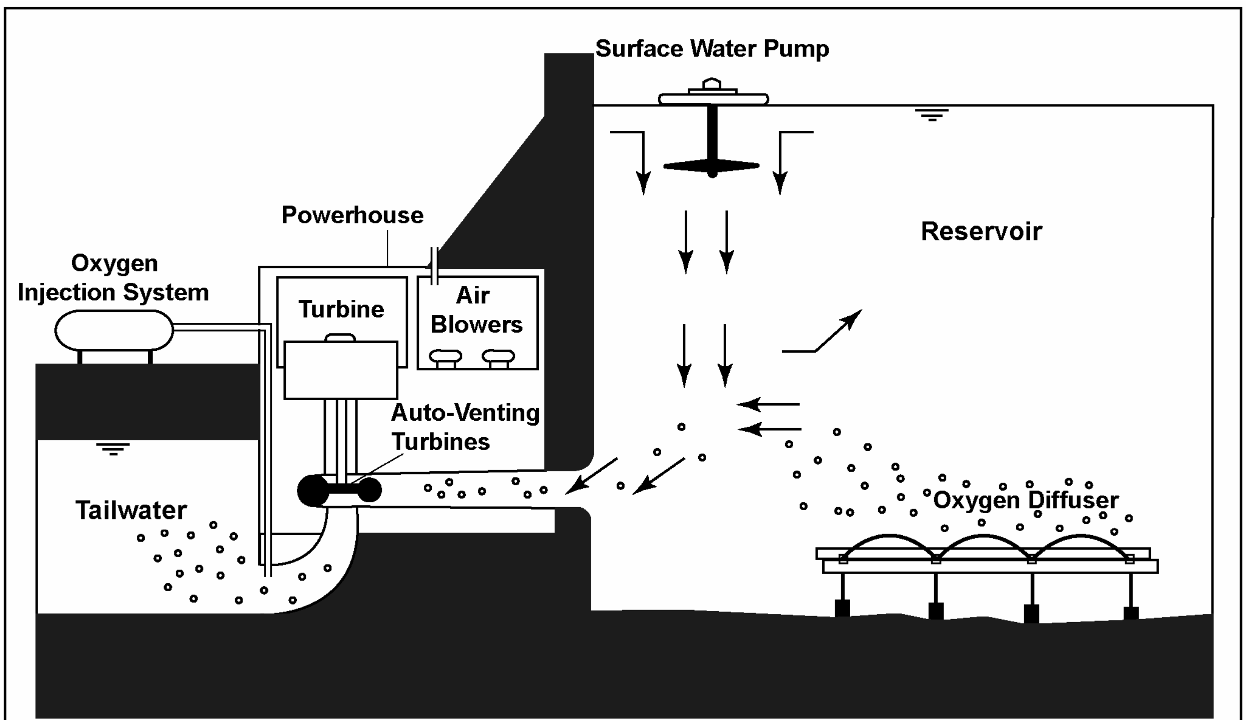
2.3.5 Operations for Water Quality

The public value placed on water quality has increased in recent years; TVA reservoir operations presently support a variety of water quality functions. These functions—previously outlined in Section 2.2.5, Water Release Guidelines, and more fully explained in the Water

Quality sections in Chapters 4 and 5—include maintaining water quality in project reservoirs and tailwaters, increasing the aeration of reservoir releases, diluting municipal and industrial waste, and ensuring adequate supplies of cooling waters for coal and nuclear power plants.

Reservoir operations and releases affect the concentration of DO in the water. Dissolved oxygen is an important water quality parameter, because insufficient DO concentration can be detrimental to the health and integrity of aquatic biota in reservoirs and tailwaters. As water is stored in reservoirs, physical and biological processes often depress the concentration of DO in the deeper waters of the reservoir. Depletion of DO concentrations is generally greater when the rate of water flow through a reservoir is less (water is held for longer periods). Higher DO concentrations accompany higher rates of flow through a reservoir. Because most hydropower turbines withdraw water from the deeper waters of the reservoir, the operation of hydropower facilities contributes to downstream DO problems, particularly below tributary dams. From June through November, hydropower releases from deeper reservoirs may contain little or no DO. This lower concentration of DO stresses aquatic life in tailwaters, cool-water species in reservoirs, and limits the water's capacity for assimilating waste.

Starting in the 1980s, under the Reservoir Release Improvement (RRI) Program, TVA developed methods to increase oxygen in the water below hydropower dams. These methods included auto-venting turbines, surface water pumps, oxygen injection systems, aerating weirs, and blowers (Figure 2.3-03). In 1991, under the Lake Improvement Plan, TVA adopted efforts to increase DO concentrations in the releases from 16 dams using these techniques (Appendix A, Table A–05) and to provide project minimum flows.



Source: TVA data 2003.

Figure 2.3-03 Aeration Methods to Increase Oxygen in Water below Hydropower Projects

A direct relationship exists between storage of water in the tributary reservoirs later into the summer and an increasing frequency of late summer water quality problems, especially DO. Increasing flow through the reservoirs in late summer, as is now accomplished by the late-summer/fall drawdown and system minimum flows, reduces DO problems. Higher DO concentrations often occur when water from the tributaries is moved through the reservoir system in late summer and early fall to meet certain other reservoir system operating priorities, such as hydropower production and system minimum flows for navigation and coal plant cooling water.

2.3.6 Operations for Recreation

Recreation on the reservoirs and tailwaters of TVA's system has grown in importance over the last 30 years. Reservoir operations presently include a variety of measures that provide recreational opportunities for residents and for visitors. Operations for recreation can be broadly divided into those for reservoir recreation and those for tailwater recreation.

Reservoir Recreation

TVA's present guidelines for reservoir levels were developed in part to improve recreational opportunities on tributary reservoirs during spring, summer, and fall. Beginning in mid-March, the 10 tributary reservoirs that are subject to substantial drawdown—Norris, Cherokee, South Holston, Watauga, Douglas, Fontana, Blue Ridge, Hiwassee, Nottely, and Chatuge—are filled to reach the target June 1 summer pool levels for recreation. The reservoirs are filled as quickly as possible, as long as reservoir levels do not exceed flood guide levels. Further, if low rainfall prevents reservoirs from filling at the desired rate, releases are limited to only those necessary for minimum flows.

Based on TVA's most recent evaluation in the Lake Improvement Plan, reservoir levels are maintained within the discretionary operating zone as much as practicable from June 1 to August 1. The rate of drawdown from June 1 to August 1, known as the period of restricted drawdown, is adjusted as necessary in an effort to generate hydropower while keeping reservoir levels above the MOG for recreation. If reservoir levels fall to the MOG due to low rainfall or high power demand, water levels are maintained as high as possible for recreation by restricting any further releases to minimum flows. On August 1, TVA begins the period of unrestricted drawdown on these reservoirs and is no longer restricted to maintaining minimum reservoir levels. Mainstem reservoirs fill earlier and drop only a few feet from summer pool to winter flood season levels.

Tailwater Recreation

There are 21 tailwaters on the reservoir system that may support recreational activities. In some tailwater reaches of the river, fishing, boating, and white-water activities (rafting and kayaking) are important. Providing recreational benefits may require managing reservoir releases for flows in tailwaters. Flows in the tailwaters should be sufficient to maintain fisheries and aquatic communities, and to support water-based recreation. Project minimum flow guidelines have been established at 20 tributary dams in the system; many of these have tailwaters that support recreational use. In addition, releases to meet system minimum flows support recreational use at various levels, depending on the specific conditions, access, accrual of flow from other tributaries, and a variety of other factors.

2.3.7 Operations for Other Objectives

TVA operates the reservoir system to achieve the primary operating objectives described earlier, but the system produces other important benefits in the watershed and Power Service Area. The following secondary benefits are generally available when they do not conflict with the reservoir system's primary objectives.

Mosquito Control

During late spring and summer, TVA fluctuates water levels every week on four mainstem reservoirs (Chickamauga, Guntersville, Wheeler, and Pickwick) by 1 foot, flow permitting. This temporary change in reservoir level disrupts mosquito habitat, reducing the number of mosquito larvae during the height of the mosquito breeding season.

Fish Spawning

In spring (generally the period of late-April to mid-May), the reservoir system is operated so that water levels in tributary reservoirs are relatively stable for a 2-week period when the water temperature at a 5-foot depth reaches 65 °Fahrenheit. At this water temperature, peak spawning occurs for several popular sport fish species (mainly largemouth bass and black crappie). If reservoir levels are reduced during the peak spawning period, fish nests and eggs may be stranded above the water line or fish may abandon nests if water becomes too shallow. Stabilizing reservoir levels aids fish spawning success for these species, ultimately improving recreational angling. During the peak spawning period, it is most beneficial to avoid more than a 1-foot-per-week change (either lowering or rising) in pool levels. Rising water levels affect fish spawning success less than falling levels.

The period to maintain constant tributary reservoirs levels for fish spawning coincides with the period for filling reservoirs to reach their target summer elevations, resulting in conflict. In addition, if the water level in a particular reservoir or group of reservoirs rises during this period due to heavy rains, it is often necessary to lower pool levels in order to recover flood storage volume.

2.3.8 System Monitoring and Decision Support

TVA's reservoir operations policy provides the framework for overall operation of the system. Day-to-day decisions on actual release schedules are based on existing and forecasted weather conditions, immediate and projected needs for river flows, and special operation requirements. To ensure the efficient operation of its complex reservoir system, TVA uses a variety of data collection, computerized reporting, and decision support systems.

TVA, in cooperation with the USGS and USACE, maintains a computerized hydrologic data network (rainfall and streamflow gauges) throughout the Tennessee Valley; these measurements are reported and used in real time, generally about every 2 hours. Forecasting of weather and scheduling of water releases are supported by an array of computerized data collection and decision support tools, allowing TVA to examine several operational options before making decisions.

TVA's operations are closely coordinated with those of other agencies, especially the Nashville District of the USACE, which operates projects in the Cumberland River Basin that can interact with TVA's operations and affect downstream conditions. During periods of flooding on the lower Ohio and Mississippi Rivers, releases from Kentucky Dam are coordinated with the USACE Great Lakes and Ohio River Division, to aid in reducing flooding on those rivers. The same is true during extreme low-flow periods, when minimum river depths for commercial navigation are not available. The interconnected Tennessee and Cumberland Rivers constitute only 6 percent of the total Mississippi River watershed area above Memphis. During low-flow periods, however, discharges from the storage dams on these rivers contribute up to 40 percent of the total flow.

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Chapter 3

Reservoir Operations Policy Alternatives

TVA

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3.1 Introduction

The National Environmental Policy Act (NEPA) requires federal agencies to evaluate a reasonable range of alternatives and the alternative of taking no action. This chapter describes the process TVA used to develop reservoir operations policy alternatives; the rationale used to develop, screen, and select a range of policy alternatives; and the policy alternatives selected for detailed analysis. Each policy alternative is compared to the other policy alternatives and to the Base Case.

For the purposes of this EIS, a policy alternative refers to a set of system-wide operational changes that would re-balance the TVA reservoir system to emphasize certain operating objectives, such as increased opportunities for recreation, hydropower production, or navigation. To be considered reasonable, an alternative was required to be capable of adjusting the balance of operating objectives in response to expressed public values; continuing basic reservoir system benefits of flood control, navigation, and power production; and being environmentally, economically, and technically feasible. The process used to formulate and select policy alternatives is presented in Section 3.2.

Process for Development of Alternatives

- Conducted public outreach to identify public's preferred reservoir operation priorities
- Compiled comments received during public scoping about suggested changes to the reservoir operations policy
- Identified major and minor issues
- Compiled operating options suggested by the public
- Developed, screened, and evaluated 65 preliminary policy alternatives
- Eliminated from further consideration those alternatives that did not meet operating objectives or were not practicable
- Formulated condensed set of 25 preliminary alternatives
- Obtained Interagency Team and Public Review Group review and comment on the condensed set of 25 preliminary alternatives
- Revised condensed set of 25 preliminary alternatives and developed a refined set of 25 alternatives
- Modeled the refined set of 25 alternatives to confirm technical and economic feasibility
- Screened and narrowed the number of alternatives to be considered by combining similar alternatives and bounding the range of possibilities
- Selected eight alternatives for further consideration (the Base Case and seven policy alternatives)
- Reexamined the eight alternatives to determine whether any additional operating objectives or policy elements should be included
- Analyzed and discussed the eight alternatives in the DEIS
- Compiled and reviewed comments on the DEIS
- Conducted additional analyses and developed a series of Preferred alternatives leading to the development of the Preferred Alternative, which is analyzed in this FEIS

Eight reservoir operations policy alternatives (seven policy alternatives and the Base Case) were selected and carried forward for detailed evaluation in the DEIS. A description of each of these alternatives is given in Section 3.3. A number of other alternatives and actions were considered but not carried through detailed analyses; the reasons for their elimination from further consideration are presented in Section 3.4. After receiving comments on the eight alternatives in the DEIS and conducting further analysis to address adverse effects of those alternatives, TVA formulated and analyzed a Preferred Alternative.

Identifying and quantifying the trade-offs between competing reservoir operating objectives were essential to evaluating the policy alternatives. In Section 3.5, the benefits achieved by each alternative and its consequences to the natural and human environment are summarized and compared. (See Chapter 5 for detailed analyses of potential impacts associated with each policy alternative.) This section also compares the public benefits that would result from implementation of any of the policy alternatives, including the Base Case.

3.2 Alternatives Development Process

TVA developed policy alternatives with extensive involvement by the public, governmental agencies, and non-governmental organizations. This process resulted in two important inputs for establishing alternatives:

- **Objectives—**public benefits to be emphasized by reservoir operations, such as increasing recreation, reducing flood risk, and improving tailwater aquatic habitat conditions. See Section 1.6.2 inset box and Table 1.6-03 for objectives identified during scoping.

- **Policy elements (or operating options)—**distinct reservoir control operations or practices suggested by the public, such as changing summer pool levels and increasing tailwater flows, that could be combined into various reservoir operations policy alternatives. These elements are identified in Table 1.6-04.

Using these operating objectives and policy elements, a large number of possible operational changes were considered and formulated into potential policy alternatives. These alternatives were narrowed to a smaller set based on the evaluation process described in the following sections.

3.2.1 Formulating Policy Alternatives

During the EIS scoping process, individuals and representatives of various agencies identified a range of issues concerning TVA's existing reservoir operations policy and possible changes that could be made. The most common and widely supported suggestions concerned changing summer and winter pool elevations and water releases to provide reservoir and tailwater recreational opportunities while protecting the environment, aquatic life, and water quality (Section 1.6.2). These issues and suggested changes were analyzed and translated into a list of objectives and a list of policy elements or operating options.

TVA reservoir operations staff then reviewed the list of operating options and combined them, along with appropriate operations terminology, to form more complete policy alternatives. This process (see the discussion of the scoping process in Section 1.6) produced 65 preliminary policy alternatives with different levels of refinement. Some alternatives involved changing or adjusting a single operations practice while others involved changing multiple practices.

3.2.2 Screening Preliminary Policy Alternatives

Each of the 65 preliminary policy alternatives could have been evaluated as a discrete, stand-alone alternative, or combined with one or more alternatives in various ways to produce innumerable alternatives to TVA's existing reservoir operations policy. To narrow the scope of the analysis to a reasonable range of alternatives, TVA used an iterative screening and evaluation process to review and refine the initial alternatives. This process yielded a range of preliminary policy alternatives for further analysis.

TVA began the screening process by considering whether any of the 65 preliminary alternatives would be impossible to implement, given the physical configuration and operational capabilities of the projects (dams and reservoirs) being studied. None of the 65 preliminary alternatives were eliminated because of such constraints.

The alternatives were then screened to identify those expected to result in substantially adverse impacts in terms of issues raised during scoping (Table 1.6-02). TVA staff used the 11 major issues as evaluation criteria for this screening process.

Using a scale of –10 to +10 for each evaluation criterion, the alternatives were screened by TVA technical staff. The score for each criterion indicated a positive or negative change from existing reservoir operations (the Base Case equaled a score of 0). A score of –5 or +5 (or greater) represented a substantial change from the Base Case. The scores for all criteria were then summed for each alternative, and the total scores for all alternatives were compared.

Those alternatives that received a positive total score were retained for further screening. Those alternatives with substantial negative impacts (–5 or a greater negative number) for any single criterion (except flood risk) were eliminated from further consideration. TVA comprehensively reevaluated flood risk as part of the ROS and did not want to eliminate alternatives on the basis of unacceptable flood risk impacts in the Tennessee River watershed prior to completing this evaluation.

When an alternative was eliminated as a result of a substantial negative impact, the screening process was stopped to determine whether any of the elements of that alternative could be added to one or more of the remaining alternatives. TVA used this approach so that specific reservoir policy elements that were important to evaluate could be carried forward for further screening and possible detailed evaluation. This process was repeated until no new alternatives could be created. TVA staff deviated from this process only to preserve, where possible, specific elements that had been supported by a substantial number of stakeholders.

Screening process results were provided to the members of the IAT and PRG. Individuals in both groups endorsed the process after having the opportunity to conduct an independent evaluation of the screening results. The initial screening of the 65 alternatives resulted in a condensed set of 25 preliminary alternatives. The list of 65 preliminary alternatives, including screening results, is part of the ROS administrative record.

3.2.3 Selecting Policy Alternatives

RESERVOIR OPERATIONS POLICY ALTERNATIVES EVALUATED IN DETAIL IN THE DEIS

Alternative Name	Number Code
Base Case	-
Reservoir Recreation A	2A
Reservoir Recreation B	3C
Summer Hydropower	4D
Equalized Summer/ Winter Flood Risk	5A
Commercial Navigation	6A
Tailwater Recreation	7C
Tailwater Habitat	8A

Starting with the condensed set of 25 preliminary policy alternatives, TVA further screened the alternatives to select those to be analyzed in detail. The 25 policy alternatives were screened using a similar process and the same major evaluation criteria that were used to screen the 65 preliminary policy alternatives. TVA staff again reviewed the alternatives to identify sets of compatible policy alternatives (or policy elements) that could be combined. For example, increasing releases to enhance hydropower generation would be compatible with increasing minimum flows to enhance water quality and aquatic resources, depending on how hydropower releases are made. The goal of this task was to combine as many policy alternatives as possible in order to reduce the list of alternatives to a more manageable number for detailed evaluation, while maintaining a reasonable range of policy alternatives that would identify the potential for greater overall public value. Some policy alternatives that resulted in substantially less improvement in overall public value compared to other similar alternatives were eliminated from consideration. Other policy alternatives were formulated during this process, but the number of alternatives retained for the next step of the evaluation process coincidentally remained at 25. (The operating guidelines that comprise the refined set of 25 alternatives are described in Appendix B.)

After the refined set of 25 policy alternatives had been screened, TVA staff performed computer simulations to determine the effect of these 25 reformulated alternatives on selected system operating parameters. These included reservoir elevations, streamflow conditions, and water availability during wet, normal, and dry years; and, for some alternatives, the cost of power and power reliability. These key parameters are associated with a range of environmental and economic issues. The outputs from these computer simulations also provided a basis for a preliminary assessment of potential impacts on other system operating objectives, including water quality and reservoir and tailwater recreation.

Based on the results of the simulations, 18 of the refined preliminary alternatives were eliminated from the list. At the conclusion of this process, eight policy alternatives (including the Base Case or No-Action Alternative) were retained for detailed analysis in the DEIS.

During the process of formulating and evaluating alternatives, a reference number/letter designation was assigned to each policy alternative. The names shown in the inset box on the preceding page were assigned to those alternatives selected for detailed analysis.

3.2.4 Developing a Preferred Alternative

After extensive public review of the DEIS and additional analyses, TVA developed a Preferred Alternative. This alternative combines and adjusts elements of the alternatives identified in the DEIS to preserve desirable characteristics and to avoid or reduce adverse impacts associated with those alternatives, especially the potential substantial impacts related to flood damages, water quality, power costs, aquatic resources, wetlands, and migratory waterfowl and shorebirds. The Preferred Alternative would establish a balance of reservoir system operating objectives that is more responsive to the values expressed by the public during the ROS and consistent with the operating priorities established by the TVA Act.

Resolving flood risk issues was a central component in formulating the Preferred Alternative because reducing flood damage is one of the most valuable benefits provided by the system. Except for the Base Case, all of the alternatives evaluated in the DEIS would result in unacceptable increases in the risk of flooding at one or more critical locations in the Tennessee Valley. Addressing flood risk was the first step in creating the Preferred Alternative. TVA used an iterative series of eight blended alternatives to eliminate increases in average annual flood damages at critical locations. TVA also used this series of alternatives to develop a more equitable way of balancing pool levels among the tributary reservoirs. Each iteration included modifications to individual project flood guides and/or regulating zones that were intended to address problem areas while preserving changes in reservoir pool levels that would enhance a range of benefits. Individual project guide curves were changed to resolve flood damage issues immediately downstream of certain projects and further downstream at damage centers.

As the flood risk issues were addressed, TVA included enhancements to reservoir and tailwater recreation and navigation, while considering impacts on low-cost/reliable electricity, water quality, and water supply. As part of these iterations, TVA investigated using both specified flow (i.e., including higher minimum flows in June, July, and August) and target reservoir elevation constraints as mechanisms for restricting drawdown from June 1 through Labor Day. The results of these iterations indicated that operating objectives could best be met by using flow constraints that reduce impacts on water quality and power system costs. Flood risk considerations indicated that earlier fill of tributary and mainstem projects was not feasible. No changes in seasonal water levels on Kentucky Reservoir were included as part of this alternative in response to concerns expressed by the USACE, the USFWS, state agencies, and some members of the public.

3.3 Alternatives Evaluated in Detail

Table 3.3-01 includes a summary of the existing reservoir operating guidelines (guide curves) and water release guidelines under the Base Case. Detailed information concerning the Base Case (for example, fill and drawdown target levels for specific reservoirs) is included in

Appendix A. Following the description of the Base Case, Table 3.3-01 lists the proposed changes to the existing guide curves and water release guidelines under each of the policy alternatives. Appendix B contains more detailed information about the policy alternatives (e.g., the specific reservoirs that would be affected by proposed changes).

Each of the alternatives is described in detail in the following sections according to its purpose, proposed operational changes, and effects on operating objectives.

- **Purpose.** The purpose statement describes the primary operating objective that was emphasized in developing the policy alternative and for which the alternative is named (e.g., reservoir recreation). Because each alternative represents a balance among operating objectives, the secondary objectives or constraints used to formulate the alternative are also identified.

- **Changes in Operations.** The changes in reservoir levels, flow releases, and other operations are identified for each policy alternative (see Appendix B for full details). Because many policy elements would remain the same across all alternatives, the descriptions below focus on how the alternatives would differ from the Base Case.

- **Achievement of Objectives.** This brief description states how the policy alternative is expected to meet the primary objective(s) of the reservoir system. Details concerning impacts on other operating objectives and environmental resources are described in Chapter 5 and are summarized in Section 3.5.

Although no alternatives are specifically designed (or named) to enhance water quality, water supply, and other objectives discussed in Chapter 1, these topics have been fully addressed in the policy alternatives that were analyzed. The policy alternatives selected for detailed analysis include a sufficiently wide range of operating conditions, including reservoir levels, flows, and timing, to address the potential impacts on these other operating objectives. Water quality in the reservoirs and regulated stream reaches is generally closely related to the timing and rate of flow through the reservoirs and tailwaters during summer and early fall. The nine alternatives (including the Base Case) examined in detail provide a wide range of operations—from maintaining higher water levels in the reservoir system into the fall to balancing drawdowns and flow through the system to be more evenly distributed over the seasons.

Under all policy alternatives, during critical power system situations—including but not limited to Power System Alerts or implementation of the Emergency Load Curtailment Plan, reservoir operations may temporarily deviate from normal system operating guidelines to meet power system needs. In such situations, water stored in the reservoirs would be used to the extent practicable to preserve the reliability of the power system.

Table 3.3-01 General Description of Operations under the Policy Alternatives That Were Evaluated in Detail

Policy Alternative	Reservoir Operating Guidelines (Guide Curves)	Water Release Guidelines
Base Case	• Continue to fill tributary reservoirs (TR) to summer pool levels by June 1 and restrict drawdown during June and July [1] • Continue to begin unrestricted TR drawdown on August 1 [1] • Continue to fill and drawdown mainstem reservoirs (MR) by targeted dates [1] • Continue to meet winter pool levels by January 1 on TR and MR [1] • Maintain MR winter pool levels until current dates [1] • Maintain 2-foot normal winter operating range on MR	• Continue established minimum flows (such as Chickamauga Reservoir releases at 13,000 cfs bi-weekly average minimum flow from June to August; 7,000 bi-weekly average minimum flow for May and September, and 3,000 daily average minimum flow for October through April) • Continue tailwater recreation releases below Watauga/Wilbur, Apalachia, Tims Ford, Ocoee #2, and Ocoee #3 Reservoirs
Reservoir Recreation Alternative A	• Extend TR summer pool levels through Labor Day • Extend MR summer pool levels to August 1 and slope MR drawdown curve by 1 foot from August 1 through Labor Day • Delay unrestricted TR drawdown until after Labor Day • Raise TR winter flood guides equal to Base Case March 15 levels • Raise MR winter flood guides by 2 feet (with a 1-foot operating range) to create 13-foot navigation channel (11 feet with 2 feet overdraft) • Reduce MR winter operating range to 1 foot	• Release only Base Case minimum flows from June 1 to August 1 • Establish weekly average Chickamauga Reservoir releases at 25,000 cfs from August 1 through Labor Day

Table 3.3-01 General Description of Operations under the Policy Alternatives That Were Evaluated in Detail (continued)

Policy Alternative	Changes to Reservoir Operating Guidelines (Guide Curves)	Changes to Water Release Guidelines
Reservoir Recreation Alternative B	• Extend TR summer pool levels to Labor Day and restrict drawdown until after Labor Day • Extend MR summer pool levels through Labor Day • Raise TR winter flood guides to levels needed to store only inflow volume of the 7-day, 500-year storm [2] • Raise MR winter flood guides by 2 feet (with a 1-foot operating range) to create 13-foot navigation channel (11 feet with 2 feet overdraft)	• Release only Base Case minimum flows from June 1 to Labor Day
Summer Hydropower Alternative	• Fill TR and MR to current full summer pool levels by June 1 • Begin TR and MR unrestricted drawdown on June 1 • No guaranteed TR and MR summer pool levels • Raise TR winter flood guides to levels needed to store only inflow volume for 7-day, 500-year storm [2]	• Establish weekly average Chickamauga Reservoir releases at 35,000 cfs from June 1 through September 15 • Provide scheduled tailwater recreation releases only for Ocoee #2
Equalized Summer/ Winter Flood Risk Alternative	• Establish year-round TR and MR flood guides at levels needed to store only inflow volume for critical-period, 500-year storm [3]	• Release only Base Case minimum flows from June 1 to August 1 • Establish weekly average Chickamauga Reservoir releases at 25,000 cfs from August 1 through Labor Day
Commercial Navigation Alternative	• Raise MR winter flood guides by 2 feet (with a 1-foot operating range) to create 13-foot navigation channel (11 feet with 2 feet overdraft)	• Increase continuous minimum instantaneous flows at Kentucky (25,000 cfs); based on elevation, increase minimum instantaneous flows at Pickwick (18,000 cfs) and Wilson (18,000 cfs) Reservoirs • Limit maximum flow at Barkley Reservoir to 28,000 cfs, except when higher flow levels are required to maintain flood storage allocation

Table 3.3-01 General Description of Operations under the Policy Alternatives That Were Evaluated in Detail (continued)

Policy Alternative	Changes to Reservoir Operating Guidelines (Guide Curves)	Changes to Water Release Guidelines
Tailwater Recreation Alternative	• Extend TR and MR summer pool levels to Labor Day once Base Case minimum flows and tailwater recreation flows are achieved (if not achieved, maintain minimum flows first, then tailwater recreation flows) • Delay TR and MR unrestricted drawdown until Labor Day • Increase TR winter flood guides to levels needed to store only inflow volume for 7-day, 500-year storm [2] • Raise MR winter flood guides by 2 feet (with a 1-foot operating range) to create 13-foot navigation channel (11 feet with 2 feet overdraft)	• Release recreation flows June 1 to Labor Day once Base Case minimum flows are achieved • Adjust flows to provide additional recreation opportunities for selected tailwaters at Norris, Watauga, Wilbur, Apalachia, South Holston, Ocoee #1, and Melton Hill Reservoirs
Tailwater Habitat Alternative	• Determine summer TR and MR pool levels by retaining 75 percent of inflow • Eliminate TR minimum operations guides • Raise TR winter flood guides equal to Base Case March 15 targeted levels • Raise MR winter flood guides by 2 feet (with a 1-foot operating range) to create 13-foot navigation channel (11 feet with 2 feet overdraft)	• Release Base Case minimum flow or 25 percent of inflow—whichever is greater—or as needed to stay below flood guides on TR and MR year round • Release 25 percent of inflow at a continuous rate; no turbine peaking allowed
Preferred Alternative	• Subject to each project meeting its minimum flow requirements and a proportionate share of the system minimum flow requirements, maintain reservoir elevations as close as possible to the flood guides on 10 tributary reservoir projects during summer (June 1 through Labor Day) • Begin unrestricted tributary reservoir drawdown after Labor Day • Maintain Base Case summer operating zone through Labor Day for Chickamauga, Guntersville, Pickwick, and Wheeler	• Adjust weekly average system flow from Chickamauga as follows: ▸ If water in storage is above the system Minimum Operations Guide (system MOG), increase weekly average flow each week during June and July (beginning with 14,000 cfs the first week in June, increasing to 25,000 cfs the last week in July) ▸ If water in storage is below the system MOG, release 13,000 cfs weekly average minimum flow during June and July

Table 3.3-01 General Description of Operations under the Policy Alternatives That Were Evaluated in Detail (continued)

Policy Alternative	Changes to Reservoir Operating Guidelines (Guide Curves)	Changes to Water Release Guidelines
Preferred Alternative (continued)	• Raise winter flood guide to elevations based on flood risk analysis for 10 tributary reservoir projects • Great Falls—Fill reservoir to summer pool by Memorial Day • Raise minimum winter pool elevation by 0.5 foot at Wheeler • Follow the Base Case fill schedule during the first week in April for Chickamauga, Fort Loudoun, and Watts Bar. Then delay the fill to reach summer operating zone by mid-May	▸ Release 29,000 cfs weekly average flow from August 1 through Labor Day if water in storage is above the system MOG or 25,000 cfs if it is below the system MOG ▸ During normal operations June through Labor Day, weekly average system flows would not be lower than the amounts specified to ensure adequate flow through the system. Also, they would not be higher than the specified amounts to maintain pool levels as close as possible to the flood guides on 10 tributary reservoirs. After periods of high inflow, higher flows would be released as necessary to recover allocated flood storage space. • Provide continuous minimum flows up to 25,000 cfs at Kentucky, as needed, to maintain minimum tailwater elevation of 301 feet • Maintain Base Case minimum flow commitments with additional scheduled tailwater recreation releases • Provide 25 cfs in Apalachia Bypass reach from June 1 through November 1

Notes:

The above information is a general description. Reservoir-specific information can be found in Appendices A and B.

Refer to Appendix A, Table A-02 for specific flood guide elevations under the Base Case. See Sections 2.1 through 2.3 for a complete description of the Base Case and Appendix B for a complete description of each policy alternative.

cfs = Cubic feet per second.
MOG = Minimum Operations Guide.
MR = Mainstem reservoir.
TR = Tributary reservoir.

Table 3.3-01 General Description of Operations under the Policy Alternatives That Were Evaluated in Detail (continued)

[1] Wherever fill and drawdown target dates for the Base Case are referenced, the specific dates can be found in Appendix A, Table A-08.

[2] The 7-day, 500-year storage for a given reservoir is the storage volume required to store the maximum 7-day average local inflow from a storm expected to occur no more frequently than once every 500 years. The storage volume required for a specific reservoir assumes no releases from upstream projects

[3] The critical-period, 500-year storage for a given reservoir is the maximum storage volume required to store the inflow from a storm expected to occur no more frequently than once every 500 years. The storage volume required for a specific reservoir also takes into account the reservoir's natural inflow/discharge and inflows from upstream projects.

3.3.1 Base Case

> **Base Case—**operates the reservoir system in accordance with existing reservoir operating guidelines, water release guidelines, other guidelines, and project commitments and constraints.

The Base Case (required by NEPA to be evaluated in an EIS as the No-Action Alternative) serves to document the existing reservoir operations policy. Under the Base Case, TVA would continue to operate its water control system in accordance with existing reservoir operating guidelines (guide curves), water release guidelines, other guidelines, and project commitments and constraints. (Existing operations and the structure of the water control system are described in detail in Sections 2.1 through 2.3.)

The Base Case also involves a number of other actions that would occur regardless of changes in the reservoir operations policy, including the continued implementation of ongoing TVA programs and meeting the existing contractual and other commitments for operation of the system. The following sections describe the ongoing programs and conditions that were included in the Base Case and each of the eight action alternatives.

2030 Consumptive Water Use

According to the USGS, the Tennessee River basin has the lowest rate of consumptive water use (water withdrawn but not returned to the river system) in the United States. Basin-wide consumptive use is presently about 5 percent of the water withdrawn. Increase in consumptive uses is not expected to exceed 7 percent or 331 million gallons each day by 2030 (Hutson et al. 2003). Once water is consumed, it is not available for use within the TVA system and must be accounted for in the evaluation of each alternative. TVA used the USGS estimates of 2030 consumptive water use by sub-basin (Appendix A, Table A-06) and accounted for future reductions in the amount of water available in its hydrologic modeling for all alternatives. Consumptive water use was assigned to the TVA system in sub-basins where use was projected to occur. Therefore, the analyses presented in this FEIS for all policy alternatives have accounted for the anticipated future consumptive water use.

Hydro Modernization Projects

In 1991, TVA began to rehabilitate and upgrade its hydropower generation facilities. Eventually, as many as 92 hydro turbine units at 26 plant sites may be rehabilitated and modernized. The goal of TVA's HMOD projects is to provide for a safer and more reliable hydropower system, improved operational efficiency, and increases in system capacity at an acceptable economical cost and return to TVA. The HMOD projects that were designed and funded, implemented, or completed on or before October 2001 are considered in this EIS as part of the Base Case (see Appendix A, Table A-09). The projects yet to be designed or implemented as of October 2001 are considered in the cumulative impacts analysis.

Hydro Automation Program

The purpose of the Hydro Automation Program is to install systems at TVA hydro plant sites to enable all control functions, such as starting, stopping, loading, and protecting the generating units, to be handled by remote and local computers. The hydro plants will be dispatched through the transmittal of operating schedules from the Hydro Dispatch Control Cell, located in the Power System Operations Center in Chattanooga. This central point of dispatch for the entire hydro system, in addition to local computers at the plants actually handling the operation of the generating units, allows for rapid system-wide response to varying power demands. Once complete in 2004, the program will greatly improve the flexibility TVA has to control all 109 of its conventional hydro generating units. This flexibility will allow TVA to reduce overall operating expenses and increase operating efficiencies. Upon completion of the program, TVA will be able to provide rapid, automatic, real-time dispatching of the generating units. This change in the operation of the system has been included in the evaluation of the Base Case and all of the policy alternatives.

Browns Ferry Nuclear Plant

In 2002, TVA decided to refurbish and restart Unit 1 at its Browns Ferry Nuclear Plant. TVA is also seeking to extend operation of all three units at the facility for an additional 20 years by renewing the operating licenses for Units 1, 2, and 3 prior to their expiration in 2013, 2014, and 2016, respectively. Coincident with the license renewal and Unit 1 refurbishment efforts, TVA is also uprating the capacity of all three units. Restart of Unit 1 could occur as early as 2007. Restart and operation of Unit 1 will require construction of an additional cooling tower and increasing intake flow rates by approximately 10 percent. The plant will be operated to ensure that the maximum cooling water discharge temperature and the temperature rise between intake and discharge remain within permitted limits. Use of cooling towers will increase and, on infrequent occasions when the cooling towers are unable to meet thermal limits, the plant will be derated to remain in compliance with the established limits. These operational revisions at Browns Ferry have been included in the evaluation of the Base Case and all of the policy alternatives.

3.3.2 Reservoir Recreation Alternative A

Reservoir Recreation Alternative A— operates the reservoir system to increase reservoir recreational opportunities while maintaining a degree of power system reliability.

Purpose. The purpose of Reservoir Recreation Alternative A is to evaluate the balance of public benefits that would result if the reservoir system is operated to increase reservoir recreational opportunities while maintaining a degree of power system reliability. This alternative would maintain some summer contribution of hydropower to support power system reliability but at levels less than under the Base Case. Higher winter pool levels that may better support navigation on mainstem reservoirs and winter recreation are secondary components of this alternative.

Changes in Operations. Reservoir Recreation Alternative A would extend the summer pool period and would delay unrestricted drawdown on 10 tributary reservoirs (Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Nottely, Norris, South Holston, and Watauga) until Labor Day (a month longer than under the Base Case). For Great Falls, the summer fill period would be completed by Memorial Day. On six mainstem reservoirs (Chickamauga, Guntersville, Kentucky/Barkley, Pickwick, Watts Bar, and Wheeler), the summer pool period would be extended to August 1 and then reduced by 1 foot from August 1 to Labor Day.

To maintain summer pool levels, reservoir releases during summer would be generally limited to those necessary to meet project and system minimum flow[1] requirements and to maintain flood storage allocation. However, the bi-weekly average releases from Chickamauga Reservoir under the Base Case would be increased and limited to 25,000 cubic feet per second (cfs) weekly average from August 1 to Labor Day, providing sufficient flow through the mainstem reservoir system to minimize additional derating of nuclear and coal power plants.

Under Reservoir Recreation Alternative A, the winter flood guide levels would be increased on 10 tributary reservoirs (Blue Ridge, Chatuge, Cherokee, Douglas, Hiwassee, Nottely, Norris, South Holston, Tims Ford, and Watauga) to the targeted March 15 levels under the Base Case (Appendix A, Table A-02). On five mainstem reservoirs (Chickamauga, Fort Loudoun, Pickwick, Wheeler, and Watts Bar), the minimum winter elevation would be raised by 2 feet to provide a 13-foot navigation channel (11 feet with a 2-foot overdraft protection), and the typical 2-foot winter fluctuating zone under the Base Case would be reduced to 1 foot for these five mainstem reservoirs under Reservoir Recreation Alternative A.

Achievement of Objectives. Extending the period of summer pool and limiting releases during this period is expected to increase reservoir recreational opportunities. Reservoirs at or near summer pool elevation during the primary recreation period provide the greatest surface area for recreation; maximize access to the water via docks, marinas, and boat ramps; and generally increase reservoir and shoreline access. Higher winter reservoir levels are expected to increase recreational opportunities during off-peak recreation seasons but also may increase flood risk.

Limitations on discretionary reservoir releases between June 1 and Labor Day are expected to help maintain summer pool levels but are likely to reduce tailwater recreational opportunities and production of hydropower during the summer peak period. Reservoir Recreation Alternative A would likely improve the scenic beauty of the reservoirs during summer and reduce the exposure of flats and areas of dry reservoir bottom, contributing to an improved overall recreational experience. This alternative is expected to benefit recreation by increasing

[1] System minimum flows are indicators of total flow through the system to meet specific system requirements for navigation, water supply, waste assimilation, and other benefits—including the assurance that adequate cooling water is provided to avoid derates at TVA's nuclear and coal-fired plants. System minimum flows are measured at the Chickamauga, Kentucky, and Pickwick Dams, and other locations. These flows include a bi-weekly average minimum flow in summer and a daily average minimum flow in winter. If the total of the project minimum flows plus any additional runoff from the watershed is insufficient to meet these system minimum flows, additional water must be released from upstream reservoirs to make up the difference.

the likelihood of achieving the June 1 target levels in the tributaries, which are expected to improve flatwater recreational activities.

Adoption of Reservoir Recreation Alternative A would likely reduce operational benefits achieved by the system in several areas. Maintaining reservoir levels longer in summer may reduce some early-fall flood storage volume, incrementally increasing flood risk. Extending summer pool levels is expected to delay the availability of water for discretionary releases to produce hydropower, possibly when peaking power is needed most. The reduction in summer hydropower production may be offset to some extent by maintaining the average weekly 25,000-cfs flow at Chickamauga Reservoir that would provide cooling water for power plants and minimize summer power plant derates. The additional water that is expected to be available for releases after Labor Day could reduce the need to derate power production at coal and nuclear plants that may occur during fall. Raising mainstem winter pools and reducing the range of fluctuation in reservoirs are expected to benefit navigation.

3.3.3 Reservoir Recreation Alternative B

Purpose. The purpose of Reservoir Recreation Alternative B is to evaluate the balance of public benefits that would result if the reservoir system is operated to increase reservoir recreational opportunities while maintaining a lower degree of power system reliability than under Reservoir Recreation Alternative A.

> **Reservoir Recreation Alternative B—** operates the reservoir system to increase reservoir recreational opportunities.

Changes in Operations. As under Reservoir Recreation Alternative A, targeted summer pool levels would be extended to Labor Day on 10 tributary reservoirs (Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Nottely, Norris, South Holston, and Watauga) by delaying the beginning of unrestricted drawdown to Labor Day (a month longer than under the Base Case). On six mainstem reservoirs (Chickamauga, Fort Loudoun, Guntersville, Kentucky/Barkley, Pickwick, Wheeler, and Watts Bar), the summer pool elevations would be extended to Labor Day (as compared to August 1 under Reservoir Recreation Alternative A). In contrast to Reservoir Recreation Alternative A, Reservoir Recreation Alternative B would have no allowance for mainstem drawdown between August 1 and Labor Day.

Under Reservoir Recreation Alternative B, the method of flood storage allocation would be changed to provide adequate storage for the 7-day, 500-year inflow.[2] Reservoir releases would be limited to only minimum flows from June 1 to Labor Day. Chickamauga Reservoir minimum releases would remain at 13,000 cfs (as under the Base Case).

[2] The 7-day, 500-year storage for a given reservoir is the storage volume required to store the maximum 7-day average local inflow from a storm with a probability of occurrence in any given year of 0.002 (commonly referred to as the 500-year flood). The storage volume required for a specific reservoir assumes no releases from upstream projects.

In most cases, winter reservoir levels on tributary reservoirs would be higher under Reservoir Recreation Alternative B than under the Base Case but by an amount that would vary among reservoirs, depending on the level needed to store the volume of the 7-day, 500-year storm inflow. On mainstem reservoirs, the minimum winter elevation would be raised 2 feet, where possible, to create a 13-foot navigation channel (11 feet with a 2-foot overdraft). The typical 2-foot winter fluctuating zone under the Base Case would be reduced to 1 foot for these mainstem reservoirs under Reservoir Recreation Alternative B.

Achievement of Objectives. Under Reservoir Recreation Alternative B, extending the summer pool period and limiting releases between June 1 and Labor Day are expected to result in increased reservoir recreational opportunities—by a greater amount than under Reservoir Recreation Alternative A. The changes in operations during winter drawdown are likely to result in higher but more variable spring reservoir elevations as compared to the Base Case. Extended summer and increased winter reservoir levels may increase recreational opportunities beyond what would occur under Reservoir Recreation Alternative A.

Limitations of discretionary reservoir releases after June 1 would help maintain summer pool levels but would likely reduce tailwater recreational opportunities and production of hydropower during the summer peak period. Reservoir Recreation Alternative B is also expected to increase flood risk and reduce hydropower generation. Navigation benefits should be the same as those described for Reservoir Recreation Alternative A, except for increased benefit at Kentucky Reservoir. Continuation of releases from Chickamauga Reservoir at the present 13,000-cfs level, coupled with higher flood guides for tributary reservoirs, would likely reduce overall power generation and could, at times, reduce the availability of hydropower to meet summer peak loads. Maintaining only existing minimum flows at Chickamauga Reservoir, coupled with the shift of hydropower generation from summer to fall, may also increase the frequency of derating coal and nuclear plants.

3.3.4 Summer Hydropower Alternative

Purpose. The purpose of the Summer Hydropower Alternative is to evaluate the balance of public benefits that would result if the reservoir system is operated to increase production of hydropower during the peak summer demand period.

> **Summer Hydropower Alternative—** operates the reservoir system to increase the production of hydropower during the peak summer demand period.

Changes in Operation. The principal change under the Summer Hydropower Alternative would be to begin unrestricted drawdown immediately after June 1 in order to increase power production and flood storage volume on both tributary and mainstem reservoirs.

Under the Summer Hydropower Alternative, the method of flood storage allocation would be revised to provide for inflow for the 7-day, 500-year storm—allowing flood guides on tributary reservoirs to be raised in some cases. Weekly average releases from Chickamauga Reservoir would increase to 35,000 cfs as compared to 13,000 cfs bi-weekly under the Base Case. The only scheduled tailwater releases would occur at Ocoee #2 Reservoir.

Achievement of Objectives. Beginning unrestricted drawdown on June 1 is expected to provide releases for hydropower production throughout summer and into fall as long as sufficient water is available. Increased releases from Chickamauga Reservoir would likely provide sufficient flow through the reservoir system to substantially reduce the potential for derating of nuclear and coal power plants, at least as long as water is available. These releases should allow greater generation of hydropower and may also sustain higher flows in tailwaters, possibly supporting more tailwater recreational opportunities. Reducing the winter flood allocation for tributary reservoirs is expected to increase winter reservoir levels and may increase winter recreational opportunities.

Water now stored during the summer period would likely not be available in fall to maintain navigation flows or minimize derates at coal and nuclear power plants. Reduced winter tributary flood storage allocation may result in higher winter reservoir levels and increased risk of flood.

Increasing hydropower production is expected to reduce benefits from several other operating objectives. Reservoir recreational opportunities are expected to decrease throughout summer and fall, compared to the Base Case. Beginning unrestricted releases from reservoirs on June 1 and continuing through summer would lower reservoir levels and may decrease associated recreational opportunities. However, these lower levels would provide additional summer flood storage. Lower reservoir levels at the end of summer resulting from maximizing hydropower production may also provide less water to be released during fall in order to maintain water quality. In some years, less flow could be available to offset derating coal and nuclear power plant operations affected by thermal discharge permit limitations.

3.3.5 Equalized Summer/Winter Flood Risk Alternative

Purpose. The purpose of the Equalized Summer/ Winter Flood Risk Alternative is to evaluate the balance of public benefits that would result if the reservoir system is operated to adjust summer and winter reservoir elevations so that flood risk is similar throughout the year in all reservoirs.

> **Equalized Summer/Winter Flood Risk Alternative—**operates the reservoir system to seasonally equalize flood risk by adjusting summer and winter elevations.

Changes in Operations. The principal changes to system operations under the Equalized Summer/Winter Flood Risk Alternative would involve establishing year-round flood guides for tributary and mainstem reservoirs that would vary by reservoir and month, depending on the anticipated runoff. These flood guides would be based on a reservoir's capacity to store inflow from the critical-period, 500-year storm[3] and would equalize the level of flood risk in all seasons. For tributary projects, a year-round flood guide would generally result in higher winter reservoir levels and lower summer reservoir levels, compared to the Base Case. For mainstem projects, the guide curves were modified to begin fill on April 1 and reach summer pool elevation by the

[3] The critical-period, 500-year storage for a given reservoir is the maximum storage volume required to store the inflow from a storm, with a probability occurrence in any given year of 0.002 (commonly referred to as the 500-year storm). The storage volume required for a specific reservoir also takes into account the reservoir's natural inflow/discharge and inflows from upstream projects.

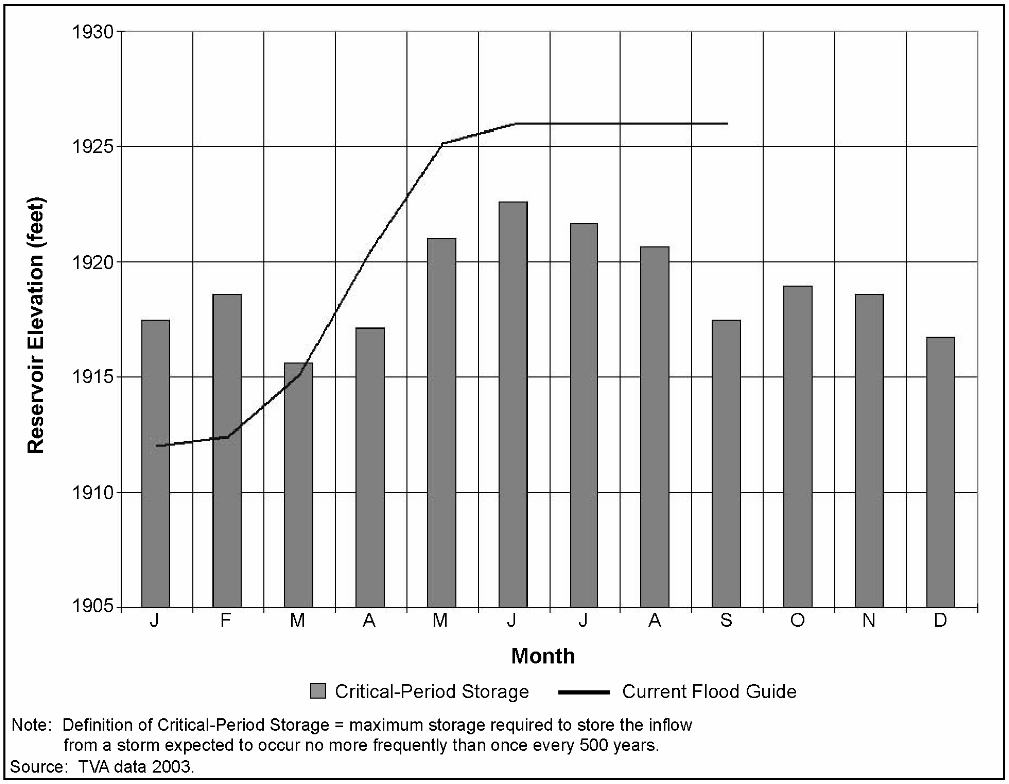

Figure 3.3-01 Example of Critical-Period Storage Versus Current Flood Guide at Chatuge Reservoir

end of May. Figure 3.3-01 is an example of the critical-period storage versus a current flood guide.

Reservoir releases from June 1 to Labor Day would be limited to only those necessary to maintain minimum flows. Releases from Chickamauga Reservoir would be increased from the 13,000-cfs bi-weekly average under the Base Case to a 25,000-cfs weekly average from August 1 to Labor Day under the Equalized Summer/Winter Flood Risk Alternative.

Achievement of Objectives. Under the Equalized Summer/Winter Flood Risk Alternative, winter flood risk generally is expected to increase somewhat and summer flood risk would decrease. Lower summer reservoir levels would likely decrease summer recreational opportunities.

Limitations of discretionary reservoir releases between June 1 and Labor Day could help to maintain summer pool levels but would likely reduce tailwater recreational opportunities and production of hydropower during the summer peak period. Increasing flows from Chickamauga Reservoir to 25,000 cfs from August 1 to Labor Day may retain the ability to limit derates at nuclear and coal power plants at levels similar to what occurs under the Base Case.

3.3.6 Commercial Navigation Alternative

Commercial Navigation Alternative— operates the reservoir system to increase the reliability and reduce the cost of commercial navigation on the Tennessee River.

Purpose. The purpose of the Commercial Navigation Alternative is to evaluate the balance of public benefits that would result if the reservoir system is operated to increase the reliability and reduce the cost of commercial navigation on the Tennessee River.

Changes in Operations. Changes to operations would primarily affect the mainstem portion of the reservoir system. Raising the winter flood guides by 2 feet on mainstem reservoirs, where possible, would increase the navigation channel depth to 13 feet (providing an 11-foot navigation channel with a 2-foot overdraft). The mainstem winter operating range would be modified to allow only a 1-foot fluctuation on those mainstem reservoirs raised 2 feet in winter.

To further support navigation operations, minimum flows would be increased at several key projects with major navigation locks. Specific instantaneous minimum flows would be provided at Kentucky, Pickwick, and Wilson Dams to reduce the difficulty of navigation at certain locations. At Pickwick and Wilson Dams, these flows would also be tied to pool elevations. A limitation on maximum flow (except in flood control situations) would be imposed at Barkley Reservoir, when practical, to reduce high-flow navigation hindrances.

Achievement of Objectives. Raising winter flood guides on mainstem reservoirs, where appropriate, and increasing minimum flows at selected projects is expected to increase the operating depth of most of the navigation channel. Increasing the depth of the navigation channel would likely provide increased access on the Tennessee River to larger or more heavily laden barges, reducing the cost of waterborne transportation.

Increasing the flood guide during the winter period would likely reduce the flood storage allocation in the mainstem reservoirs, thereby increasing flood risk. Achievement of other system benefits is not expected to change under the Commercial Navigation Alternative relative to the Base Case.

3.3.7 Tailwater Recreation Alternative

Tailwater Recreation Alternative— operates the reservoir system to increase tailwater recreational opportunities.

Purpose. The purpose of the Tailwater Recreation Alternative is to evaluate the balance of public benefits that would result if the reservoir system is operated to increase tailwater recreational opportunities. This alternative would be achieved by adopting the changes to system operations similar to those described for Reservoir Recreation Alternative B and also by scheduling reservoir releases at selected projects to increase tailwater recreational opportunities.

Changes in Operations. Under the Tailwater Recreation Alternative, tailwater recreation releases would have higher priority than maintaining water levels for reservoir recreation.

Changes under the Tailwater Recreation Alternative would include extending the summer pool period to Labor Day; changing winter tributary flood guides to the 7-day, 500-year storm inflow; and raising winter mainstem reservoir levels by 2 feet, where possible. From June 1 to Labor Day, two types of reservoir releases would occur. Releases would be made to maintain minimum flows, and releases would be scheduled to increase tailwater recreational opportunities at five projects (Apalachia, Norris, Ocoee #1, South Holston, and Watauga/Wilbur). Under the Tailwater Recreation Alternative, these releases would be formally scheduled; under the Base Case, most recreational releases are not formally scheduled and are made only after other operating requirements have been met.

Achievement of Objectives. An increase in tailwater flows to support tailwater-related recreational activities is expected to achieve the primary objective of increased tailwater recreational opportunities. Where additional releases are scheduled for recreation, the increased certainty that such flows would be available may also increase the attractiveness and reliability of those tailwaters for recreation. Other benefits described for Reservoir Recreation Alternative B are expected to occur, including increased reservoir recreational opportunities and increased boating access (although less than under Reservoir Recreation Alternative B because of the releases to the tailwaters).

The Tailwater Recreation Alternative may cause a decrease in power supply reliability by increasing the frequency of derating TVA's coal and nuclear power plants and by reducing the availability of water for discretionary production of hydropower—possibly during periods of peak demand.

3.3.8 Tailwater Habitat Alternative

Tailwater Habitat Alternative—operates the reservoir system to improve conditions in tailwater aquatic habitats.

Purpose. The purpose of the Tailwater Habitat Alternative is to evaluate the balance of public benefits that would result if the reservoir system is operated to improve conditions in tailwater aquatic habitats by adjusting tailwater flow conditions in relation to natural variations in runoff. Tailwater habitat would also be improved by decreasing the rate of river fluctuations associated with rapid changes in the number of turbines operated.

Changes in Operations. The principal change to system operations would involve releasing Base Case minimum flows or 25 percent of the inflow—whichever is greater—as a relatively continuous minimum flow with no turbine peaking. Hydroturbine pulsing would continue to be used to provide minimum flows. Minimum operations guides would be eliminated on tributary reservoirs. Tributary and mainstem reservoirs would use operating guide curves similar to the ones used under Reservoir Recreation Alternative A. Mainstem winter operating ranges would be limited to 1 foot for those projects raised 2 feet in winter.

Under the Tailwater Habitat Alternative, reservoir releases into tailwaters would produce flows, water depths, and velocities throughout the year that would be more similar to natural seasonal variability. Actual flows, limits, and changes would be determined by the inflow conditions.

During high inflows, water would be released to keep elevations below the flood guides. During low inflows, existing project minimum flows would be met. In the intermediate inflow ranges, 25 percent of the inflow would be passed. Hydropower operations would occur when water is released from the dams.

Achievement of Objectives. Decreased daily variability in tailwater flows is expected to improve aquatic habitat and tailwater water quality, increasing the viability of project tailwaters to support both aquatic plant and animal species and water-dependent wildlife species. A secondary benefit is expected to be increased tailwater recreational opportunities. Because tailwater flows would be more directly related to seasonal changes in runoff, tailwater benefits may be more related to variation in the hydrologic cycle. An increase in winter mainstem reservoir levels would likely increase navigational access and provide benefits through reduced waterborne transportation costs.

Limitations of discretionary reservoir releases are expected to help maintain summer pool levels but would likely reduce tailwater recreational opportunities and production of hydropower during the summer peak period. Obtaining additional habitat benefits may not reduce the total amount of hydropower generation but could result in a decrease in the capacity of hydropower production during the periods of peak demand. The frequency of coal and nuclear power plant derating also may be increased, especially during late summer, when derating is most likely to occur. These effects would affect the overall reliability of power supply.

3.3.9 Preferred Alternative

> **Preferred Alternative—**operates the reservoir system to provide increased opportunities for reservoir and tailwater recreation while meeting other operating objectives.

Purpose. The purpose of the Preferred Alternative is to establish a balance of system operating objectives that is more responsive to the values expressed by the public during the ROS and consistent with the operating priorities established by the TVA Act. This alternative combines and adjusts elements of the alternatives identified in the DEIS to preserve desirable characteristics and to avoid or reduce adverse impacts associated with those alternatives in order to create a more feasible, publicly responsive alternative. The Preferred Alternative was created after extensive public review of and comment on the DEIS and additional analyses.

Changes in Operations. Under the Preferred Alternative, each project would meet its own Base Case minimum flow requirements and share the responsibility for meeting increased system minimum flow requirements. After meeting those requirements, elevations on 10 tributary reservoirs (Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Nottely, Hiwassee, Norris, South Holston, and Watauga) would be maintained as close as possible to the summer flood guide from June 1 through Labor Day, resulting in restricted drawdown during this period. When rainfall and runoff are insufficient to meet system flow requirements, the needed water would be released from the upstream tributary reservoirs to augment the natural inflows, resulting in some drawdown of all of these projects. This would be expected to occur in about 90 percent of the years.

Reservoir balancing guides established for each tributary storage reservoir would be used under the Preferred Alternative to ensure that the proportional water releases for downstream system needs are drawn from the tributary reservoirs equitably. A balancing guide is a seasonal reservoir pool elevation that defines the relative drawdown at each tributary reservoir when downstream flow augmentation is required. Subject to variations in rainfall and runoff across the projects, and the necessity to ensure at least minimal hydropower capacity at each tributary project (up to a water equivalent of 17 hours of use per week at best turbine efficiency from July 1 through Labor Day), water would be drawn from each tributary reservoir so that elevation of each reservoir would be similar relative to its position between the flood guide and the balancing guide. Summer operating zones would be maintained through Labor Day at four additional mainstem projects (Chickamauga, Guntersville, Pickwick, and Wheeler). Base Case minimum flows, except for the increases noted below, and the DO targets adopted following completion of the 1990 Lake Improvement Plan would continue to be met.

Subject to flood control operations or extreme drought conditions, scheduled releases would be provided at five additional tributary projects (Ocoee #1, Apalachia, Norris, Watauga/Wilbur, and South Holston) to increase tailwater recreational opportunities. Under the Base Case, recreational releases are not formally scheduled at these five projects and are made only after other operating requirements have been met.

Under the Preferred Alternative, the weekly average system flow requirement from June 1 through Labor Day measured at Chickamauga Dam would be determined by the volume of water in storage at 10 upstream tributary reservoirs relative to a system MOG. This guide is a seasonal storage guide that defines the combined storage volume for those 10 tributary reservoirs (Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Nottely, Hiwassee, Norris, South Holston, and Watauga). If the volume of water in storage is more than the system MOG, the weekly average system flow requirement would be increased each week from 14,000 cfs the first week of June to 25,000 cfs the last week of July. Beginning August 1 and continuing through Labor Day, the weekly average flow requirement would be 29,000 cfs. If the volume of water in storage is less than the system MOG, only 13,000 cfs weekly average flows would be released between June 1 and July 31, and only 25,000 cfs weekly average flows would be released from August 1 through Labor Day. During normal operations June through Labor Day, weekly average system flows would not be lower than the amounts specified to ensure adequate flow through the system. Also, they would not be higher than the specified amounts to maintain pool levels as close as possible to the flood guides on 10 tributary reservoirs. After periods of high inflow, higher flows would be released as necessary to recover allocated flood storage space. Continuous minimum flows would be provided in the Apalachia Bypass reach from June 1 through November 1.

The winter flood guide levels would be raised on 10 tributary reservoirs (Boone, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Norris, Nottely, South Holston, and Watauga) based on the results of the flood risk analysis. On Wheeler Reservoir, the minimum winter elevation would be raised by 0.5 foot to better ensure an 11-foot minimum depth in the navigation channel. Steady water releases up to 25,000 cfs of flow would be provided as necessary at Kentucky Dam to maintain a tailwater elevation of 301 feet. Great Falls Reservoir would be filled earlier to reach full summer pool by Memorial Day. On Fort Loudoun, Watts Bar, and Chickamauga Reservoirs, the fill period would follow the Base Case fill schedule during the first week in April. Then, the fill schedule would be delayed to reach summer operating zone by mid-May.

Specific details of the Preferred Alternative are presented in Table 3.3-01 and Appendix B.

Achievement of Objectives. Adjusting flood guide elevations based on flood risk analysis and providing increased minimum flows during June, July, and August would avoid and reduce impacts related to the primary reservoir system operating objectives of flood control, navigation, and power generation that were associated with other alternatives identified in the DEIS. This alternative would not increase annual average flood damages at any critical location within the Tennessee Valley, including Chattanooga. It would provide a more equitable way of balancing pool levels among the tributary reservoirs. It would increase the minimum depth of the Tennessee River navigation channel at two locations and would maintain power system reliability while lessening impacts on delivered cost of power compared to other alternatives.

Maintaining reservoir pool elevations as close to the flood guide as possible during summer and delaying the unrestricted drawdown would provide greater recreational opportunities and use of the reservoirs. Higher winter pool levels are expected to increase recreational opportunities during off-peak recreation seasons as well as increase hydropower production. Where additional water releases are scheduled for recreation, the increased certainty that such flows would be available may also increase the attractiveness and reliability of those tailwaters for recreation.

With reservoir pool levels similar to the Base Case, impacts on wetland extent, distribution, and habitat connectivity would be reduced. Not changing the operating guide curves for Kentucky Reservoir would reduce the potential adverse effects on flood control, seasonal exposure of flats habitats, interference with the operation and integrity of managed areas, and impacts on adjacent forested wetlands compared to the other action alternatives.

As a result of higher minimum flows from June 1 through Labor Day, impacts on water quality would be reduced compared to the other action alternatives, except for the Commercial Navigation Alternative. Reducing water quality impacts would also benefit aquatic resources, because water quality is a major factor that influences the health of fisheries and the quality of aquatic habitat.

3.4 Other Actions Considered

Many policy elements were considered during formulation of the policy alternatives. Discussion of these elements revealed that some could be implemented independent of a change in TVA's overall reservoir operations policy while others were infeasible to be included in any reservoir operations policy. Actions that could be implemented independent of a change in the reservoir operations policy are discussed in Section 3.4.1. Elements that have not been included in any of the policy alternatives are discussed in Section 3.4.2. Alternatives that included these elements were determined to be unreasonable primarily because the negative effects outweighed the potential benefits, and overall public value of the reservoir system was not improved.

3.4.1 Actions That Exist or Could Be Implemented Independent of a Change in the Reservoir Operations Policy

Bear Creek and Normandy Projects

Although the Bear Creek (Bear Creek, Cedar Creek, Little Bear Creek, and Upper Bear Creek) and Normandy Projects are included in the 35 projects being studied in the ROS, it was determined that the operating guidelines already established for the five projects would not change as a consequence of a change in the overall reservoir operations policy for the following reasons:

- The guide curves for Normandy, Bear Creek, Cedar Creek, and Little Bear Creek have summer pool elevations that span from mid-April to mid-November.
- Guide curves for Normandy, Bear Creek, Cedar Creek, and Little Bear Creek already have a limited flood storage allocation, leaving little opportunity for further changing winter flood storage.
- The guide curve for Upper Bear Creek has little planned annual fluctuation and no flood storage allocation.
- Releases to the tailwaters of these five projects are already controlled to maintain appropriate water quality parameters (primarily DO) for water supply and fish hatchery needs below Normandy.

After review, TVA concluded that operation of these projects would not be modified under any of the policy alternatives.

Ramping Rates

The IAT/PRG members asked TVA to consider reducing ramping rates in order to moderate fluctuations in downstream tailwater flows. Existing ramping rates were designed to generate cost-effective hydropower during periods of peak electricity demand during the day. Some fluctuations in water releases must occur when bringing turbine units online to meet peak demands; at times, units may need to be ramped up quickly. Changing ramping rates was included as an element of the Tailwater Habitat Alternative. This alternative would reduce turbine peaking effects on tailwaters.

In addition to evaluating ramping rates in the ROS, TVA is automating most of its conventional hydropower generating units (see discussion of the Hydro Automation Program in Section 2.3

under Hydropower Generation Facilities). The automated system will enable TVA to operate turbines at several hydro plants at the same time to generate needed power rather than using multiple turbines at only a few hydro plants to achieve the same amount of generation. This new ability will allow TVA to more effectively shape water flows throughout the water control system.

Fish Spawning

Organized angling groups, individuals, and state fishery management agencies recommended filling reservoirs earlier and extending the period of stable water levels (see the discussion of fish spawning in Section 2.3.7) to enhance fish spawning success. Based on its analysis, TVA determined that this could not be done due to increased flood risk and impacts on achieving full summer pool. However, TVA plans to stabilize reservoir levels to the extent possible for 2 weeks during the spring spawning period (by limiting a drop in pool elevations to a maximum of 1 foot per week except for flood storage recovery or critical power situations) when water temperatures reach 60 °F (instead of the present trigger level of 65 °F). This will improve the spawning conditions of cooler water species (see Section 5.7, Aquatic Ecology, for further discussion).

Biodiversity Considerations

Diverse assemblages of aquatic species occur in the flowing-water habitats downstream from several tributary and mainstem dams. In some of these tailwater reaches, the abundance and diversity of these aquatic communities could be improved through a combination of operational and physical modifications to the dam. These modifications might involve changing project minimum flows; the timing of releases; or the quality of the released water, such as its temperature. For example, substantial flow and temperature fluctuations occur in the downstream part of the Elk River when the hydropower unit at Tims Ford Dam is operated. Changing operations at the hydropower plant could reduce variations in the tailwater habitat and could aid in the recovery of the diverse but sparse aquatic community in this river reach. Independent of the ROS, TVA is evaluating project-specific alternatives for operating Tims Ford Dam to improve the diversity of the aquatic community in the Elk River. Other project-specific actions to improve biodiversity could be analyzed on a case-by-case basis as the opportunity for habitat improvement is identified.

Under all of the action alternatives, TVA would provide a continuous minimum flow up to 25 cfs in the 13-mile reach of the Hiwassee River between Apalachia Dam and Apalachia Powerhouse from June 1 through November 1 to enhance the diversity of aquatic species in that waterbody. The augmented flow would increase the amount of and improve the quality of the habitats for aquatic life that exist or could be introduced to this part of the Hiwassee River (see Section 5.13, Threatened and Endangered Species, for further discussion).

Operations under Drought Conditions

During drought conditions, TVA must continue to meet water quality and water supply commitments, and, to the extent possible, uses the flexibility in its reservoir operations policy to maintain other minimum benefits. TVA is considering development of a formal drought management plan that would include other agencies and entities and provide revised guidelines for operating under drought conditions. Depending on the recommendations that may result from this effort, a supplement to the reservoir operations policy that TVA may adopt as a result of the ROS could be proposed. For the purposes of this EIS, simulated operations assumed continued operation at only minimum flows during drought conditions.

Adaptive Management

During the public scoping process, adaptive management was proposed as an implementation strategy to be included in a revised reservoir operations policy. Adaptive management involves monitoring and modifying system operations as appropriate in response to future changes in regulatory requirements, unanticipated trends in future water availability, the status of various sectors of the environment, and changes in technology. TVA currently practices adaptive management through the flexibility built into the guidelines for management of the water control system and extensive monitoring of the reservoir system. TVA uses this flexibility to adjust reservoir operations in response to variability in water availability and other environmental conditions.

Because TVA practices adaptive management, evaluation of adaptive management as a separate policy implementation strategy was not considered necessary. Regardless of the alternative selected, TVA would continue its ongoing adaptive management approach.

3.4.2 Actions Not Included in Any Policy Alternative

Structural Modification to Dams and Levee Construction

The ROS is a comprehensive evaluation of how TVA should operate its existing water control system to enhance its public value. Removal of or major structural modifications to project dams and levees was not carried forward as an element of any of the policy alternatives. Dam removal would result in lost power, recreational, and economic benefits, as well as increased flood risk—depending on the dam to be removed. TVA does not consider dam removal a reasonable alternative for detailed evaluation because it would not achieve the project purpose of increasing the overall public value of operating the existing reservoir system. Structural modifications at specific locations could be considered in the future, as appropriate, depending on identified needs.

Building a system of levees to provide additional flood protection for Chattanooga was considered in the original design of the flood control system for the eastern half of the Tennessee Valley. Instead of building these levees, Chattanooga city government and area residents assumed the risk of flood damages that cannot be prevented by TVA flood control operations. Land that is subject to flooding has been identified, and property owners can purchase flood insurance if eligible. In addition, the city of Chattanooga has made the river a focal point for the community. To build levees today would almost completely eliminate use and views of the river. TVA does not believe that such a levee system is likely to be constructed because of the extremely high construction costs and the probable adverse effects on such resources as aesthetics, water quality, and aquatic ecology.

Maintaining Year-Round Summer Reservoir Levels

Maintaining all reservoirs at summer pool level year-round would reduce flood storage allocation throughout the system in winter, the period of greatest runoff. This practice would increase flood risk and associated flood damage to unacceptable levels—for example, exposing Chattanooga and other cities to similar levels of flood risk that occurred before construction of the TVA system. Therefore, this element was not considered in the formulation of alternatives.

Reducing Minimum Flows from Tributary Dams

During the scoping process, reducing minimum flows from tributary dams was suggested to assist in maintaining higher summer pool levels. Minimum flows included in the existing operating guidelines are described in Chapter 2 and in Appendix A, Table A-03. These flows were designed to improve water quality conditions and protect aquatic habitat. The RRI Program and the 1990 Lake Improvement Plan were developed to address the operating objective of water quality. These initiatives concluded that water releases were directly connected with water quality and that improved water quality would be achieved by increasing minimum flows and using aeration techniques. Reducing minimum flows is inconsistent with the policy changes adopted as part of these prior evaluations and would negatively affect water quality (which was identified as an operating objective during public scoping). Therefore, reducing minimum flows was not included as an element of any of the policy alternatives that were evaluated in detail.

Earlier Filling and Later Drawdowns

During the formulation of the initial 25 alternatives, the ideas of raising reservoirs to summer pool levels by March 1 or April 1 and delaying unrestricted drawdown until October 1 or November 1 were evaluated but not carried forward. Filling reservoirs to summer pool by March 1 or April 1 was not considered for detailed analysis because filling reservoirs before the end of the flood season would compromise TVA's ability to control runoff in spring and consequently increase flood damage. Delaying unrestricted drawdown until October 1 or November 1 would reduce flows from the Tennessee and Cumberland Rivers during September and October, when water levels on the lower Ohio and Mississippi Rivers already are likely to be low. Effects on navigation, combined with shifts in power generation, impacts on power system reliability, and environmental effects, outweigh the potential benefits to be gained from improvements in scenery, reservoir fisheries, recreation, residential development, and associated economic growth around the affected reservoirs. Accordingly, this would not improve the overall public value of the reservoir system.

Providing Recreational Flows on the Ocoee River

Some recreational interest groups recommended providing additional recreational flows on the Ocoee River. Recreational flows for Ocoee #2 and Ocoee #3 were the subject of two separate EISs that included decisions concerning recreational releases to the Ocoee River and are not included in this FEIS (USDA et al. 1994, 1997). This EIS does consider recreational flows from Ocoee #1 and potential impacts of reservoir operations policy alternatives on the Ocoee River.

Reducing the Navigation Channel to 9 Feet

Reducing the commercial navigation channel on the Tennessee River to a 9-foot channel depth would impede navigation because the river would become narrower and shallower. A 9-foot channel depth would leave only a 7-foot draft for barge traffic. Shipments by barge from the Ohio and Mississippi Rivers would be required to trans-ship (transfer cargo from one barge to another) to smaller barges for the Tennessee/Cumberland Rivers portion of their trips. Similarly, shipments leaving the Tennessee/Cumberland Rivers could trans-ship to deeper draft barges. Both of these scenarios would result in barge terminal congestion and higher costs. In addition, less water would likely be available in drought years to fill the pools on the lower Ohio and Mississippi Rivers, impairing navigation on these rivers.

Reducing the navigation channel also would result in environmental and economic impacts. Potential adverse environmental impacts would include shoreline erosion and sedimentation, impacts on water quality and aquatic habitats, damage to riparian habitats, loss of archaeological resources, and increased boating hazards. The economic impacts for firms or industries that ship or receive large volumes or bulk commodities would likely be substantial as they would be required to switch to alternative transportation modes. Given these potential adverse impacts and loss of overall public value, TVA did not evaluate this alternative in detail.

Dredging the Navigation Channel

Dredging the existing navigation channel to provide a 12- to 13-foot channel would require extensive excavation and blasting, interrupt shipping, be costly, and adversely affect the environment. Dredging and disposal would cost between $10 and $25 billion. The potential environmental effects of dredging would likely include adverse impacts on threatened and endangered species, commercial fisheries, and water quality. In addition, it is highly unlikely that government agencies and other constituents would approve such a project. TVA did not evaluate this alternative in detail for these reasons.

Improving Existing Facilities and Reservoir Access

During the scoping process, some members of the public recommended improving public access to TVA reservoirs by providing better maintenance for existing facilities, constructing new facilities at existing access sites, and developing new access points. These actions were not included as a policy element in any alternative that was evaluated in detail because they were considered outside the scope of a programmatic analysis of how TVA should operate its existing water control system. Each of these actions could be evaluated and undertaken on a project-by-project basis.

Strengthening TVA's Regulatory Authority to Enforce Laws and Control Pollution

During the scoping process, some commentors suggested giving TVA more regulatory authority to enforce laws related to water pollution. This issue was raised and addressed in the 1990 Lake Improvement Plan. Existing federal, state, and local government agencies have jurisdiction over water pollution issues. It is unlikely that the agencies with the authority to enforce water pollution laws or Congress would support legislation providing such authority to TVA; therefore, this policy element was removed from further evaluation.

Creating Incentives for Energy and Water Conservation

During the public scoping process, it was suggested that TVA investigate providing incentives for energy conservation as a way of reducing the need for more expensive forms of power generation. Although a valuable suggestion, public incentives for energy conservation are not within the scope of this EIS. The ROS study involves the review of the reservoir operations policy. In addition, incentives for energy conservation and demand-side management were considered in TVA's Energy Vision 2020 EIS.

Constructing or Relying on New and Alternative Energy Sources

TVA operates the river system for several reasons including hydropower production. Hydropower is the most economical form of electricity available on the TVA system. It offers versatility and dependability that cannot be equaled by any other type of capacity, and it is more efficient than any other form of power generation. Despite the numerous advantages of hydropower, obtaining permission to build and finance the construction of new dams would be difficult.

Alternatives to hydropower are likely to be expensive to install, more expensive to operate, and less flexible in supplying peaking power and coping with system emergencies. They also would require more backup capacity. Purchases of power from an interconnected power system are an option, but the supply and price of this interchange power have fluctuated widely. In addition, a range of alternative energy sources was fully evaluated in TVA's Energy Vision 2020 EIS.

3.5 Comparison of Alternatives

Identifying the trade-offs between competing reservoir operating objectives was essential to evaluating the policy alternatives. TVA performed a comprehensive environmental and economic evaluation of each of the policy alternatives, which are described by resource sector in Chapter 5. Three separate evaluations were performed—one with respect to the objectives identified during the public scoping process (see Section 3.5.1), a second to evaluate impacts on each of the environmental resources (see Section 3.5.2), and a third to calculate regional economic benefits (see Section 3.5.3).

3.5.1 Objectives Identified during Scoping

TVA conducted an extensive scoping process to obtain public input on future operations of the water control system. Through this process, TVA identified 12 objectives that were the basis of formulating and evaluating policy alternatives (see Sections 1.6 and 3.2). Table 3.5-01 shows how well each policy alternative performed in relation to these objectives.

3.5.2 Impacts on Resource Areas

TVA analyzed 24 resource areas that reflect a wide range of issues important to the residents of the Tennessee River basin. Table 3.5-02 compares the effects of the policy alternatives on each of these resource areas. This table summarizes the results of TVA's environmental analysis, which is documented in Chapter 5.

Tables 3.5-01 and 3.5-02 present different but closely related information. Table 3.5-01 focuses on the specific objectives identified by the public. Table 3.5-02 summarizes the results of technical analyses of the 24 resource areas by specialists, using more detailed metrics, modeling, and analysis. Table 3.5-01 is not derived directly from the results presented in Table 3.5-02.

Impacts on elements of the 24 resource areas were assessed using four impact levels, including No Change, Slightly Adverse/Slightly Beneficial, Adverse/Beneficial, and Substantially Adverse/Substantially Beneficial (see inset box for definitions). The extent, duration, and intensity determined the level of impact. In some cases, the impact was listed as Variable for resources where impacts varied across the study area to a degree that they could not be classified within a single impact level.

DEFINITIONS OF IMPACT

Level of Impact	Description
No change	Impact on the resource area is negligibly positive or negative but is barely perceptible or not measurable, or confined to a small area; or the extent of the impact is limited to a very small portion of the resource.
Slightly adverse/slightly beneficial	Impact on the resource area is perceptible and measurable, and is localized; or its intensity is minor but over a broader area and would not have an appreciable effect on the resource. This also can refer to impacts with short duration and not recurring.
Adverse/beneficial	Impact is clearly detectable and could have an appreciable effect on the resource area. Moderate impacts can be caused by combinations of impacts, ranging from high-intensity impacts over a smaller area to small to moderate impacts over a larger area. This also can occur with minor to moderate impacts that are recurring over a period of years.
Substantially adverse/ substantially beneficial	Impact would result in a major, highly noticeable influence on the resource area—generally over a broader geographic extent and/or recurring for many years.

Table 3.5-01 Summary of Policy Alternative Performance by Objectives Identified during Public Scoping

Objective	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Low-cost/reliable electricity [1]	No change	$30 M increase in power costs	$67 M increase in power costs	$3 M increase in power costs	$108 M increase in power costs	$11 M decrease in power costs	$66 M increase in power costs	$295 M increase in power costs	$14 M increase in power costs
Revenue from recreation [2]	No change ($65.1 M existing revenue)	$11 M (17%) increase in revenue	$14 M (22%) increase in revenue	$10 M (15%) decrease in revenue	$1 M (2%) increase in revenue	$1M (2%) decrease in revenue	$14 M (22%) increase in revenue	$13 M (20%) increase in revenue	$9 M (14%) increase in revenue
Flood risk and flood-related damages	No change	Increase	Substantial increase	Increase	No change	Increase	Substantial increase	Substantial increase	No change
Cost of transporting materials on the commercial waterway [3]	No change ($426 M existing costs)	No change in shipper costs	No change in shipper costs	$12 M (3%) increase in shipper costs	$1 M (<1%) increase in shipper costs	$17 M (4%) decrease in shipper costs	No change in shipper costs	No change in shipper costs	$2.5 M (1%) decrease in shipper costs
Water for municipal, agricultural, and industrial purposes [4]	No change	No change	No change	$12.5 M increase in costs	No change	$3.4 M increase in costs	No change	No change	No change
Recreation on reservoirs and tailwaters [5]	No change (6.57 million base user days)	1.34 M (20%) increase in user days	1.54 M (24%) increase in user days	1.27 M (19%) decrease in user days	0.24 M (4%) increase in user days	0.12 M (1.9%) decrease in user days	1.55 M (23%) increase in user days	1.44 M (22%) increase in user days	1.17 M (18%) increase in user days
Water quality in reservoirs and tailwaters	No change (natural variability from year to year)	No change to adverse effects on water quality	No change to substantially adverse effects on water quality	Adverse to beneficial effects on water quality	No change to adverse effects on water quality	No change to slightly beneficial effects on water quality	No change to substantially adverse effects on water quality	Adverse effects on water quality	No change to slightly adverse effects on water quality

Table 3.5-01 Summary of Policy Alternative Performance by Objectives Identified during Public Scoping (continued)

Objective	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Aquatic habitat in reservoirs and tailwaters	No change	Slightly adverse to slightly beneficial effects on aquatic habitat	Slightly adverse to slightly beneficial effects on aquatic habitat	Slightly adverse to slightly beneficial effects on aquatic habitat	Slightly adverse to slightly beneficial effects on aquatic habitat	Slightly beneficial effects on aquatic habitat	Adverse to slightly beneficial effects on aquatic habitat	No change to adverse effects on aquatic habitat	Slightly adverse to slightly beneficial effects on aquatic habitat
Erosion of reservoir shoreline and tailwater riverbanks	No change	Slightly increased erosion	Slightly increased erosion	No change to slightly reduced erosion	No change to slightly reduced erosion	No change	Slightly increased erosion	Slightly increased to increased erosion	Slightly increased erosion
Threatened and endangered species	No change	No change to slightly adverse effects	No change to slightly adverse effects	Adverse effects	No change to slightly beneficial effects	No change to slightly beneficial effects	No change to slightly adverse effects	Beneficial to slightly adverse effects	Slightly adverse to slightly beneficial effects
Wetlands and other ecologically sensitive areas	No change	Slightly adverse to slightly beneficial effects	Adverse to slightly beneficial effects	Substan-tially adverse effects	Adverse to substantially adverse effects	No change	Slightly adverse to slightly beneficial effects	Slightly adverse to slightly beneficial effects	Slightly adverse to slightly beneficial effects
Scenic beauty of reservoirs	No change	Improved	Substantially improved	Reduced	Slightly reduced	Slightly improved	Substantially improved	Substantially improved	Improved

Notes:
1 Millions of dollars annually.
2 Changes in recreational expenditures from outside the TVA region in millions of dollars annually for the year 2010 in 2002 dollars (percent change from Base Case for 2010 in 2002 dollars).
3 Change in shipping costs in millions of dollars annually (percent change from Base Case for 2010 in 2002 dollars).
4 Cost in millions of dollars (2002 dollars) to modify intakes on reservoirs with pool levels below TVA-published minimum elevations.
5 Total recreation use in user days (percent change from Base Case in user days).

Table 3.5-02 Summary of Impacts by Policy Alternative

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Air Resources									
Air emissions	No change in projected annual emissions (in tons) of about 469,000 SO_2, 202,000 NO_x, 13,000 particulates, 10,000 CO, 1,200 VOCs, and 1.6 Hg	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	No change	Slightly adverse	Beneficial (Due to non-emission generation)	No change to slightly adverse
Climate									
Greenhouse emissions	No change in projected annual emission of 106.5 million tons CO_2	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly adverse	Beneficial (Decrease of almost 2 million tons in annual CO_2 emissions)	Slightly beneficial
Water Quality									
Assimilative capacity – storage tributaries	No change in volume of water to assimilate oxygen-demanding waste	Slightly beneficial	Slightly beneficial	No change to slightly adverse	No change to slightly adverse	No change	Slightly beneficial	Slightly beneficial (Effects vary among reservoirs)	Slightly beneficial
Assimilative capacity – transitional tributaries [1]	No change in volume of water to assimilate oxygen-demanding waste	No change to slightly adverse	No change	No change to slightly adverse	Slightly adverse	No change	No change	No change to slightly adverse	No change

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Water Quality (continued)									
Assimilative capacity –mainstem reservoirs	No change in volume of water to assimilate oxygen-demanding waste	No change.	No change	No change to slightly adverse	No change	No change	No change	No change	No change
Anoxia – storage tributaries	No change in volume of water with DO concentration less than 1mg/L	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly beneficial (Effects vary among reservoirs)	No change	No change to adverse (Increase in volume of water with DO concentration less than 1mg/L)	Adverse (Increase in volume of water with DO concentration less than 1mg/L)	No change
Anoxia – transitional tributaries	No change in volume of water with DO concentration less than 1mg/L	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	No change to slightly adverse	Slightly adverse to slightly beneficial (Effects vary among reservoirs)	No change to slightly adverse (Effects vary among reservoirs)	Slightly adverse to slightly beneficial (Effects vary among reservoirs)
Anoxia – mainstem reservoirs	No change in volume of water with DO concentration less than 1mg/L	Adverse (Increase in volume of water with DO concentration less than 1mg/L)	Substantially adverse (Substantial increase in volume of water with DO concentration less than 1mg/L)	Substantially beneficial (Substantial decrease in volume of water with DO concentration less than 1mg/L)	Adverse to substantially adverse (Substantial increase in volume of water with DO concentration less than 1mg/L for some mainstem reservoirs)	Slightly beneficial	Substantially adverse (Substantial increase in volume of water with DO concentration less than 1mg/L for most mainstem reservoirs)	Adverse to substantially adverse (Substantial increase in volume of water with DO concentration less than 1mg/L for some mainstem reservoirs)	Slightly adverse

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Water Supply									
Water supply delivery (costs)	No change in parameters affecting cost of water supply pumping from reservoirs and intake modifications due to lower reservoir levels	Slightly beneficial (Savings of $1 million)	Slightly beneficial (Savings of $1.4 million)	Substantially adverse (Additional cost of $13 million)	Slightly beneficial (Savings of $0.2 million)	Adverse (Additional cost of $2.8 million)	Slightly beneficial (Savings of $1.4 million)	Slightly beneficial (Savings of $1.1 million)	Slightly beneficial (Savings of $0.5 million)
Water supply quality (treatment)	No change in parameters affecting cost of water treatment of water withdrawn from TVA reservoirs	Slightly adverse	Adverse (High potential for soluble iron and manganese formation based on increase in volume of water with DO less than 1 mg/L)	No change to adverse (Wide variability in potential for soluble iron and manganese formation, depending on reservoir and year)	Slightly adverse	No change	Adverse (High potential for soluble iron and manganese formation based on increase in volume of water with DO less than 1 mg/L)	Adverse (High potential for soluble iron and manganese formation based on increase in volume of water with DO less than 1 mg/L)	No change to slightly adverse
Groundwater Resources									
Groundwater levels – reservoirs	No change in existing groundwater use	Slightly beneficial	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly beneficial	Slightly beneficial

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Aquatic Resources									
Biodiversity – tributary reservoirs	No change Benthic aquatic insect and mussel communities would still be affected by seasonal thermal stratification, low DO, and large water level fluctuations	No change	Slightly adverse	Adverse (Shoreline fluctuation would adversely affect shoreline habitat)	No change	No change	Slightly adverse	Slightly adverse	No change
Biodiversity – mainstem reservoirs	No change Aquatic insect communities would remain fair, status of mussels in flowing portions would remain poor for riverine species and favorable for pool-adapted species	Slightly adverse	Slightly adverse	Slightly beneficial	No change to slightly adverse	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse to slightly beneficial (Effects vary among reservoirs)
Biodiversity – warm-water tailwaters [2]	No change Biodiversity would continue to be limited due to the restraints of a regulated system	No change to slightly adverse	No change to slightly adverse	Adverse (Water quality and the stability of daily water elevations would decrease)	No change	No change	No change to slightly adverse	No change to slightly adverse	No change to slightly adverse

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Aquatic Resources (continued)									
Sport fish – tributary reservoirs	No change Conditions would continue to be stressful for cool-water species and favorable for warm-water species	No change to slightly beneficial	Slightly beneficial	Slightly adverse to slightly beneficial (Effects vary among reservoirs)	Slightly adverse	No change to slightly beneficial	Slightly beneficial	Slightly adverse	No change to slightly beneficial
Sport fish – mainstem reservoirs	No change Communities would continue to vary based on environmental conditions	No change to slightly adverse	No change to slightly adverse	No change to slightly beneficial	Slightly adverse	No change to slightly beneficial	No change to slightly adverse	Adverse (Lower DO, therefore less available habitat)	Slightly adverse
Sport fish – warm tailwaters	No change Communities would continue to vary based on environmental conditions	No change	No change to slightly beneficial	Slightly beneficial	Slightly adverse to slightly beneficial (Effects vary among reservoirs)	No change	No change to slightly beneficial	Slightly adverse to slightly beneficial (Effects vary among reservoirs)	Slightly adverse to slightly beneficial (Effects vary among reservoirs)
Sport fish – cool-to-warm tailwaters	No change Improvements would continue due to RRI initiatives; warm-water species would continue to be limited	Slightly beneficial to slightly adverse	Slightly beneficial to slightly adverse	Slightly beneficial	Slightly beneficial to slightly adverse	No change	Slightly beneficial to slightly adverse	Slightly beneficial to slightly adverse	Slightly beneficial to slightly adverse

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Aquatic Resources (continued)									
Sport fish – cool/cold tailwaters	No change Improvements would continue due to RRI initiatives	Slightly adverse	Slightly adverse	Adverse (Water temperatures would be higher in tributary reservoirs due to less cold water storage in late summer)	Slightly adverse	No change	Slightly adverse	Adverse (Increased hours with temperatures greater than 20°C)	Slightly beneficial
Commercial fisheries – reservoirs	No change Communities would continue to vary based on environmental conditions	Adverse (Increase in volume of water with poor water quality due to delayed summer drawdown)	Adverse (Increase in volume of water with poor water quality due to delayed summer drawdown)	Beneficial (Increase of flow through mainstem reservoirs, which would increase water quality)	Slightly adverse to adverse (Increase in yearly volumes of water with low DO)	No change	Adverse (Increase in volume of water with poor water quality due to delayed summer drawdown)	Adverse (Increased volume of water with low DO in mainstem reservoirs)	Slightly adverse to slightly beneficial (Effects vary among reservoirs)
Wetlands									
Location	No change Wetland extent and distribution are expected to follow existing trends	No change to slightly beneficial	Slightly beneficial	Substantially adverse (Less water would be available during the growing season for wetlands)	Substantially adverse (Less water would be available during the growing season for wetlands on tributary reservoirs)	No change	Slightly beneficial	No change to slightly beneficial	No change to slightly beneficial

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Wetlands (continued)									
Type	No change Shifts in wetland types are expected to follow existing trends	Slightly adverse	Adverse (Changes in the timing of the presence of water would adversely affect flats, scrub/shrub, and forested wetlands)	Substantially adverse (Changes in the timing of the presence of water would adversely affect all wetland types)	Substantially adverse (Changes in the timing of the presence of water would adversely affect all wetland types)	Slightly adverse	Adverse (Changes in the timing of the presence of water would adversely affect flats, scrub/shrub, and forested wetlands)	Slightly adverse	Slightly adverse
Function	No change Slow decline in wetland functions are expected to continue	Slightly adverse	Adverse (Changes in wetland types would cause a moderate decrease in wetland functions)	Substantially adverse (Changes in water regimes and wetland types would cause a major decrease in wetland functions)	Substantially adverse (Changes in water regimes and wetland types would cause a major decrease in wetland functions)	No change	Adverse (Changes in wetland types would cause a moderate decrease in wetland functions)	Slightly adverse	Slightly adverse
Aquatic Plants									
Tributary reservoirs	No change Aquatic plant coverage would continue to increase or decrease based on hydrologic and climatic events	Slight increase	Slight increase	Slight decrease	Slight increase to slight decrease (Effects vary slightly among reservoirs and years)	No change	Slight increase	Slight increase	Slight increase

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Aquatic Plants (continued)									
Mainstem reservoirs	No change Aquatic plant coverage would continue to increase or decrease based on hydrologic and climatic events	No change	No change	Substantial decrease (Large reduction of aquatic plants in upper portion of drawdown zone)	Slight decrease	No change	No change	No change	No change
Population abundance and spread of invasive emergent plants [3]	No change Emergent invasive plants would continue to increase or decrease based on natural fluctuation associated with hydrologic and climatic events	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly adverse	No change	Slightly adverse	Slightly adverse	Slightly adverse
Terrestrial Ecology									
Upland and lowland plant communities	No change Plant communities would continue to increase in biomass and biodiversity through natural succession	Adverse (Loss of bottomland hardwood communities from extended summer pool and higher winter pool)	Adverse (Loss of bottomland hardwood communities from extended summer pool and higher winter pool)	Substantially adverse (Loss of wetland plant communities due to early drawdown of summer pool and higher winter pool)	Adverse (Loss of lowland plant communities from extended summer pool and higher winter pool)	Adverse (Loss of bottomland hardwood communities from higher winter pool)	Adverse (Loss of bottomland hardwood communities from extended summer pool and higher winter pool)	Adverse (Loss of lowland plant communities from extended summer pool and higher winter pool)	Slightly adverse to adverse (Loss of bottomland hardwood communities from extended summer pool)

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Terrestrial Ecology (continued)									
Migratory shorebirds and waterfowl	No change Flats would continue to be exposed during late summer	Adverse (Flats not exposed during late summer, resulting in loss of feeding habitat)	Adverse (Flats not exposed during late summer, resulting in loss of feeding habitat)	Substantially adverse (Extent of flats would be altered throughout TVA system)	Adverse (Flats not exposed during late summer, resulting in loss of feeding habitat)	Slightly adverse	Adverse (Flats not exposed during late summer, resulting in loss of feeding habitat)	Adverse (Flats not exposed during late summer, resulting in loss of feeding habitat)	Slightly adverse
Wildlife	No change Areas used by wildlife would continue to be available	Slightly beneficial to adverse (Slight increases in aquatic beds would benefit wildlife; changes in wetland communities would adversely affect various species of wildlife)	Slightly beneficial to adverse (Slight increases in aquatic beds would benefit wildlife; changes in wetland communities would adversely affect various species of wildlife)	Adverse (Loss in variety of lowland habitats)	Slightly beneficial to adverse (Slight increases in aquatic beds would benefit wildlife; loss of flats would adversely affect waterfowl and other species of wildlife)	No change to slightly adverse	Slightly beneficial to adverse (Slight increases in aquatic beds would benefit wildlife; changes in wetland communities would adversely affect various species of wildlife)	Slightly beneficial to slightly adverse	Slightly beneficial to slightly adverse
Invasive Plants and Animals									
Population abundance and spread of invasive species [4]	No change Present trends relative to rate of establish-ment and spread would continue	No change	No change	Slightly adverse	No change	No change	No change	No change	No change

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Vector (Mosquito) Control									
Population abundance	No change to the number of days mosquito breeding habitat would be present	Adverse (Increase in the number of days mosquito breeding habitat would be present)	Adverse (Increase in the number of days mosquito breeding habitat would be present)	Beneficial (Reduction in mosquito breeding habitat)	Slightly adverse	No change	Adverse (Increase in the number of days mosquito breeding habitat would be present)	Adverse (Increase in the number of days mosquito breeding habitat would be present)	Adverse (Increase in the number of days mosquito breeding habitat would be present)
Threatened and Endangered Species									
Flowing-water mainstem reservoirs and tailwaters	No change Continuation of existing trends could lead to eventual loss of some mussel species	Slightly beneficial	Slightly beneficial	Beneficial (Probably higher flows and DO levels)	No change	Beneficial (Higher minimum water levels on most tailwaters)	Beneficial (Higher minimum water levels on tailwaters)	Variable (Higher minimum water levels on tailwaters, larger volume of low DO water, longer time of low DO dis-charges at one dam)	No change
Flowing-water tributary reservoirs and tailwaters	No change Continuation of existing trends would include increasing diversity and reintroduction of protected species	Variable (Less natural water temperatures in some tailwaters, more natural in others, less late summer temperature variation in some tailwaters)	Variable (Less natural water temperatures in some tailwaters, more natural in others, less late summer temperature variation in some tailwaters)	Adverse (Probably more variable summer flows and water temperatures)	Beneficial (Less variation in June flow rates and less late summer temperature variation in some tailwaters, more natural summer water temperatures in most tailwaters)	Slightly beneficial	Variable (Less natural water temperatures in some tailwaters, more natural in others; less late summer temperature variation in some tailwaters)	Beneficial (Less variation in June flow rates and less late summer temperature variation in some tailwaters, more natural summer water temperatures in most tailwaters)	Few changes from Base Case (Less natural water temperatures in some tailwaters, more natural in others)

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	**Reservoir Recreation A**	**Reservoir Recreation B**	**Summer Hydropower**	**Equalized Summer/ Winter Flood Risk**	**Commercial Navigation**	**Tailwater Recreation**	**Tailwater Habitat**	**Preferred**
Threatened and Endangered Species (continued)									
Shorelines and lowland habitats	No change Continuation of existing trends would include the gradual loss of habitats and species populations	Slightly adverse	Slightly adverse	Adverse (Unreplaced loss of wetland habitats due to shorter duration of summer pool levels)	Adverse (Unreplaced loss of wetland habitats due to frequent changes in pool levels)	Slightly beneficial	Slightly adverse	Adverse (Unreplaced loss of scrub/shrub habitats due to higher summer pool levels)	Slightly adverse
Upland habitats	No change Existing trends would continue	No change	No change	No change	No change	No change	No change	No change	No change
Apalachia Bypass reach	No change Existing trends would continue	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Wide-ranging species	No change Existing trends would continue	Slightly beneficial	Slightly beneficial	Adverse (Potential adverse effects to gray bats)	No change	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Reservoir inflow areas	No change Existing trends would continue	No change	No change	No change	No change	No change	No change	No change	No change
Cave aquifers	No change Existing trends would continue	No change	No change	No change	No change	No change	No change	No change	No change

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Managed Areas and Ecologically Significant Sites									
Integrity of sites	No change Continued difficulty in protecting integrity of bottomland hardwoods and some aquatic endangered species sites	Slightly adverse to slightly beneficial	Slightly adverse	Adverse (Shifts or losses in wetlands type and function)	Adverse (Shifts or losses in waterfowl subimpound-ments, flats, scrub/shrub, and forested wet-lands, and some asso-ciated wildlife; slight benefits to some wildlife on tributary reservoirs)	Slightly adverse to slightly beneficial	Slightly adverse	Slightly adverse to slightly beneficial	Slightly adverse to slightly beneficial
Land Use									
Indirect effect on natural condition	No change Projected rate of shoreline residential development would continue	Slightly adverse	Slightly adverse	Slightly beneficial	No change to slightly beneficial	No change	Slightly adverse	No change to slightly adverse	Slightly adverse

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Shoreline Erosion									
Reservoir effects	No change Shoreline erosion would continue at existing rates	Adverse (Longer reservoir pool durations at summer levels and increased recreational boating would increase reservoir shoreline erosion)	Adverse (Longer reservoir pool durations at summer levels and increased recreational boating would increase existing erosion)	Beneficial (Shorter reservoir pool durations at summer levels and decreased recreational boating would decrease existing erosion)	Beneficial (Shorter reservoir pool durations at summer levels and higher winter pools would reduce reservoir shoreline erosion)	No change	Adverse (Longer reservoir pool durations at summer levels and increased recreational boating would increase reservoir shoreline erosion)	Substantially adverse (Substantially longer reservoir pool durations at summer levels and increased recreational boating would increase existing erosion)	Slightly adverse
Tailwater effects	No change Bank erosion would continue at existing rates	No change	No change	No change	No change	No change	No change	No change	No change
Prime Farmland									
Conversion of prime farmland	No change Current conversion rates would continue	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly beneficial	No change	Slightly adverse	Slightly adverse	Slightly adverse

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Cultural Resources									
Indirect effects	No change Impacts would continue at existing rates due to land development	Slightly adverse	Slightly adverse	Slightly beneficial	Slightly beneficial	No change	Slightly adverse	Slightly adverse	Slightly adverse
Direct effects	No change Impacts would continue at existing rates due mainly to erosion	Adverse (Increase in shoreline erosion)	Adverse (Increase in shoreline erosion)	Beneficial (Decrease in shoreline erosion)	Beneficial (Decrease in shoreline erosion)	No change	Adverse (Increase in shoreline erosion)	Substantially adverse (Substantial increase in shoreline erosion)	Slightly adverse
Visual Resources									
Scenic integrity	No change Scenic integrity would remain as presently exists	Beneficial (Overall, less fluctuation and longer duration at higher pool elevations)	Substantially beneficial (Overall, longer duration of higher pool elevations and less fluctuation compared to Reservoir Recreation A)	Adverse (Overall reduction in duration of higher pool elevations)	Slightly adverse	Slightly beneficial	Substantially beneficial (Overall, longer duration of higher pool elevations and less fluctuation compared to Reservoir Recreation A)	Substantially beneficial (Overall, longest duration of higher pool elevations and less fluctuation in pool levels)	Substantially beneficial (Overall, tributary reservoirs would have less fluctuation and longer duration at higher pool elevations)
Dam Safety									
Reservoir-induced seismicity	No change in existing conditions	No change	No change	No change	No change	No change	No change	No change	No change
Leakage	No change in existing conditions	No change	No change	No change	No change	No change	No change	No change	No change
Design flood maximum reservoir levels	No change in existing conditions	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	No change	Slightly adverse	Slightly adverse	Slightly adverse

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Navigation									
Change in annual shipper savings [5]	No change Regional shipper savings of approximately $378 million are expected to increase to $597 million by 2030	No change $0	No change $0	Slightly adverse (Losses range from $11 million in 2004 to over $17 million in 2030)	Slightly adverse (Losses range from $1 million in 2004 to $1.9 million in 2030)	Slightly beneficial (Savings of $15 million in 2004 to $24 million in 2030)	No change $0	No change $0	Slightly beneficial (Savings of $2.4 million in 2004 to $3.8 million in 2030)
Flood Control									
Peak discharge–historical inflows	No change in existing conditions	Adverse (Increase in peak discharge)	Substantially adverse (Substantial increase in peak discharge)	Adverse (Increase in peak discharge)	No change	Adverse (Increase in peak discharge)	Substantially adverse (Substantial increase in peak discharge)	Substantially adverse (Substantial increase in peak discharge)	No change
Peak discharge–design storms	No change in existing conditions	Adverse (Increase in peak discharge)	Substantially adverse (Substantial increase in peak discharge)	Adverse (Increase in peak discharge)	No change	Adverse (Increase in peak discharge)	Substantially adverse (Substantial increase in peak discharge)	Substantially adverse (Substantial increase in peak discharge)	No change
Potential damage	No change in average annual flood related damages of approximately $1,460,000	Adverse (29% increase in total average annual damages)	Substantially adverse (49% increase in total average annual damages)	Adverse (Approximately 25% increase in total average annual damages)	No change (3% increase in total average annual damages)	Adverse (37% increase in total average annual damages)	Substantially adverse (Approximately 40% increase in total average annual damages)	Substantially adverse (44% increase in total average annual damages)	No change (6% decrease in total average annual damages)

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Power									
Change in annual power cost [5]	No change Annual power supply costs would continue as projected in the 2003 forecast	Slightly adverse Increase cost of $30 million	Slightly adverse Increase cost of $67 million	No change to slightly adverse Increase cost of $3 million	Slightly adverse Increase cost of $108 million	Slightly beneficial Decrease cost of $11 million	Slightly adverse Increase cost of $66 million	Adverse Increase cost of $295 million	Slightly adverse Increase cost of $14 million
Recreation [5, 6]									
Change in annual recreation spending	No change Expenditure of $65 million	Slightly beneficial Increase of $11 million	Slightly beneficial Increase of $14 million	Slightly adverse Decrease of $10 million	Slightly beneficial Increase of $1 million	Slightly adverse Decrease of $1 million	Slightly beneficial Increase of $14 million	Slightly beneficial Increase of $13 million	Slightly beneficial Increase of $9 million
Public access site use in reservoirs	No change Total use August through October is 670,000 user days	Slightly beneficial (Increase of ~21,000 user days [3%])	Slightly beneficial (Increase of ~40,000 user days [6%])	Slightly adverse (Decrease of ~15,000 user days [-2%])	No change (Decrease of 3,000 user days [-0.5%])	No change (Decrease of 1,000 user days [-0.1%])	Slightly beneficial (Increase of ~40,000 user days [5.9%])	Slightly beneficial (Increase of ~40,000 user days [5.9%])	Slightly beneficial (increase of 19,000 user days [2.8%])
Public access site use in tailwaters	No change Total use August through October is 200,000 user days	No change (Increase of approximately 1,000 user days [0.5%])	Slightly beneficial (increase of approximately 5,000 user days [3.0%])	Slightly adverse (Decrease of approximately 10,000 user days [-5.0%])	Slightly adverse (Decrease of approximately 11,000 user days [-5.5%])	No change (Decrease of less than 300 user days [-0.1%])	Slightly beneficial (Increase of ~5,000 user days [2.5%])	No change (Increase of 300 user days [-0.1])	No change Increase of 1,000 user days [0.6%])
Commercial site use [7]	No change Total use August through October is 3,800,000 user days	Slightly beneficial (Increase of ~150,000 user days [4.0%])	Slightly beneficial (Increase of ~250,000 user days [7.0%])	Slightly adverse (Decrease of ~120,000 user days [-3.0%])	Slightly beneficial Increase of 47,000 user days [1.2%])	No change (Increase of 3,000 user days [0.1%])	Slightly beneficial (Increase of ~250,000 user days [7.0%])	Slightly beneficial (Increase of ~250,000 user days [7.0%])	Slightly beneficial (Increase of 110,000 user days [2.8%])

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Resource Area	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Recreation (continued)									
Private access site use	No change Total use August through October is 1,850,000 user days	Substantially beneficial (Increase of ~1,100,000 user days [63%])	Substantially beneficial (Increase of ~1,200,000 user days [67%])	Substantially adverse (Decrease of ~1,100,000 user days [-61%])	Beneficial (Increase of 210,000 user days [11%])	Slightly adverse (Decrease of 120,000 user days [-6%])	Substantially beneficial (Increase of ~1,200,000 user days [67%])	Substantially beneficial (Increase of ~1,100,000 user days [61%])	Substantially beneficial (Increase of 1,040,000 user days [56%])
Social and Economic Resources									
Gross regional product	No change in forecasted GRP	Slightly adverse ($13.6 million decrease in GRP)	Slightly adverse ($32.5 million decrease in GRP)	Slightly adverse ($43.2 million decrease in GRP)	Slightly adverse ($76.5 million decrease in GRP)	Slightly beneficial ($54.0 million increase in GRP)	Slightly adverse ($30.8 million decrease in GRP)	Adverse ($160.8 million decrease in GRP)	Slightly adverse ($6.0 million decrease in GRP)
Personal income	No change in forecasted personal income	Slightly adverse ($4.4 million decrease in PI)	Slightly adverse ($11.5 million decrease in PI)	Slightly adverse ($14.6 million decrease in PI)	Slightly adverse ($31.1 million decrease in PI)	Slightly beneficial ($15.8 million increase in PI)	Slightly adverse ($10.9 million decrease in PI)	Adverse ($63.7 million decrease in PI)	Slightly adverse ($1.9 million decrease in PI)
Employment	No change in forecasted regional employment	Slightly adverse (Decrease of 43 workers)	Slightly adverse (Decrease of 220 workers)	Slightly adverse (Decrease of 413 workers)	Slightly adverse (Decrease of 745 workers)	Slightly beneficial (Increase of 408 workers)	Slightly adverse (Decrease of 201 workers)	Adverse (Decrease of 1,522 workers)	No change (Estimated increase of 2 workers)
Population	No change in forecasted regional population	Slightly adverse (408 residents leaving the region)	Slightly adverse (769 residents leaving the region)	Slightly adverse (372 residents leaving the region)	Slightly adverse (1,571 residents leaving the region)	Slightly beneficial (In-migration of 405 residents)	Slightly adverse (745 residents leaving the region)	Adverse (3,518 residents leaving the region)	Slightly adverse (191 residents leaving the region)

Table 3.5-02 Summary of Impacts by Policy Alternative (continued)

Notes:

Brackets indicate negative values.

CO	=	Carbon monoxide
CO_2	=	Carbon dioxide.
DO	=	Dissolved oxygen.
GRP	=	Gross regional product.
Hg	=	Mercury.
HPA	=	Habitat protection area.
mg/L	=	Milligrams per liter.
NOx	=	Nitrogen oxides
NWR	=	National wildlife refuge.
PI	=	Personal income.
RRI	=	Reservoir Release Improvement Program.
SO2	=	Sulfur dioxide.
VOCs	=	Volatile organic compounds.

[1] Transitional reservoirs are so categorized because they are unique cases that do not include all of the general characteristics of mainstem or tributary reservoirs described in Section 3.5. They include Boone, Fort Patrick Henry, Tellico, Apalachia, and Melton Hill Reservoirs.

[2] Cold-water tailwaters are not included because resident communities are minimal due to the cold-water releases, and no alternative would change this general condition.

[3] A change in coverage includes either an increase or a decrease in the number of plant acres. Changes can be seen as adverse or beneficial, depending on the reader's perspective.

[4] Terrestrial plants and animals and aquatic animals.

[5] Projected costs in 2010 stated in 2002 dollars; indicative of trends.

[6] Impacts are reported for the months of August, September, and October—the months for which the recreation analysis was completed.

[7] Commercial whitewater rafting activity on Ocoee # 2 and Ocoee # 3 is considered in this summary. Under the Summer Hydropower Alternatives and the Tailwater Habitat Alternative, commercial whitewater releases would be suspended on Ocoee # 3. For purposes of this summary, it was assumed that this would result in the closure of commercial whitewater activities on Ocoee #3.

Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Tailwater Recreation Alternative, and Tailwater Habitat Alternative

These alternatives are similar in that they would produce benefits for recreational use of the reservoirs, substantially increased visual quality, and other beneficial resource improvements. However, these alternatives would also result in water quality impacts that would affect some aquatic resources, increase erosion and related impacts on cultural resources, and adversely affect the treatment of water supply. As a group, they represent a mixed set of impacts on environmental resources.

This group of alternatives would change, to various degrees, reservoir levels and flows through the reservoir system and their seasonal timing. These are the major factors driving the level of adverse and beneficial impacts on aquatic systems, wetland systems, and shoreline conditions, and the frequency and duration of thermal plant derates. Higher reservoir levels and reduced flows through the system would result in a suite of adverse and beneficial changes to the reservoir system. These would include some complex, inter-connected changes in the environment.

Holding summer pool levels higher later into summer and fall would result in increased thermal stratification in some reservoirs, and decreased water quality and low DO conditions and anoxia, depending on the reservoir. Decreased water quality would adversely affect some aquatic resources and, at specific locations, threatened and endangered species. It would be costly to mitigate the water quality impacts resulting from low DO in project releases, and some impacts may be unavoidable.

Within this group of alternatives, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative would result in the most adverse impact on water quality, because they would maintain summer pool levels longer and/or reduce flow through the system in summer to a greater extent. Reservoir Recreation Alternative A would achieve recreational and aesthetic benefits without the more substantial water quality impacts that accompany the other alternatives in this group.

Maintaining summer pool levels longer would result in greater potential for shoreline erosion, with associated adverse effects on cultural resources and some shoreline habitats. Under all these alternatives, increased erosion would occur; erosion would be greatest under the Tailwater Habitat Alternative. Impacts on cultural resources under these alternatives would be slightly adverse to substantially adverse.

The alternatives in this group would result in variable and adverse impacts on wetlands overall, because they would change the timing of inundation of various wetland, lowland, and shallow-water habitats.

Summer Hydropower Alternative and Equalized Summer/Winter Flood Risk Alternative

These alternatives are similar in the fact that they would produce few beneficial or substantially beneficial environmental resource impacts overall within the TVA reservoir system but would result in a number of substantially adverse environmental effects. The Equalized Summer/Winter Flood Risk Alternative would produce benefits for private recreational use of the reservoirs, but little change is projected for public and commercial recreation use. It would result in slightly adverse impacts on scenic integrity. The Summer Hydropower Alternative would produce substantially adverse impacts on private recreational use of the reservoirs and slightly adverse impacts on public and commercial recreation use. It would result in adverse impacts on scenic integrity. A suite of environmental resources would be adversely affected, especially under the Summer Hydropower Alternative. Both the Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative would result in substantial impacts on wetland resources. The Summer Hydropower Alternative would result in additional adverse environmental impacts on water quality in some tributary reservoirs, adverse impacts on several threatened and endangered species, and water supply withdrawal structures and pumping costs.

Base Case and Commercial Navigation Alternative

These alternatives are similar in the fact that they would produce few changes in the balance of beneficial or substantially beneficial impacts overall within the TVA system but also would result in fewer adverse environmental effects than the other alternatives. The Commercial Navigation Alternative would increase shipper savings, result in some slightly adverse impacts on wetland plant communities, terrestrial ecology (use of flats and some bottomland hardwood wetlands), and cultural resources. In general, the Commercial Navigation Alternative would not result in any adverse effects on protected species and would provide beneficial effects on summer water temperatures, minimum mainstem water levels, and increased stability of wetland habitats in comparison to the Base Case.

Preferred Alternative

After extensive public review of the DEIS and additional analyses, TVA developed a Preferred Alternative. This alternative combines and adjusts elements of the alternatives identified in the DEIS to preserve desirable characteristics and to avoid or reduce adverse impacts associated with those alternatives. The Preferred Alternative establishes a balance of reservoir system operating objectives that is more responsive to public values expressed during the ROS and consistent with the operating priorities established by the TVA Act. Adjusting project flood guides and delaying the complete filling of upper mainstem projects until May 15 would reduce potential flood damage compared to all other alternatives except the Base Case. Based on computer simulations, the Preferred Alternative would not result in increased flood damages associated with flood events up to a 500-year magnitude at any critical location within the Tennessee Valley, including Chattanooga. A flood event with a 500-year magnitude has a 1 in 500 chance of happening in any given year. Resolving flood risk issues was a central component in formulating the Preferred Alternative because reducing flood damage is one of the most valuable benefits provided by the system. Except for the Base Case, all of the alternatives evaluated in the DEIS would result in unacceptable increases in the risk of flooding at one or more critical locations. The Preferred Alternative would also provide a more equitable way of balancing pool levels among the tributary reservoirs, increase the minimum depth of the Tennessee River navigation channel at two locations, and maintain power system reliability while lessening impacts on delivered cost of power.

Under the Preferred Alternative, providing a longer duration of higher pool levels during summer (June 1 through Labor Day) would result in a beneficial increase in recreational opportunities and use of the reservoirs and tailwaters. Substantial beneficial increase in user days is anticipated for private access sites, with a slightly beneficial increase in public user days compared to the Base Case. It would also provide for more reliable recreational tailwater releases. Less fluctuation and longer duration of higher pool elevations on tributary reservoirs would substantially increase the scenic integrity of the reservoir system. The resulting reservoir pool elevations would produce slightly adverse impacts on shoreline erosion and associated slightly adverse effects on cultural resources.

Under the Preferred Alternative, reservoir pool levels would be maintained in a manner that continues to support wetlands extent, distribution, and habitat connectivity at levels similar to conditions under the Base Case. The Preferred Alternative would reduce some of the adverse impacts on flats, scrub/shrub, and forested wetlands that are associated with water levels being held too long during the growing season, and would ensure timely seasonal exposure of flats habitats important to migratory shorebirds and waterfowl at some of the more important mainstem reservoirs. However, it would result in slightly adverse impacts on certain wetland types and locations. In some cases, impacts may vary from year to year—depending on the reservoir, annual rainfall conditions, and other factors. The Preferred Alternative would result in slightly adverse effects on some protected species that occur in wetland habitats on most reservoirs, but would result in effects similar to the Base Case with regard to protected species on Kentucky Reservoir.

Compared to the Base Case, higher system flows would be required under the Preferred Alternative June through Labor Day when the volume of water in storage is above the system MOG. During normal operations in this period, weekly average system flows would not be higher than these minimum requirements to maintain pool levels as close as possible to the flood guides on 10 tributary reservoirs. Therefore, actual flows would be lower most of the time during this period. The Preferred Alternative would have little effect on water quality in tributary reservoirs. Effects would vary among mainstem reservoirs—some would have volumes of low DO water similar to the Base Case and others a substantially larger volume. Effects on water quality would be slightly adverse. The Preferred Alternative would maintain tailwater minimum flows and DO targets while reducing impacts on reservoir water quality, as compared to some of the other alternatives that hold summer pool levels longer, and would provide for more balanced tributary reservoir levels across the system.

Potential mitigation measures for TVA's Preferred Alternative have been specified in Table 7.4-01 for adverse to substantially adverse impacts. The mitigation measures listed in Table 7.4-01 are based on the incremental impacts as compared to the Base Case.

3.5.3 Regional Economic Effects

In 2000, the ROS area population was 9.2 million, total employment was 5.4 million jobs, total personal income was $235 billion, and gross regional product (GRP) was $275 billion (2002 dollars). The region attained these levels after strong growth over the 1990s, outpacing national economic growth. Gross regional product, population, employment, and income in the region grew at a faster rate than their national counterparts during the same period.

Under the Base Case, regional economic growth is projected to continue to outpace national economic growth over the rest of the decade. Overall, the region is projected to experience a GRP increase of 3.2 percent per year, compared to 3.0 percent nationally, from 2000 to 2010. Total employment is forecasted to grow at 1.2 percent while increasing at 1.0 percent nationally. With this job growth and with the region remaining a desirable place to live, regional population is also expected to continue to outpace national growth, increasing at 1.1 percent per year versus 1.0 percent for the nation.

To determine the economic effects of an alternative reservoir operations policy as compared to the Base Case, TVA evaluated several economic parameters. This evaluation integrated changes to the cost of power, revenues from recreation, shipper savings from river transportation, cost of municipal water supplies, and changes in property values into a measure of overall effects on the regional economy. Table 3.5-03 shows the effect of each of the reservoir operations policy alternatives as measured by change (from the Base Case) in the GRP, which is the sum dollar value of all goods and services in the economy that is commonly used as a broad measure of economic activity. The GRP includes direct economic effects, such as changes in power costs, and also includes the ripple effect of changed power costs on other economic sectors.

Table 3.5-03 Annual Economic Effects of Policy Alternatives Based on Changes in Gross Regional Product (2010)

	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Change	[$13.6 million]	[$32.5 million]	[$43.2 million]	[$76.5 million]	$54.0 million	[$30.8 million]	[$160.8 million]	[$6.0 million]
Percent of gross regional product	-0.004	-0.01	-0.012	-0.02	0.02	-0.01	-0.043	-0.002

Note: Brackets indicate negative values.

As measured by the GRP, only the Commercial Navigation Alternative is expected to positively affect the regional economy. All other action alternatives are expected to result in a negative regional economic effect. The actual magnitude of these effects, either negative or positive, would be small as a percent of the GRP. Effects for 2010 are shown in Table 3.5-03. The impacts for 2010 represent the effects after changes to the operations policy have been absorbed into the regional economy.

3.6 TVA's Preferred Alternative

Based on the evaluation included in this EIS, TVA staff will recommend that the TVA Board implement the ROS Preferred Alternative. This alternative would establish a balance of reservoir system operating objectives that is more responsive to values expressed by the public during the ROS and consistent with the operating priorities established by the TVA Act.

The Preferred Alternative would increase reservoir and tailwater recreation opportunities and visual quality. Based on computer simulations, the Preferred Alternative would not result in increased flood damage associated with flood events up to a 500-year magnitude at any critical location within the Tennessee Valley, including Chattanooga. A flood event with a 500-year magnitude has a 1 in 500 chance of happening in any given year. The Preferred Alternative would provide a more equitable way of balancing pool levels among tributary reservoirs. The Preferred Alternative would increase the minimum depth of the Tennessee River navigation channel at two locations and would maintain power system reliability while lessening impacts on the delivered cost of power compared to other alternatives.

The Preferred Alternative would maintain tailwater minimum flows and DO targets. Additionally, it would lessen impacts on reservoir water quality, as well as shoreline erosion and its associated adverse effects on cultural resources and some shoreline habitats—as compared to Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative. Responding to flood control, wetland, and wildlife concerns expressed by the USACE, the USFWS, state agencies, and some members of the public, no changes in seasonal water levels on Kentucky Reservoir were included in the Preferred Alternative.

Once the formulation of the Preferred Alternative was complete, TVA initiated consultations on this proposed action with the USFWS regarding the Endangered Species Act and with the seven State Historic Preservation Officers regarding the National Historic Preservation Act. Results of the Endangered Species Act consultation (presented in Appendix G) indicate that adoption of the Preferred Alternative would not jeopardize the continued existence of any listed or candidate federal threatened or endangered species. The National Historic Preservation Act consultations resulted in development of a Programmatic Agreement (presented in Appendix H) that covers the identification and protection or mitigation of historic properties that could be affected by adoption of the Preferred Alternative.

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Chapter 4

Description of Affected Environment

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4.1 Introduction to Affected Environment

The Description of Affected Environment consists of 24 individual sections that describe the existing conditions of the environmental resource areas evaluated in the ROS EIS. The specific resource areas were designed to reflect:

- Operating objectives of the TVA system (e.g., navigation and flood control);
- Issues raised during the scoping process (see Section 1.6); and,
- Topics that are typical for NEPA reviews (e.g., Prime Farmlands).

This introduction explains the common content and organization of the 24 resource area sections in Chapter 4, defines the reservoir and waterbody classifications that are used to describe existing resources, and describes the soils and geology that characterize the TVA region.

4.1.1 Organization of Resource-Specific Sections

The Affected Environment discussion for each resource area identifies the issues of concern used to measure potential impacts on the resource, the study area (or boundaries) for the analysis, the regulatory programs and TVA management activities that govern the resource area, and the existing conditions and future trends for the resource area. Table 4.1-01 lists the specific resource areas in the order they are presented in Chapter 4 and the main issues associated with each topic.

Key Issues

For each resource area, one or more key issues were identified that could measure whether a change in the existing reservoir operations policy would affect the resource and the amount of the effect associated with each policy alternative. Impacts measured for each issue were used to assess impacts on all aspects of the resource area.

Regulatory Programs and TVA Management Activities

Existing federal, state, and local regulations govern many of the specific resource areas. In addition, TVA implements ongoing programs to conserve resources. The relevant regulatory programs and TVA management activities are identified for each resource area. These laws and TVA's management actions were considered when assessing potential impacts of alternative reservoir operations policies.

Table 4.1-01 Resource Areas Included in the EIS and Focus of Discussion

Resource Area	Key Issues
4.2 Air Resources	Air quality (sulfur dioxide, ozone, nitrogen dioxide, particulate matter, carbon monoxide, and lead)
4.3 Climate	Greenhouse gases (emissions that are thought to be associated with global warming)
4.4 Water Quality	Reservoir and tailwater water quality conditions (residence time in a waterbody, thermal stratification, dissolved oxygen depletion, algal growth, sediment transport, and anoxic products)
4.5 Water Supply	Availability of water supplies, water supply delivery, and water treatment
4.6 Groundwater Resources	Groundwater levels and effects on groundwater use and wetland areas
4.7 Aquatic Resources	Biological conditions and diversity of species, sport and commercial fisheries
4.8 Wetlands	Wetland locations, types, and their ability to provide important functions
4.9 Aquatic Plants	Species abundance and composition
4.10 Terrestrial Ecology	Distribution of plant species in lowland and upland communities, and associated wildlife communities
4.11 Invasive Plants and Animals	Population abundance and spread of invasive and nuisance terrestrial and aquatic animals and terrestrial plants
4.12 Vector Control	Population abundance of permanent pool and floodwater mosquito species which are related to the potential transmission of vector-borne diseases
4.13 Threatened and Endangered Species	Occurrence patterns of federal-and state-protected species in aquatic habitats, along shoreline and lowland habitats, and along upland habitats
4.14 Managed Areas and Ecologically Significant Sites	Integrity of sites and viability of managing these areas for their intended use
4.15 Land Use	Rate of shoreline residential development and land use along shorelines
4.16 Shoreline Erosion	Rate of erosion of reservoir and tailwater shorelines
4.17 Prime Farmland	Rate of conversion or loss of important farmlands
4.18 Cultural Resources	Effects on archaeological sites or historic structures from shoreline erosion, shoreline development, and site exposure along shorelines
4.19 Visual Resources	Scenic attractiveness, landscape visibility, and scenic integrity

Table 4.1-01 Resource Areas Included in the EIS and Focus of Discussion (continued)

Resource Area	Key Issues
4.20 Dam Safety	Dam structure integrity associated with geology and seismicity, normal and design flood headwater levels, drawdown rates, and leakage
4.21 Navigation	Commodity movements by river barge on the Tennessee River, commodity movements along the Ohio River, and changes to mode of transportation (river vs. land) selected by shippers
4.22 Flood Control	Magnitude of flood flows, potential flood damage, and flood recovery
4.23 Power	The amount and timing of use of hydropower and non-hydropower generation, power system reliability, and the cost of power
4.24 Recreation	Public, commercial, and private recreation use
4.25 Social and Economic Resources	Regional economy as measured by population, employment, and economic activity from the economic drivers (navigation, power, water supply, property values, and recreation)

Study Area

The general project area is the Tennessee River Valley. The study area for each resource area was tailored to the distribution of the resource in the TVA region and the potential effects of the reservoir operation policy alternatives on the resource. For example, Water Quality focused on the waterbodies within the water control system—both reservoirs and tailwaters. Groundwater Resources defined the maximum zone of influence of reservoir surface water levels on groundwater resources near the reservoir. Cultural Resources focused on an area within 0.25 mile from reservoir shorelines to ensure that the analysis included direct and indirect impacts resulting from changes in the reservoir operations policy. Several resource areas also selected representative reservoirs to describe the Affected Environment for the entire water control system and resources within the TVA region. The impacts identified for representative reservoirs affect the entire water control system.

4.1.2 Reservoir and Waterbody Classifications

As described in Chapter 2, The Water Control System, each TVA reservoir falls into one of four general categories that are closely related to its characteristics, primary function, and operation in the reservoir system: mainstem storage, mainstem run-of-river, tributary storage, and tributary run-of-river. The location, size, and ranges in water levels of the reservoirs and tailwaters of the Tennessee River system—and the reservoir characteristics—are identified in Table 2.1-01 and in Appendix A.

Because the ecological and geographic characteristics of waterbodies were important to describe the Affected Environment for the specific resource areas and evaluate potential impacts from changes in the existing reservoir operations policy, an additional waterbody classification was developed. The ROS waterbody classification (presented in Figure 4.1-01 and in Table 4.1-02) identifies eight types of waterbodies, ranging from flowing mainstem reaches to warm tributary tailwaters. Each waterbody in the TVA system was defined as a "reach," extending from an upstream boundary to a downstream boundary, and was classified into one of the eight waterbody types. The eight categories reflect several important differences among the waterbodies, including geographic location (physiographic regions), whether the reaches were pooled or flowing, and thermal characteristics (warm, cool, or cold water).

Most resource areas use both the general reservoir system classification and the ROS waterbody classifications. In some cases, these classifications were further modified based on the need to describe the Affected Environment and potential impacts associated with a particular resource area. Each resource area provides the description and rationale for such modifications.

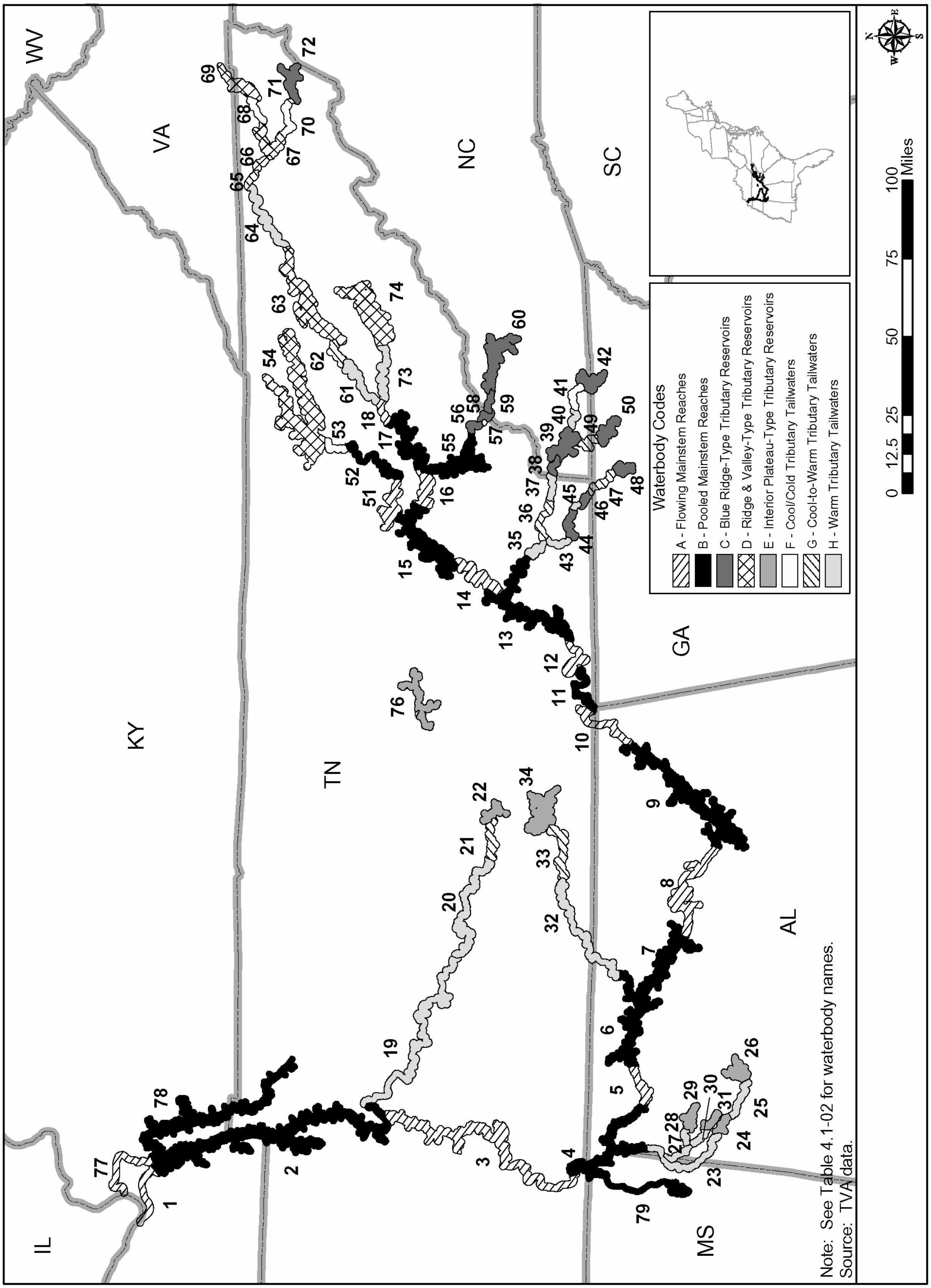
4.1.4 General Setting

Tennessee River Watershed

The Tennessee River watershed covers approximately 41,000 square miles. This area includes 129 counties within much of Tennessee and parts of Alabama, Kentucky, Georgia, Mississippi, North Carolina, and Virginia. The larger TVA Power Service Area covers 80,000 square miles and includes 201 counties in the same seven states (Figure 1.1-02).

The Tennessee River watershed begins with headwaters in the mountains of western Virginia and North Carolina, eastern Tennessee, and northern Georgia. At Knoxville, Tennessee, the Holston and French Broad Rivers join to form the Tennessee River, which then flows southwest through the state—gaining water from three other large tributaries: the Little Tennessee, Clinch, and Hiwassee Rivers. The Tennessee River eventually flows into Alabama, where it picks up another large tributary, the Elk River. At the northeast corner of Mississippi, the river turns north, re-crosses Tennessee—picking up the Duck River, and continues to Paducah, Kentucky, where it enters the Ohio River.

The total river elevation change from the maximum reservoir surface elevation at Watauga Dam (highest elevation on the system) to the minimum tailwater surface elevation at Kentucky Dam (lowest elevation on the system) is 1,675 feet in 828.6 river miles. The Tennessee, the main river, has a fall of 515 feet in 579.9 river miles from the top of the Fort Loudoun Dam gates to the minimum tailwater elevation at Kentucky Dam. The mainstem fall is gradual except in the Muscle Shoals area of Alabama, where a drop of 100 feet is found in a stretch of less than 20 miles (TVA 1990).



Note: See Table 4.1-02 for waterbody names.
Source: TVA data.

Figure 4.1-01 Reservoir Operations Study Waterbodies

Table 4.1-02 ROS Waterbodies Classifications

A—Flowing Mainstem Reaches (11 Reaches)	Reach Length (stream miles)
1. Kentucky tailwater	22.4
3. Pickwick tailwater	95.9
5. Wilson tailwater	14.4
8. Guntersville tailwater	38.3
10. Nickajack tailwater	22.7
12. Chickamauga tailwater	39.9
14. Watts Bar tailwater	23.9
16. Fort Loudoun tailwater	26.3
18. Fort Loudoun [Inflow]	11.2
51. Clinch River to Melton Hill Dam	18.6
77. Cumberland R.—Barkley Dam tailwater	30.6
Total miles	**344.2**
B—Pooled Mainstem Reaches (12 Reaches)	
2. Kentucky Reservoir to Duck River	88.4
4. Pickwick Reservoir to Colbert	38.3
6. Wilson Reservoir	15.5
7. Wheeler Reservoir to Limestone Creek	35.8
9. Guntersville Reservoir to Scottsboro	53.0
11. Nickajack Reservoir to Raccoon Mountain	21.3
13. Chickamauga Reservoir to Gillespie Bend	35.0
15. Watts Bar Reservoir to Paint Rock Creek	46.1
17. Fort Loudoun Reservoir to Peter Blow Bend	38.7
52. Melton Hill Reservoir to Clinton (Route 61)	43.2
55. Tellico Reservoir to Chilhowee Dam	33.2
78. Barkley Reservoir to Cumberland City	73.4
Total miles	**521.9**
C—Blue Ridge-Type Tributary Reservoirs (12 Reaches)	
38. Apalachia Reservoir	9.8
39. Hiwassee Reservoir to 19/64 bridge	21.0
42. Chatuge Reservoir	12.6
44. Parksville Reservoir to Ocoee #2 Dam	12.3
46. Ocoee #3 Reservoir	6.4

Table 4.1-02 ROS Waterbodies Classifications (continued)

C—Blue Ridge-Type Tributary Reservoirs (continued)	Reach Length (stream miles)
48. Blue Ridge Reservoir	12.0
50. Notteley Reservoir	17.5
56. Chilhowee to Calderwood Powerhouse	8.8
58. Calderwood Dam to Cheoah Dam	7.8
59. Cheoah Dam to Fontana Dam	9.6
60. Fontana Reservoir	28.8
72. Watauga Reservoir	16.3
Total miles	**162.9**
D—Ridge and Valley-Type Tributary Reservoirs (6 Reaches)	
54. Norris Reservoir	72.2
63. Cherokee Reservoir to John Sevier	54.4
66. Fort Patrick Henry Reservoir	10.4
67. Boone Reservoir	17.4
69. South Fork Holston Reservoir	24.8
74. Douglas Reservoir	44.2
Total miles	**223.4**
E—Interior Plateau-Type Tributary Reservoirs (7 Reaches)	
22. Normandy Reservoir	17.8
24. Bear Creek Reservoir	15.9
26. Upper Bear Reservoir	16.4
29. Cedar Creek Reservoir	16.0
31. Little Bear Creek Reservoir	11.1
34. Tims Ford Reservoir	35.2
76. Great Falls Reservoir	19.4
Total miles	**131.8**
F—Cool/Cold Tributary Tailwaters (6 Reaches)	
41. Mission Dam to Chatuge Dam	14.9
53. Norris Dam tailwater	13.5
57. Calderwood powerhouse to dam	1.2
68. South Fork Holston Dam tailwater	13.8
70. Watauga River—Boone to Wilbur	18.2
71. Wilbur Reservoir	2.7
Total miles	**64.3**

Table 4.1-02 ROS Waterbodies Classifications (continued)

G—Cool-to-Warm Tributary Tailwaters (7 Reaches)	Reach Length (stream miles)
21. Duck River—Shelbyville to Normandy	27.2
33. Elk River—Fayetteville to Tims Ford	43.5
36. Hiwassee River—Ocoee River to Powerhouse	18.4
47. Blue Ridge tailwater	17.4
49. Nottely River to Nottely Dam	14.6
62. Holston River Nance Ferry—Cherokee Dam	19.0
65. Fort Patrick Henry Dam tailwater	8.2
Total miles	**148.3**
H—Warm Tributary Tailwaters (7 Reaches)	
19. Duck River to Columbia	123.5
20. Duck River—Columbia to Shelbyville	87.9
23. Bear Creek to Bear Creek Dam	60.4
25. Upper Bear tailwater	24.0
27. Cedar Creek to Little Bear Creek	14.9
28. Cedar Creek Reservoir tailwater	8.3
30. Little Bear Creek to dam	11.5
32. Elk River—to Fayetteville	73.8
35. Hiwassee River to Ocoee River mouth	15.9
37. Hiwassee River—Apalachia cut-off reach	13.2
40. Mission Dam tailwater	14.3
43. Ocoee River—mouth to Parksville Dam	11.9
45. Ocoee #2 Reservoir to Ocoee #3 Dam	5.0
61. Holston River to Nance Ferry	33.3
64. Holston River—John Sevier to North Fork	35.5
73. French Broad River to Douglas Dam	32.3
75. Caney Fork—Great Falls Dam tailwater	0.8
Total miles	**566.5**

Note:

The numbers that precede reach names correspond to the locations of each waterbody on Figure 4.1-01.

Source: TVA source data 2002.

The eastern half of the Tennessee Valley includes the slopes of the Blue Ridge and Great Smoky Mountains, where an abundant growth of timber covers the ground. The western half of the Valley is less rugged, with substantial areas of flat or rolling land occurring in middle Tennessee and along the western edge.

Physiography, Soils, and Geology

Reservoirs and the associated tailwaters of the Tennessee River Valley span six physiographic regions, including the Highland Rim, Coastal Plain, Cumberland Plateau, Blue Ridge, Central Basin, and Valley and Ridge (Figure 4.1-02). Thirty-nine percent of the TVA region is in the Highland Rim, and 40 percent in the Coastal Plain.

The geology and soils associated with the physiographic regions for each of the TVA reservoirs in the scope of this study were determined in previous studies (Eckel et al. 1940, TVA 1949, Sapp and Emplaincourt 1975, Fenneman 1938, Redmond and Scott 1996, Clark and Zisa 1976, Springer and Elder 1980) (see Table 4.1-03).

The eastern portion of the Tennessee River watershed is located in the Blue Ridge (Unaka Mountains) and the Valley and Ridge Physiographic Regions. The headwaters of the Tennessee River originate in the rugged Unaka Mountains in North Carolina and eastern Tennessee. This region has undergone multiple orogenic (mountain-building) events and is underlain by folded and faulted complexes of igneous, metamorphic or sedimentary rocks dating from the Precambrian and Paleozoic Eras. The soils of the Blue Ridge Physiographic Region consist of highly weatherable material. The depth of soil varies from 1 to 3 feet at higher elevations and from to 3 to 7 feet on the lower side slopes. The valleys contain a variety of soils and are generally productive. Soil depths of the Valley and Ridge Physiographic Region range from shallow over shales and sandstones to very deep over the dolomitic limestone. The upland soils are primarily highly leached, and strongly acid with low fertility. Because of the variable landscape, soils properties vary over short distances, resulting in small patches of productive land intermixed with average land or large tracts of rough land.

The Tennessee River flows southwest from the Valley and Ridge Physiographic Region into the Cumberland Plateau Physiographic Region. This region consists of a high tableland that is underlain by nearly flat-lying sedimentary rocks of Paleozoic age. The Plateau is highly dissected by streams and rivers, forming valleys with moderate to high relief. Because limestone underlies portions of this region, karst (an irregular limestone region with sinks, underground streams, and caverns) landscapes and extensive cave systems have developed. The Cumberland Plateau is bounded on the west and east by escarpments. The terrain is gently rolling to hilly highland with deeply cut gorges.

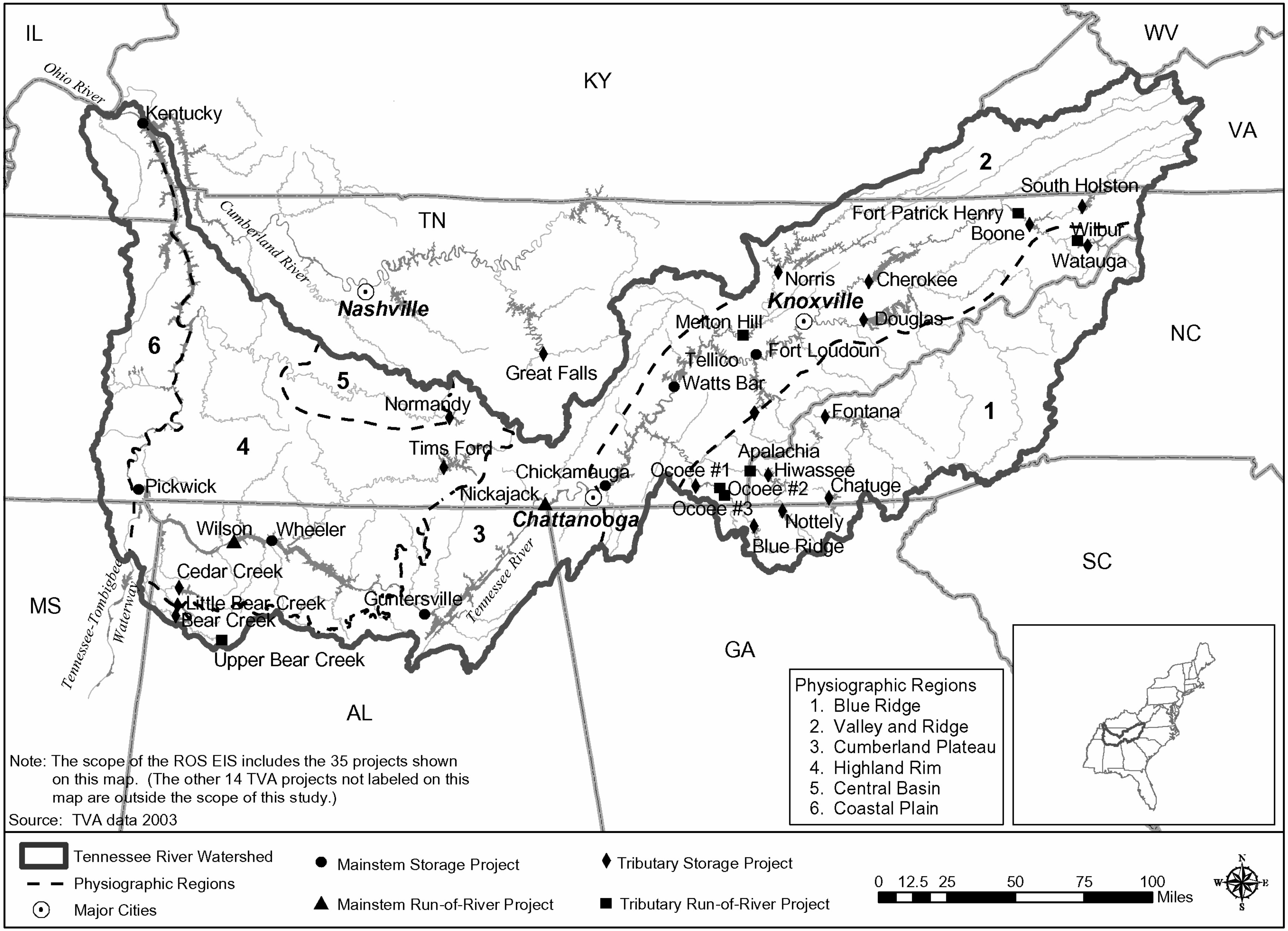


Figure 4.1-02 Physiographic Regions within the Tennessee River Watershed

Table 4.1-03 Physiographic Regions of the Tennessee Valley

Physiographic Region	Topography	Bedrock Geology	Geologic Structure
Blue Ridge Mountains	Rugged terrain, heavily forested slopes, rushing streams, and waterfalls	Metamorphic and igneous rocks, minor sedimentary rocks of Precambrian and Paleozoic Age	Complex structure closely folded and faulted
Valley and Ridge	Narrow parallel ridges and broader intervening valleys of northeast-southwest trend	Highly deformed but non-metamorphosed sedimentary rocks of Paleozoic Age	Thrust faults and folds; resistant sandstone cap ridge tops; less resistant carbonate rocks valleys
Cumberland Plateau	Northern portion maturely dissected mountainous and rugged; southern region plateau submaturely dissected, youthful valleys	Paleozoic Age sandstones and shales	Rocks nearly horizontal, some folding in the eastern region; faults rare
Highland Rim	Bench separating central basin and the Cumberland Plateau; gently rolling uplands	Paleozoic Age limestones, shales and sandstones	Simple structure, strata dip gently away to form central basin
Central Basin	Broad irregularly shaped basin, solution features and erosional knobs	Paleozoic Age limestones and shales	Eroded structural dome; bedrock dipping radically outward; faults rare
Coastal Plain	Flat-lying region of low relief (300 feet or less) with low-gradient streams in broad, flat valleys	Late Mesozoic and Cenozoic Age clastic sedimentary rocks overlying Paleozoic Age sedimentary rocks; recent sediments composed of alluvial sands and loess	Formations horizontally layered, with gentle dip to embayment; folds and faults rare

Sources: Luther 1995, Moore 1999, and Miller 1994.

From the Cumberland Plateau, the Tennessee River flows northwest through the Highland Rim Physiographic Region. This region consists of a highly dissected flat-lying tableland that is underlain by nearly flat-lying Paleozoic age limestone. Due to the presence of limestone, an extensive karst plain has developed, with numerous sinkholes, disappearing streams, and cave systems (Bingham and Helton 1999). The hill slope soils were formed from limestone and have clayey and cherty subsoils. The more level areas and hill caps have soils formed from thin loess (windblown material) and limestone residuum. The soils are highly leached and strongly acid with low fertility—except near the Kentucky–Tennessee border.

The Central Basin Physiographic Region is within the Highland Rim. The Central Basin is one of the smaller physiographic regions of the Tennessee Valley watershed and includes parts of the Duck River and Cumberland River drainages. The Basin is underlain by upwarped Paleozoic age limestone that has been eroded to form a basin surrounded by the Highland Rim. The inner portion of the Basin is relatively flat lying with low relief, and is bordered by large hills and ridges along its outer edge. Due to the weathering and erosion of the underlying limestone, karst topography is present in this region.

From the Highland Rim, the Tennessee River flows north through the Coastal Plain Physiographic Region. The portion of this region that lies within the Tennessee Valley is almost entirely west or southwest of the Tennessee River and includes the drainages of the Beech River and Bear Creek. The relief within this area is generally low; consequently, stream gradients are very low—their valleys are broad and flat and filled with thick accumulations of alluvium. The rocks exposed in the Gulf Coastal Plain are all unconsolidated sediments, with Paleozoic rocks underlying the whole area at great depth. The soils of the Coastal Plain Physiographic Region are highly leached, low in fertility, and strongly acid. Quality cropland is found mainly on the bottoms and terraces. Control of erosion is of major concern, as evidenced by deep gullies that are common on some hillsides.

4.2 Air Resources

4.2.1 Introduction

Resource Issues

- Air quality, including sulfur dioxide, ozone, nitrogen dioxide, particulate matter, carbon monoxide, and lead

This section addresses existing air quality in the TVA Power Service Area. Air quality is good, and, based on long-term air pollution trends, improving. TVA and other emissions sources contribute to local and regional air quality primarily through emissions associated with the combustion of fossil fuels (coal, gas, and oil). Although air quality has, for the most part, greatly improved, air quality issues—including ozone, fine particles, and visibility—will continue to challenge the region and nation for years to come.

4.2.2 Regulatory Programs and TVA Management Activities

Through the Clean Air Act (CAA), Congress mandated the protection and enhancement of the nation's air quality resources. National Ambient Air Quality Standards (NAAQS) for the following pollutants have been established to protect the public health and welfare (these NAAQS are shown in detail in Table 4.2-01):

- Sulfur dioxide (SO_2);
- Ozone (O_3);
- Nitrogen dioxide (NO_2);
- Particulate matter less than or equal to 10 micrometers in diameter (PM_{10}) and less than or equal to 2.5 micrometers ($PM_{2.5}$) in diameter;
- Carbon monoxide (CO); and,
- Lead (Pb).

Other regulatory programs affecting emissions include the Acid Rain Control Program and the Regional Haze Rule.

The USEPA promulgated two revised NAAQS in 1997: an 8-hour ozone NAAQS and annual and 24-hour $PM_{2.5}$ NAAQS. Although attainment (air quality equal or better than standard) or non-attainment (air quality worse than standard) status has as yet to be determined, it is likely that a number of areas in and around the Tennessee Valley will not meet one or more of these stringent clean air standards.

Table 4.2-01 National Ambient Air Quality Standards

Pollutant	Standard Value[1]	Standard Type[2]
Particulate Matter (PM_{10})		
Annual arithmetic mean	50 $\mu g/m^3$	Primary & secondary
24-Hour average	150 $\mu g/m^3$	Primary & secondary
Particulate Matter ($PM_{2.5}$)		
Annual arithmetic mean	15 $\mu g/m^3$	Primary & secondary
24-Hour average	65 $\mu g/m^3$	Primary & secondary
Sulfur Dioxide (SO_2)		
Annual arithmetic mean	30 ppb (80 $\mu g/m^3$)	Primary
24-Hour average	140 ppb (365 $\mu g/m^3$)	Primary
3-Hour average	500 ppb (1300 $\mu g/m^3$)	Secondary
Ozone (O_3)		
1-Hour maximum	120 ppb (235 $\mu g/m^3$)	Primary & secondary
8-Hour maximum	80 ppb (157 $\mu g/m^3$)	Primary & secondary
Nitrogen Dioxide (NO_2)		
Annual average	53 ppb (100 $\mu g/m^3$)	Primary & secondary
Carbon Monoxide (CO)		
8-Hour maximum	9 ppm (10 mg/m^3)	Primary
1-Hour maximum	35 ppm (40 mg/m^3)	Primary
Lead (Pb)		
Quarterly average	1.5 $\mu g/m^3$	Primary & secondary

1 ppm = parts per million, ppb = parts per billion, mg/m3 = milligrams per cubic meter, and μg/m3 = micrograms per cubic meter. Parenthetical values are an approximately equivalent concentration.

2 Primary National Ambient Air Quality Standards (NAAQS) protect public health and secondary NAAQS protect public welfare.

4.2.3 Existing Conditions

National Ambient Air Quality Standards

One of the best measures of current air quality is whether or not an area attains the NAAQS. The TVA Power Service Area currently meets all NAAQS. However, three ozone non-attainment areas (Smyth County, Virginia; Birmingham, Alabama; and Atlanta, Georgia) are just outside the TVA Power Service Area. These areas are shown in Figure 4.2-01.

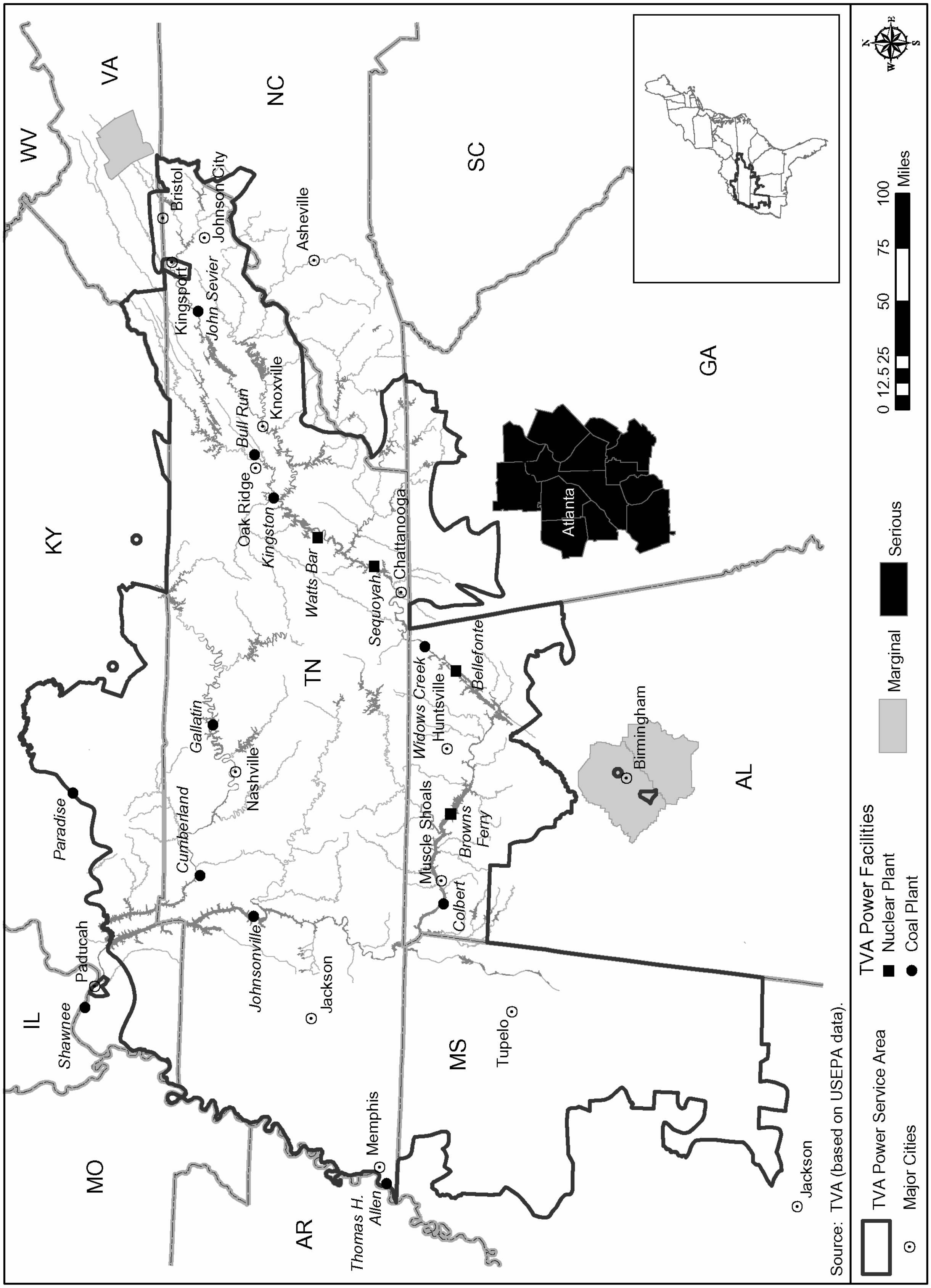


Figure 4.2-01 Ozone Non-Attainment Areas in the Tennessee Valley Region - 1-Hour Standard

Trends in NAAQS Pollutants

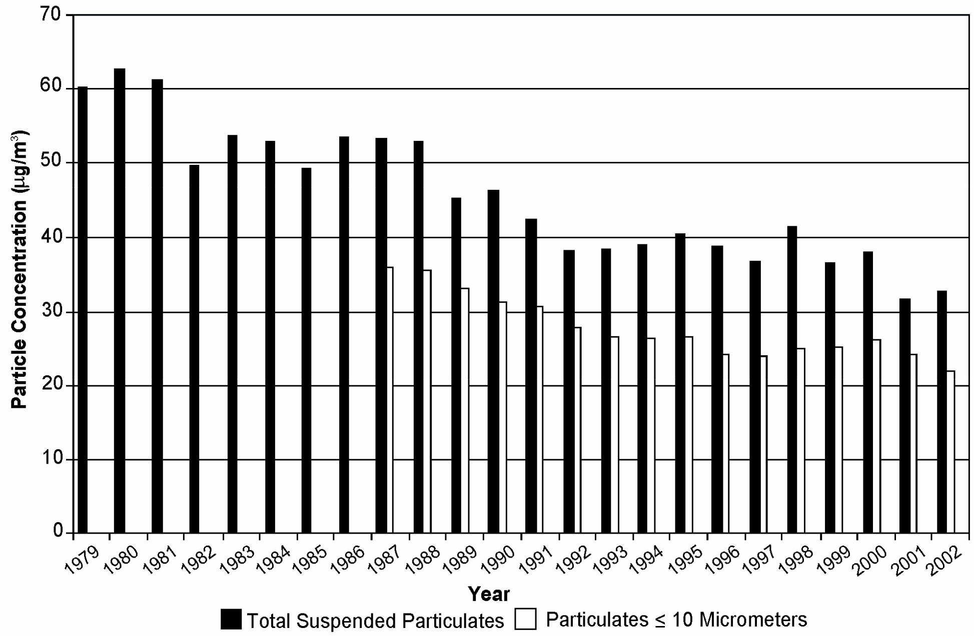
Overall, air quality in and downwind of the Tennessee Valley has greatly improved for over two decades, with significant long-term improvements (decreases) in sulfur dioxide, particulate matter (as measured by total suspended particulates [TSP] and PM_{10}), carbon monoxide, nitrogen dioxide, ozone (1-hour) and lead. Eight-hour ozone levels have not significantly changed over this same period and the fine particulate ($PM_{2.5}$) record is insufficient to establish long-term trends. These trends are consistent with long-term national and regional trends established by the USEPA (2003).

- Total suspended particulates, sulfur dioxide, and carbon monoxide have improved dramatically with air quality levels improving between 40 and 60 percent. All areas meet clean air standards for these pollutants. Two examples, the improvements in particulate matter (TSP, PM_{10}) and sulfur dioxide, are shown in Figures 4.2-02 and 4.2-03, respectively.

- Particulate matter less than 10 microns in diameter, nitrogen dioxide, and lead have improved significantly with air quality levels—improving between 20 and 30 percent. All areas meet NAAQS for these pollutants.

- Ozone levels for 1979 to 2002 are shown in Figure 4.2-04. There has been marginal improvement in the maximum 2nd-highest 1-hour ozone levels (about 7 percent) but no significant improvement in the maximum 4th-highest 8-hour levels. The 8-hour standard is not yet used to determine clean air status. The eventual implementation of this standard will lead to several urban and rural ozone non-attainment areas in and downwind of the TVA Power Service Area. Strategies to lower ozone pollution and bring areas into attainment will require further emissions controls for ozone precursor pollutants (volatile organic compounds [VOCs] and nitrogen oxides [NOx]). TVA already is implementing a nitrogen oxides control program that will considerably lower its contribution to ozone pollution.

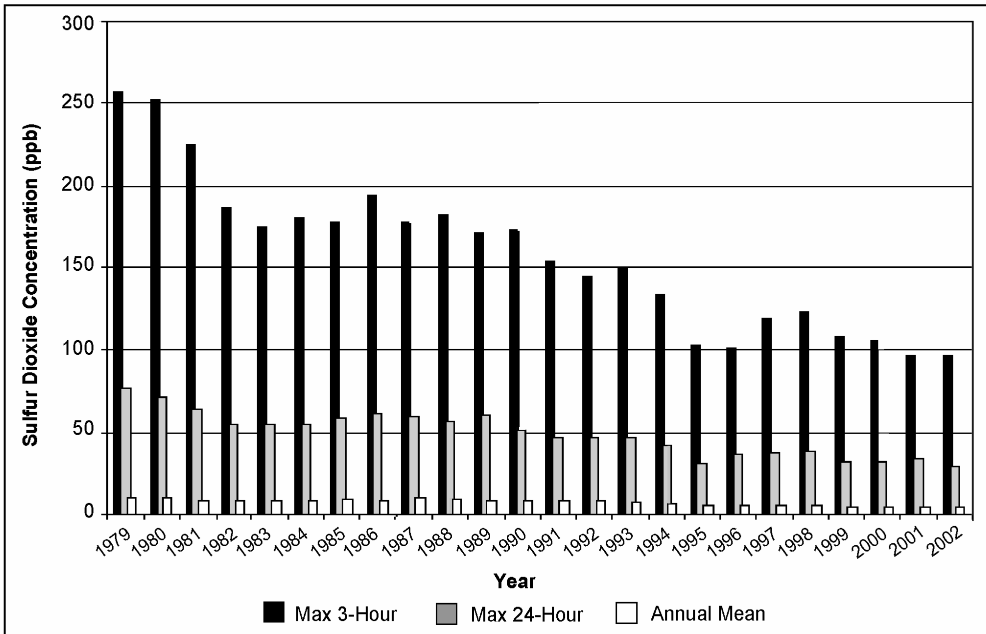
- Fine particulate air pollution–$PM_{2.5}$–could also prove a challenge in the coming years. The fine particulate standards are not yet used to determine clean air status, and there is insufficient record for trend assessment. The eventual implementation of these standards will likely result in several urban $PM_{2.5}$ non-attainment areas in and downwind of the TVA Power Service Area. Strategies to reduce fine particulate levels and bring these areas into attainment will likely require further emissions controls on sources of VOCs, elemental carbon, sulfur dioxide, and, perhaps, nitrogen oxides. TVA's nitrogen oxides and sulfur dioxide emission control programs will considerably lower its contribution to fine particulate air pollution.



Note: The annual average national ambient air quality standard for particulates ≤10 micrometers is 50 µg/m³.

Source: USEPA

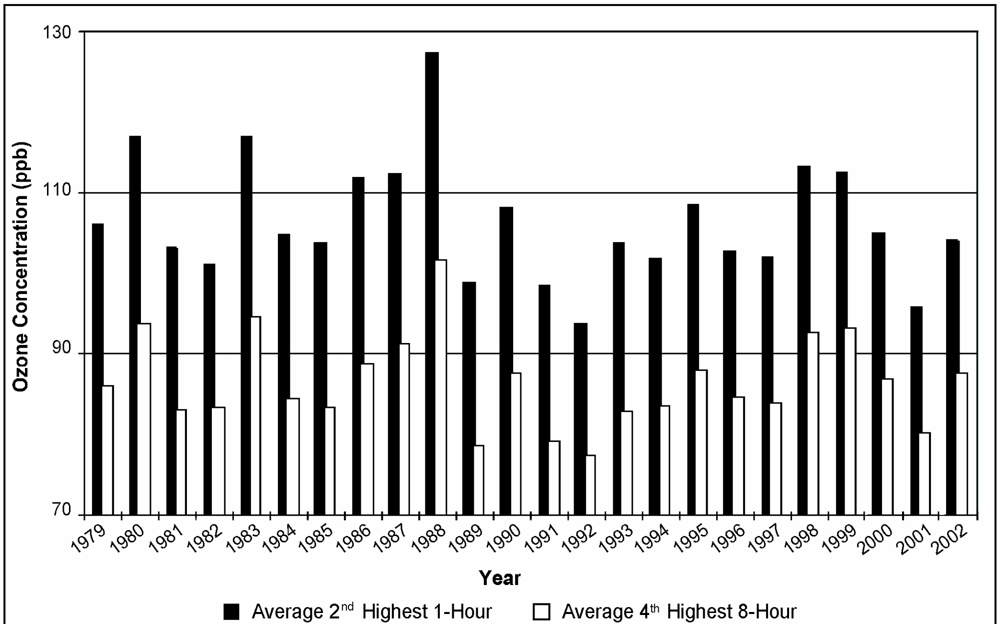
Figure 4.2-02 Air Quality Trends for Particulate Matter in the Tennessee Valley Region (1979 to 2002)



Note: The national ambient air quality primary average annual standard for sulfur dioxide is 30 parts per billion (ppb), the 24-hour primary standard is 140 ppb, and the 3-hour secondary standard is 500 ppb.

Source: USEPA

Figure 4.2-03 Air Quality Trends for Sulfur Dioxide in the Tennessee Valley Region (1979 to 2002)



Note: The national ambient air quality primary and secondary 1-hour standard for ozone is 120 parts per billion (ppb) and the 8-hour primary and secondary standard is 80 ppb.

Source: USEPA

Figure 4.2-04 Air Quality Trends for Ozone in the Tennessee Valley Region (1979 to 2002)

<u>Status of TVA's Emissions</u>

Existing emissions of regulated air pollutants from the TVA power generation system are summarized in Table 4.2-02. Over the long-term, the emissions of principal concern to TVA—sulfur dioxide and nitrogen oxides—have been reduced substantially. System-wide sulfur dioxide emissions have been reduced by 76 percent from the peak in 1977 while nitrogen oxides emissions have been reduced by 51 percent from the peak in 1995. Year-to-year emission changes also vary, depending on changes in demand, fuel type, and type of plant dispatched.

Air Quality-Related Values

An air quality-related value (AQRV) is a term often applied to the non-health impacts of air pollutants. These impacts are relevant to the health and enjoyment of the environment. USEPA's efforts to control pollutant emissions related to AQRVs include the Acid Rain Control Program and the Regional Haze Rule. These programs are primarily directed at managing pollution-caused impacts in national parks and wilderness areas (Class I areas), which have been set aside to preserve and protect the natural environment. Figure 4.2-05 shows the Class I national park and national wilderness areas in and around the Tennessee Valley region.

Table 4.2-02 Summary of TVA Power Plant Emissions of Air Pollutants

Emissions	Estimated Total Actual (tons)	
	2000	2001
Particulate matter	12,853	16,391
Sulfur dioxide	727,355	605,390
Nitrogen oxides	288,016	270,166
Carbon monoxide	12,390	12,446
Volatile organic hydrocarbon	1,531	1,530
Sulfuric acid	6,640	4,663
Total trace elements	19,401	15,679
Mercury	2.2	1.9
Organic hazardous air pollutants	39.6	35.3

Acid rain (also called acid deposition or atmospheric deposition) refers to the production and impact of human-made acidifying air pollutants. Humankinds' principal influence on rainfall acidity is through the emission of sulfur dioxide and nitrogen oxides, which are eventually deposited as gases or particles in rainfall, snow, or fog. Acid rain has been associated with a number of detrimental environmental effects, including declines in fish, agricultural, and forest productivity and accelerated weathering and corrosion of building products.

Visibility is defined as the greatest distance at which an observer can "just" see a black object viewed against the horizon sky. However, visibility is more than simply a measurement of how far an object can be seen; it is related to the conditions that allow appreciation of the inherent beauty of landscape features. Regional visibility is estimated to have declined by as much as 60 percent over the past 50 years in the eastern United States, with the poorest visibility conditions occurring during summer.

The deterioration in visibility is linked to an increase in regional haze, a type of visibility impairment resulting from widely dispersed and intermixed pollutants from many sources. Atmospheric particles and gases that reduce visual contrast and visual range by absorbing and scattering light have their origins in both natural and human-caused processes. For example, the bluish "smoky mountain" haze characteristic of southern Appalachia originates from organic (i.e., carbon-based) aerosols emitted by mountain forests. Much of the light extinction in our regional haze that reduces visibility is due to fine sulfate particles. Sulfates can originate from natural sources, but these are of minor importance. Instead, regional haze is mostly due to fine sulfate particles related to the emission of sulfur dioxide.

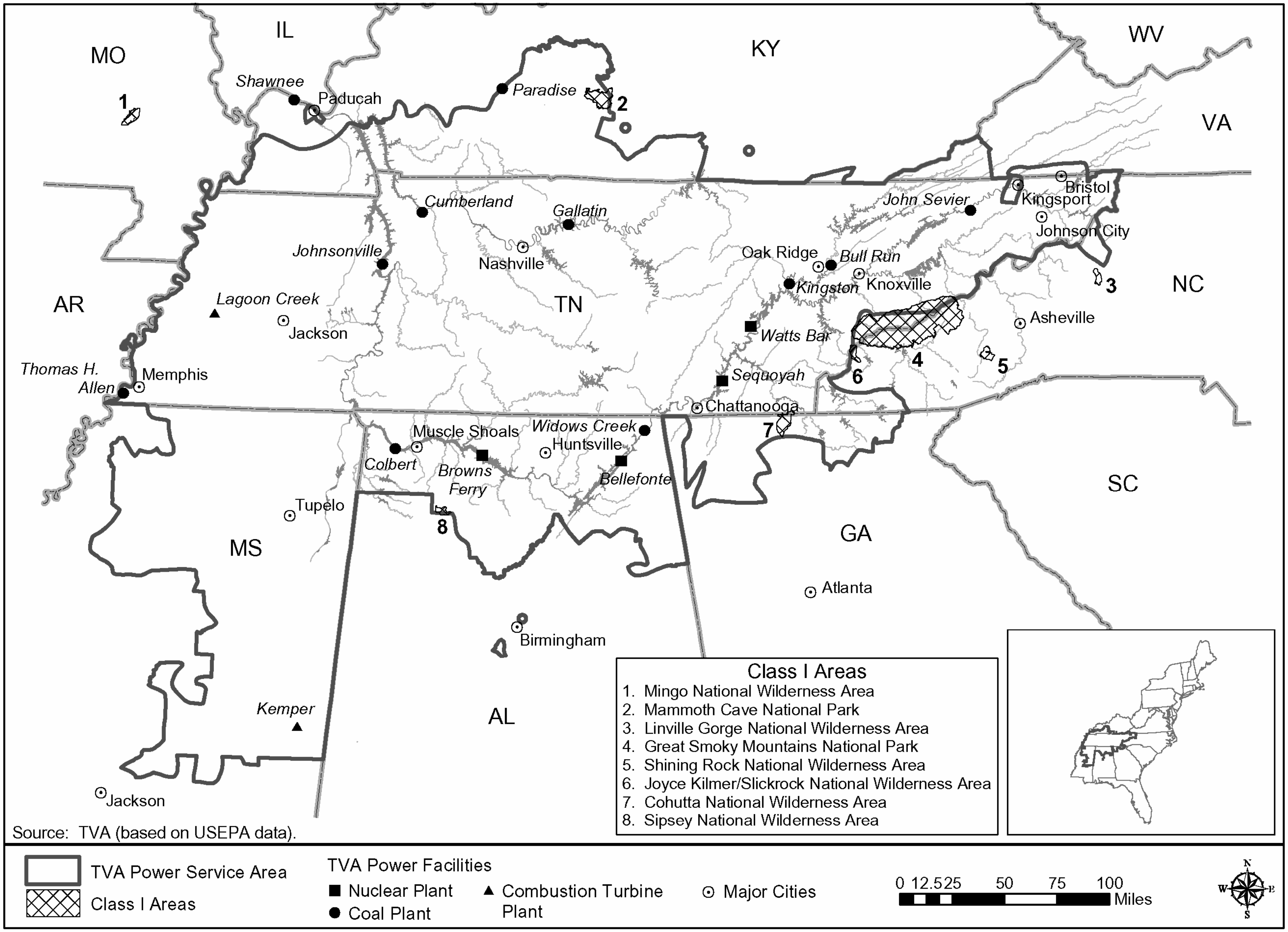


Figure 4.2-05 National Park and National Wilderness Areas Designated as Air Quality Class I Areas for the Prevention of Significant Deterioration in the Tennessee Valley Region

Trends in AQRVs in the Tennessee Valley Region

Significant reductions in acid deposition have been achieved. Figures 4.2-06 and 4.2-07 show the reduction in hydrogen ion concentrations and sulfate in precipitation in the Tennessee Valley region. Environmental management programs to address ozone and $PM_{2.5}$ attainment issues should also lead to further improvements in acid rain and regional haze.

Hazardous Air Pollutants

Hazardous or toxic air pollutants are any of more than 650 chemicals that, with adequate exposure, may cause potential health problems. Examples of toxic pollutants include those defined as hazardous compounds in the CAA (asbestos, beryllium, mercury, vinyl-chloride, benzene, arsenic, and radionuclides), heavy metals (such as chromium, cadmium, and nickel), and persistent bioaccumulating compounds (such as PCBs, dioxin, and pesticides).

The sources of toxic air pollutants range from very large industries—including those using or producing plastics, pesticides, solvents, fossil fuels, petrochemical fuels, agrochemicals and waste treatment facilities, such as incinerators, sewage treatment plants, and landfills—to very small ones, such as the corner dry cleaners, gas stations, print shops, and common household products. While the total amount of toxic emissions is important, personal exposure to toxic pollutants can be dominated by small, nearby sources.

Status of TVA Emissions

On Earth Day 1997, the USEPA added coal- and oil-fired electric generating units to the list of facilities required to report annual air, water, and land releases of potentially toxic substances to the USEPA-maintained, public-access Toxics Release Inventory (TRI) database beginning in 1998.

TVA issued its first TRI release reports (for calendar year 1998) on July 1, 1999. These facility-specific reports estimate the land, air, and water release of more than 20 potentially toxic substances, including antimony, arsenic, barium, beryllium, chromium, cobalt, copper, hydrochloric acid, hydrogen fluoride, lead, manganese, nickel, selenium, sulfuric acid, thallium, zinc, n-hexane, and 1,2,4-trimethylbenzene.

While the total amount of TVA's TRI releases is substantial, quantity alone does not provide a meaningful picture of associated health risk. To gain this perspective, it is necessary to estimate human exposure. Beginning in 1999, TVA conducted plant-specific, inhalation risk assessments based on annual air TRI emissions estimates for each of its plants. These risk assessments combine environmental exposure estimates with evolving health effects guidelines developed by USEPA and others. The risk estimates provided by these annual assessments helps TVA gauge the health significance of its TRI releases.

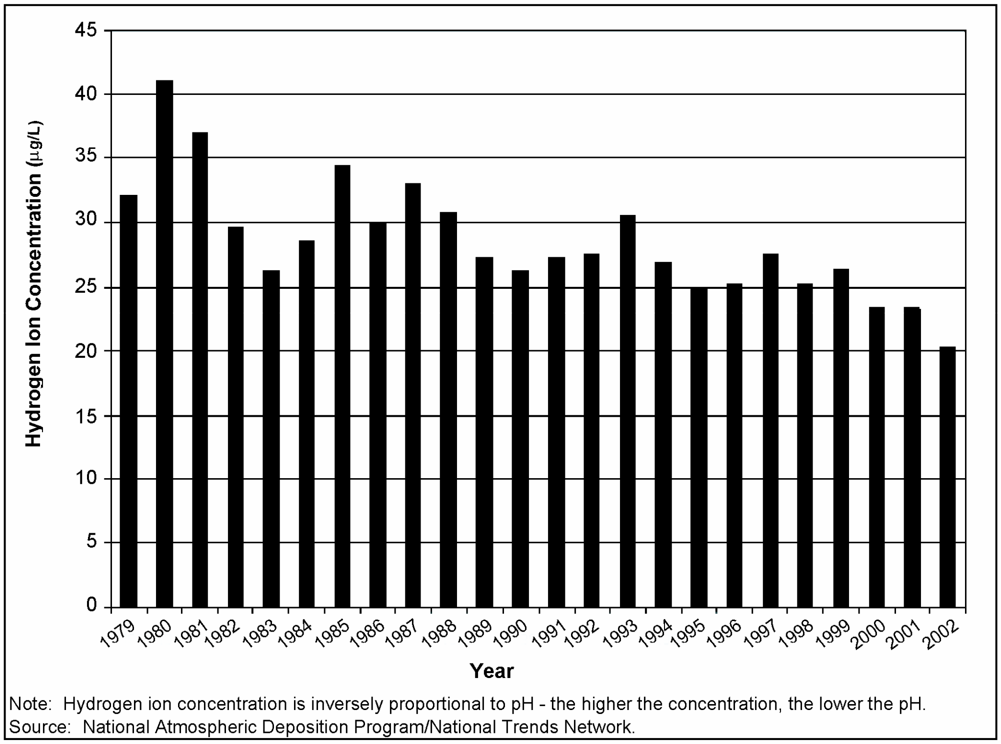


Figure 4.2-06 Rainfall Hydrogen Ion Concentration in the Tennessee Valley Region (1979 to 2002)

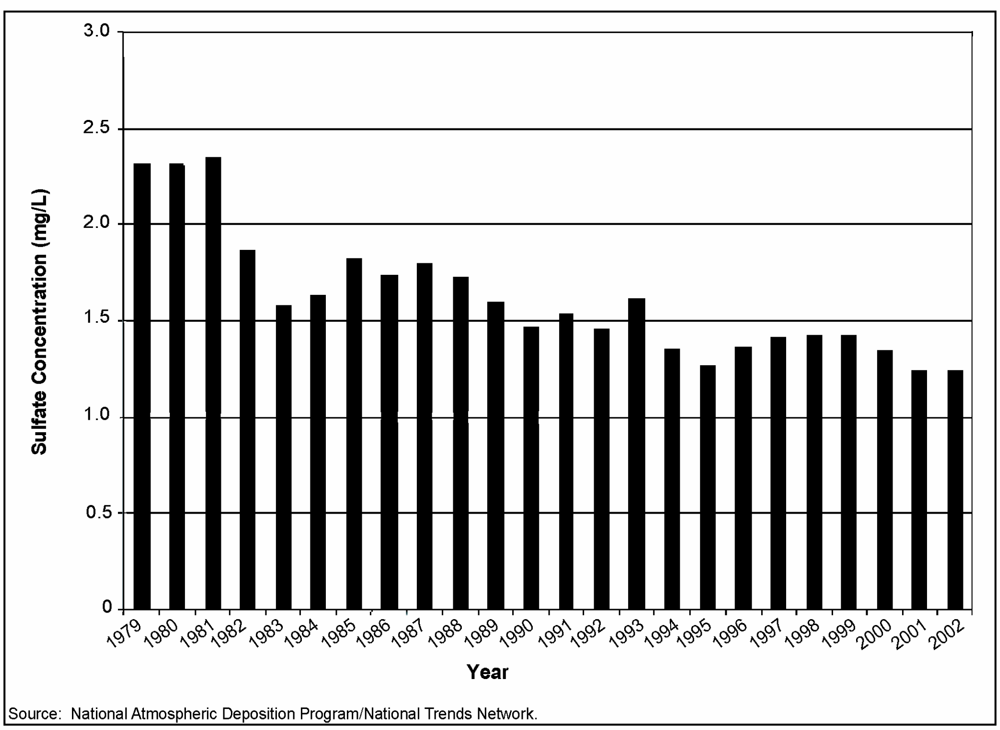


Figure 4.2-07 Rainfall Sulfate Concentration in the Tennessee Valley Region (1979 to 2002)

The results from TVA health risk assessments indicate that emissions of TRI/HAP substances from TVA plants do not pose a significant health risk to either TVA employees or the general public. These findings are consistent with independent assessments (USEPA, EPRI, Harvard University).

Trends in TVA Hazardous Air Pollutant Emissions

TVA's estimated Hazardous Air Pollutant (HAP) emissions vary greatly from year-to-year, depending largely on changes in fossil fuel type and generating load. Emissions control systems also have a significant impact. Utility generating sources presently are not required to control for specific HAP compounds. Existing and planned particle and gaseous emissions reduction programs do and will provide some significant HAP control benefits. The USEPA is in the process of establishing mercury control requirements for utilities.

4.2.4 Expected Future Changes in Emissions

The region is currently in attainment with all clean air standards. The upcoming implementation of the revised 8-hour ozone and fine particulate standards is an emerging challenge. TVA's ongoing sulfur dioxide and nitrogen oxides emissions control programs will further reduce TVA's contribution to both ozone and fine particulate pollution, but attainment of these stringent standards will require significant controls from other source sectors as well. TVA's ongoing emissions control programs will also benefit regional AQRVs, including acid rain and visibility. These environmental control investments should also result in a beneficial effect on TVA HAP/TRI emissions.

NAAQS Pollutants

Controls to Meet the New Ozone NAAQS. Once 8-hour non-attainment areas are determined, state and local environmental regulatory programs will develop plans to achieve the ozone NAAQS. TVA's ongoing nitrogen oxides control program will further reduce TVA's contribution to ozone pollution. It must also be recognized that NOx and VOC controls from other emissions sectors will be needed to attain this standard. Just as TVA NOx emissions are part of the problem, TVA controls are only part of the solution.

Controls to Meet the New Fine Particle NAAQS. Once $PM_{2.5}$ non-attainment areas are determined, state and local environmental regulatory programs will develop plans to achieve this NAAQS. TVA's ongoing sulfur dioxide and nitrogen oxides control programs will further reduce TVA's contribution to $PM_{2.5}$. Additional VOC and elemental carbon controls from other emissions sectors will also be needed to attain this standard.

Controls to Meet AQRV. TVA is fully compliant with the acid rain control program established in the CAA. It is expected that ongoing sulfur dioxide and nitrogen oxides control programs will further reduce TVA's contribution to acid rain. TVA's ongoing sulfur dioxide and nitrogen oxides control programs will further reduce TVA's contribution to regional haze through 2010.

Hazardous Air Pollutants

TVA has reduced emissions of HAPs through application of control devices that capture particulate matter, sulfur dioxide, and nitrogen oxides. The collection of the HAPs is a natural adjunct to the main target of the control. As more control devices are added, further reductions are expected.

4.3 Climate

4.3.1 Introduction

Resource Issues
▸ Greenhouse gases

The primary issue in the ROS concerning climate is greenhouse gases, emissions that are thought to be associated with global warming (also referred to as greenhouse gas emissions). The link between emissions from thermal generation and climate change is disputed. Moreover, the influence of emissions from a region such as the TVA Power Service Area cannot be reliably determined based on changes in the climate of the same region because global warming is a global effect. Assuming the potential for impacts on climate from atmospheric emissions, this section describes the current climate in the TVA Power Service Area, existing emissions, and anticipated future trends.

Some policy alternatives could result in a change in the mix of the generating resources TVA uses to meet its energy supply requirements to customers in its service area. TVA presently uses a mix of hydro, nuclear, and fossil-fueled generation and a small amount of renewable resources to meet its load. A change in the availability of hydropower could create an increase in the use of fossil-fired generation, resulting in corresponding increases in carbon dioxide (CO_2) emissions—a greenhouse gas. Similarly, an increase in the availability of hydropower generation could decrease TVA's use of fossil-fueled generation, reducing the emission of greenhouse gases. In addition, an alternative that increases or decreases barge traffic along the Tennessee River may shift CO_2 emissions from trucks to barges or from barges to trucks.

The timing of an increase or decrease in hydropower generation is of particular concern. If decreases occur in summer, when demand for electricity is at its peak, TVA would have less flexibility in reducing greenhouse emissions from replacement generation. Hydropower reductions in summer would most likely be replaced by fossil fuel generation, potentially increasing greenhouse emissions.

4.3.2 Regulatory Programs and TVA Management Activities

Regulatory Programs

No regulations currently limit emissions of CO_2, the primary greenhouse gas emitted by TVA plants. The Administration has called for a voluntary program, and several members of the U.S. Senate are proposing regulatory programs for these emissions.

TVA Management Activities

As a regional development agency and producer of public power, TVA was the first in the nation to participate in the "Climate Challenge," a voluntary greenhouse gas reduction program for electric utilities sponsored by the U.S. Department of Energy. Through this program, TVA has reduced, avoided (for example, by using nuclear power instead of fossil fuels and by using wind and solar power), or sequestered (removed from the atmosphere, for example by planting trees) a cumulative total of about 200 million tons of CO_2 over the past decade. The initial voluntary reporting commitment for reduction, avoidance, or sequestration of 27 million tons annually by 2000 was exceeded that year, when 30.3 million tons was actually reported.

TVA has identified additional voluntary actions to continue efforts to reduce, avoid, or sequester CO_2 emissions. Among these are increasing use of renewable energy sources (such as wind, solar, and methane gas), co-firing with waste materials, vehicle and energy efficiency measures, sequestration of CO_2 through reforestation efforts, power upgrading of Units 2 and 3 at Browns Ferry, restarting Browns Ferry Unit 1, and increasing generation at hydroelectric units by modernizing equipment.

4.3.3 Existing Conditions

Although no reliable analysis documents changes to the climate of the TVA Power Service Area due to global warming, temperature and precipitation records can be used to describe recent climate conditions.

Table 4.3-01 shows the average surface temperatures for the regions within the TVA Power Service Area. Table 4.3-01 compares the average temperatures from 1931 to 2000 with those from 1971 to 2000. These data show a generally declining pattern of temperatures throughout the region except for the North Carolina Mountains, which warmed slightly. There is also a discernable pattern of the southerly portion of the TVA Power Service Area cooling more than the northern portion. Thus, the TVA Power Service Area is generally cooling and not experiencing increasing temperatures that may be associated with global warming.

Precipitation is another measure of changing climate conditions. Figure 4.3-01 shows the precipitation departure from normal precipitation for three distinct areas in the Tennessee River basin from 1971 to 2000. Normal means the average precipitation for the three areas, as follows:

- Above Kentucky Dam, 51.01 inches per year;
- Below Chattanooga, 51.93 inches per year; and,
- Above Chattanooga, 50.20 inches per year.

Precipitation varied from 15 inches above normal to 15 inches below normal. The four wettest consecutive years in TVA history (1972 to 1975) occurred during this period, as well as the four driest (1985 to 1988) consecutive years. No distinct global warming pattern is associated with this precipitation.

Table 4.3-01 Average Temperatures and Departures for the TVA Power Service Area

National Weather Service Area		Temperature ºF		
		1930 to 2000 Average	1971 to 2000 Average	Change
Kentucky	Western	57.1	57.2	+0.1
	Central	56.0	56.0	0.0
Virginia	Southwestern	52.5	52.1	-0.4
Tennessee	Western	59.5	59.2	-0.3
	Middle	58.2	57.8	-0.4
	Cumberland Plateau	56.4	56.3	-0.1
	Eastern	57.0	56.7	-0.3
North Carolina	Northern Mountains	52.7	52.9	+0.2
	Southern Mountains	55.1	55.2	+0.1
Mississippi	North Central	61.3	60.7	-0.6
	Northeast	61.1	60.6	-0.5
	East Central	63.0	62.5	-0.5
Alabama	Northern Valley	60.5	60.0	-0.5
	Appalachian	60.4	60.1	-0.3
Georgia	Northwest	60.2	59.7	-0.5
	North Central	59.6	59.3	-0.3

Source: National Climatic Data Center 2002.

4.3.4 Emissions of Greenhouse Gases

Emissions of greenhouse gases could potentially affect the global climate. The term greenhouse gases includes CO_2 (generally a product of combustion), methane (generally a product of natural gas and decomposition of organic material), nitrous oxide (a product of combustion), and chlorofluorocarbons (freons). These compounds do not contribute equally to global warming. For instance, pound for pound, methane is considered to contribute 21 times more to global warming as a greenhouse gas than CO_2. Because emissions of CO_2 from combustion represent the largest quantity of manmade greenhouse gas emissions, CO_2 often is used as a gauge of total greenhouse gas emissions. Often "CO_2 equivalents" are used, where the emissions of other greenhouse gases are converted to equivalents by comparing their equivalent effects to CO_2. Another important greenhouse gas is water vapor, primarily from natural sources.

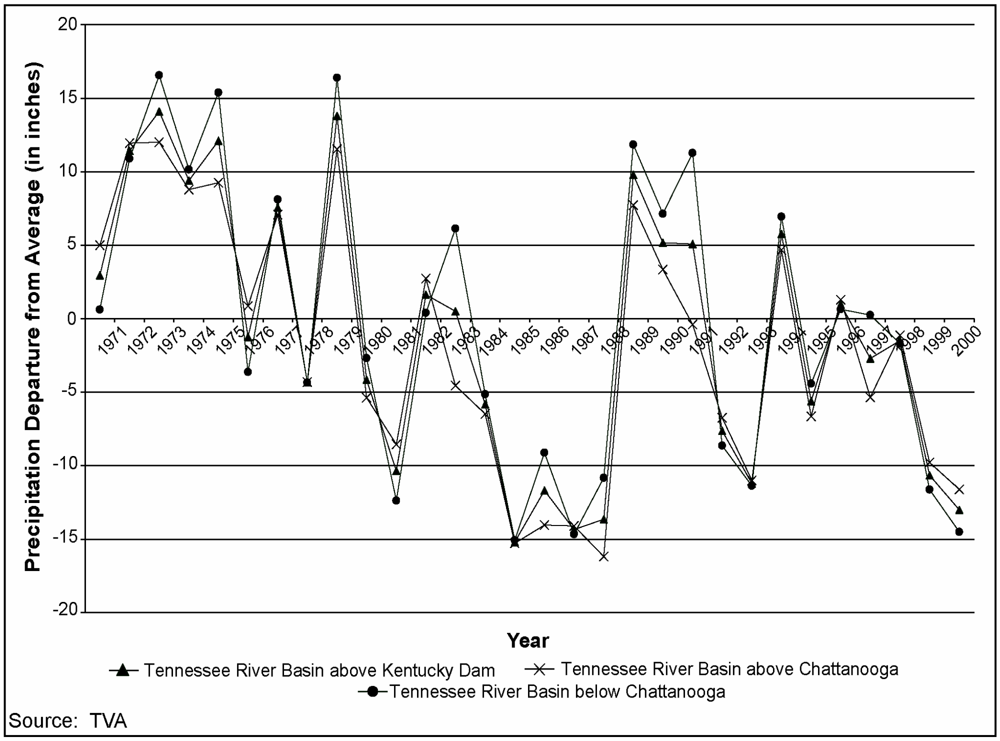


Figure 4.3-01 Precipitation Departure from the 1971 to 2000 Average in the Tennessee River Basin

Existing Conditions

Table 4.3-02 presents data on TVA emissions of CO_2 for the past 3 years. TVA's contribution to total CO_2 for the United States was 1.4 percent in 1999 and 2000 (USEPA 2002). The U.S. contribution to CO_2 equivalent emissions from the 21 highly developed industrialized nations that report was 53 percent in 1996 and 52 percent in 1990 (United Nations 1998). Total global emissions of manmade greenhouse gases are approximately double the amount reported by the 21 countries.

In the TVA Power Service Area, TVA's CO_2 emissions account for about 46 percent of the region's total CO_2 emissions and 41 percent of the region's total manmade greenhouse gas emissions (USEPA 2002). Thus, changes in TVA's CO_2 emissions may substantially affect these totals. Transportation sources account for about 32 percent of the CO_2 emissions in the TVA Power Service Area and 29 percent of total greenhouse gas emissions. Barge and truck traffic, however, represent only small percentages of the total transportation emissions for the TVA Power Service Area.

Table 4.3-02 Greenhouse Gas Emissions (millions of tons) (1990 to 2001)

Year	TVA[1]	United States[2]		United Nations[3]	
	CO_2	CO_2	Total	CO_2	Total
2001	105.5			–	–
2000	108.3	6,424	7,749	–	–
1999	103.6	6,232	7,558	–	–
1996	--	6,032	7,416	11,299	13,889
1990	--	5,498	6,790	10,680	13,169

[1] TVA data from continuous emissions monitors on TVA power plants. Estimates of TVA emissions of other greenhouse gases are not available.

[2] USEPA "Greenhouse Gases and Global Warming Potential Values," April 2002. Data are available only through 2000. The "Total" columns include other greenhouse gas emissions in carbon dioxide (CO_2) equivalents.

[3] United Nations Framework Convention on Climate Change, "Summary Compilation of Annual Greenhouse Gas Emissions Inventory Data from Annex I Parties." These totals are from only 21 individual nations, mostly in Europe and North America. Data are available only through 1996. There are no totals available for the world.

Future Trends

TVA's CO_2 emissions depend primarily on the amount of electricity generated from fossil fuels. Changes in the emission generation source (from coal to natural gas and from fossil fuel to hydropower or nuclear power) result in reduced CO_2 emissions. The U.S. trend in greenhouse gas emissions has been an increase from 1990 to 2000 of 14 percent in CO_2 equivalents. The increase from 1990 to 1996 by the 21 highly developed countries that report CO_2 equivalents was 5.5 percent.

Energy demand is expected to continue to grow in the TVA Power Service Area over the next 30 years. At an average of 0.5 percent per year (a minimal rate), energy demand would grow 17 percent during the period.

This demand is likely to be met by a combination of increased hydropower, nuclear power, and fossil fuel generation. Four TVA projects have been completed to add more natural gas-fired generation to the TVA system. Increased reliance on hydropower, nuclear, and natural gas generation is expected to reduce greenhouse gas emissions from the TVA system on an output basis (greenhouse gas emissions/total generation).

Prospects for reductions in CO_2 equivalent emissions are primarily tied to international agreements. Fluorocarbons (freons) have been significantly reduced due to worldwide—especially U.S.—implementation of the Montreal Protocol of 1988, which banned worldwide production of these high CO_2 equivalent emissions. It is difficult to predict future trends in CO_2 equivalent emissions. If the Kyoto Protocol now being discussed is signed by many countries and implemented, some reductions may occur both in the United States and worldwide. The

United States has not yet committed to participate in any worldwide program of reductions of emissions of greenhouse gases.

4.4 Water Quality

4.4.1 Introduction

TVA reservoirs affect the quality of Valley waters by changing the thermal characteristics, residence times (length of time water spends in a reservoir), oxygen consumption and re-aeration, particle settling, algal growth, and cycling of nutrients and other substances (Churchill and Nicholas 1967, TVA 1978). This section describes water quality conditions that are affected by existing reservoir operations or that may be affected by an alternative operations policy. It also summarizes existing water quality in the potentially affected reservoirs and tailwaters.

Resource Issues

- Residence time
- Algal growth
- Thermal stratification
- Dissolved oxygen depletion
- Anoxic products

The regulation of the Tennessee River and tributaries through the TVA system of dams and reservoirs controls the rate of water movement through the reservoir system. The timing of reservoir releases changes the residence time of water in the reservoir and the pattern of downstream flows. Residence time influences several water quality constituents directly and many more indirectly. Temperature, dissolved oxygen (DO), and the production of algae are affected directly by residence time. The timing and degree of thermal stratification (the separation or layering of colder and warmer waters within the reservoirs) is also directly related to residence time. DO concentrations in reservoirs are related to thermal stratification, oxygen demand (biological, chemical, and sediment), and the timing and depth of water releases. Residence time and the availability of nutrients and light affect the dynamics of algal growth. In turn, algae play a critical role in the DO balance of the system. In the context of reservoir operations, residence time, thermal stratification, DO depletion, and algal growth are key water quality processes. They reflect overall water quality conditions, eutrophication, and the ability of the reservoir to assimilate waste.

Other water quality conditions are also important to the reservoir system. Very low DO concentrations (referred to as anoxic conditions) can mobilize or dissolve metals, sulfides, and ammonia contained in bottom sediments. Nutrient loadings (nitrogen and phosphorus) from the watershed play an important role in the growth of algae in the reservoirs. These parameters and processes are assessed qualitatively in Section 5.4 based on a quantitative analysis of the potential impacts on temperature, DO, and algae.

Erosion, sedimentation, and turbidity are affected by impoundments and project operations, such as release flows and drawdowns. Reservoir releases can increase downstream erosion and sedimentation, which can affect algae (discussed in this section) and other aquatic life (see Section 4.7, Aquatic Resources). Erosion is discussed in Section 4.16, Shoreline Erosion. Other water quality issues are largely unaffected by reservoir operations. Examples include bacterial contamination and contamination of sediments by polychlorinated biphenyls (PCBs).

4.4.2 Regulatory Programs and TVA Management Activities

Regulations and implementing programs at several levels of government monitor and manage the water quality in the Valley. State and federal programs authorized by the Clean Water Act (CWA) include the National Pollutant Discharge Elimination System (NPDES) and total maximum daily loads (TMDLs). The relationship of these programs to water quality in the Valley and to reservoir operations is described in the following sections. TVA activities include the Reservoir Release Improvement (RRI) Program, Vital Signs Monitoring Program, and Shoreline Treatment Program.

State and Federal Water Quality Programs

The federal CWA is the basis for many of the state and federal programs that address water quality issues. Wastewater permits are issued by the states under the NPDES program. States have established water quality criteria based on preserving specified designated uses of stream segments. Designated uses include uses such as water supply, power production, contact recreation, aquatic life, and waste assimilation. In cases where the water quality criteria are not met for a designated use, the stream segment is designated as water-quality limited. Water-quality limited stream segments are identified in the state's Section 303(d) list. The 303(d) list is updated every 2 years. For water-quality limited stream segments, the state must establish a TMDL for the pollutant(s) causing the stream segment to violate the water quality criteria and not meet its designated use. The objective of the TMDL is to inventory all sources of the pollutant and allocate loadings such that the stream segment meets its designated use.

The majority of reservoirs and tailwaters in the Valley meet both state and federal water quality criteria and guidelines. However, many segments of the system are listed as water-quality impaired under Section 303(d) of the CWA. The state-designated impaired TVA reservoirs and tailwaters within the scope of this EIS are presented in Appendix D1, Table D1-01. The primary causes for the listing of these reservoirs and tailwaters include flow alteration; low DO concentrations; thermal modification; sediment accumulation; contamination with PCBs, other organic compounds, or metals; and pathogen (bacteria, microorganisms) contamination. Of these causes, only flow alteration, temperature, DO, and sediment accumulation are influenced substantially by reservoir operations.

Reservoir operations have the potential to change flow, DO, and temperature. Changes in these conditions can potentially cause exceedances of the water quality criteria, affecting NPDES discharge permits or TMDL allocations of pollutant loads. For example, if minimum flows or DO concentrations were decreased, or if temperature were increased, the capacity to assimilate (dilute, break down, or absorb) waste would be reduced. If the changes are large, water quality criteria may be exceeded; designated stream uses may not be met; and existing and future dischargers may be limited, prohibited, or required to reduce existing pollutant loads.

The development and implementation of TMDL plans in the Tennessee River watershed may improve water quality in certain impaired segments by reducing inputs of pollutants. On the other hand, increased population growth will likely increase development pressure in the watershed, resulting in increases in nutrient and sediment loading to the TVA system. The net impact of these potential changes on water quality constituents likely to be affected by the alternatives under consideration was assumed for purposes of this assessment to be offsetting.

Reservoir Release Improvement Program

In 1991, TVA undertook a 5-year program to address tailwater oxygen concentrations and minimum flow requirements downstream of 20 TVA dams (Higgins and Brock 1999). TVA now uses auto-venting turbines, surface water pumps, oxygen-injection systems, aerating weirs, and air compressors and blowers to increase DO concentrations to target levels (TVA 1990). Turbine pulsing, weirs, and small hydropower units are used to maintain minimum flows when hydro turbines are not operating.

The RRI Program, completed in 1996, has increased DO concentrations to target levels in 300 miles of tailwaters below TVA dams and has improved minimum flows in 180 miles of tailwaters. The number and diversity of fish and insects have increased in those sections of river, resulting in a substantial growth in tailwater fishing. DO improvements have been made in the tailwaters below Apalachia, Blue Ridge, Boone, Chatuge, Cherokee, Douglas, Fontana, Fort Loudoun, Fort Patrick Henry, Hiwassee, Norris, Nottely, South Holston, Tims Ford, Watauga, and Watts Bar Reservoirs. TVA has made the commitment that the alternatives being considered would not reverse any of the improvements that have been made under this program (TVA 2002b) to ensure that DO targets and minimum flow described in the Lake Improvement Plan are maintained.

Vital Signs Monitoring Program

TVA initiated a reservoir monitoring program in 1990 to provide information on the ecological health or integrity of major reservoirs in the Valley (TVA 2002a). TVA monitors ecological conditions at 69 sites on 31 reservoirs. Each site is monitored every other year unless a substantial change in the ecological health score occurs during a 2-year cycle. If that occurs, the site is monitored the next year to confirm that the change was not temporary. Roughly half the sites are sampled each year on an alternating basis.

Five ecological indicators (chlorophyll-a, DO, sediment quality, benthic macroinvertebrates, and fish assemblage) are monitored at up to four locations in each reservoir. To complete the ecological health scoring process, the 20 to 100 percent scoring range is divided into categories representing good, fair, and poor ecological health conditions relative to what is expected given the hydrogeomorphology of the reservoir.

In general, ecological health scores for tributary reservoirs are lower than for mainstem reservoirs (Figure 4.4-01). Dissolved oxygen is the ecological health indicator mostly responsible for this difference between mainstem and tributary reservoirs because of its effects on chemical and biological conditions. Most mainstem reservoirs rarely receive poor ratings for DO, which means that DO concentrations <2.0 milligrams per liter (mg/L) occur either infrequently or for only short durations. On the other hand, DO concentrations <2.0 mg/L occur at most tributary reservoirs each summer and fall and, as a result, they received poor ratings. Transitional reservoirs, a designation used in the impacts assessment in Section 5.4, function somewhat differently than both mainstem and tributary reservoirs. The ecological health scores of transitional reservoirs are distributed throughout the poor to fair range.

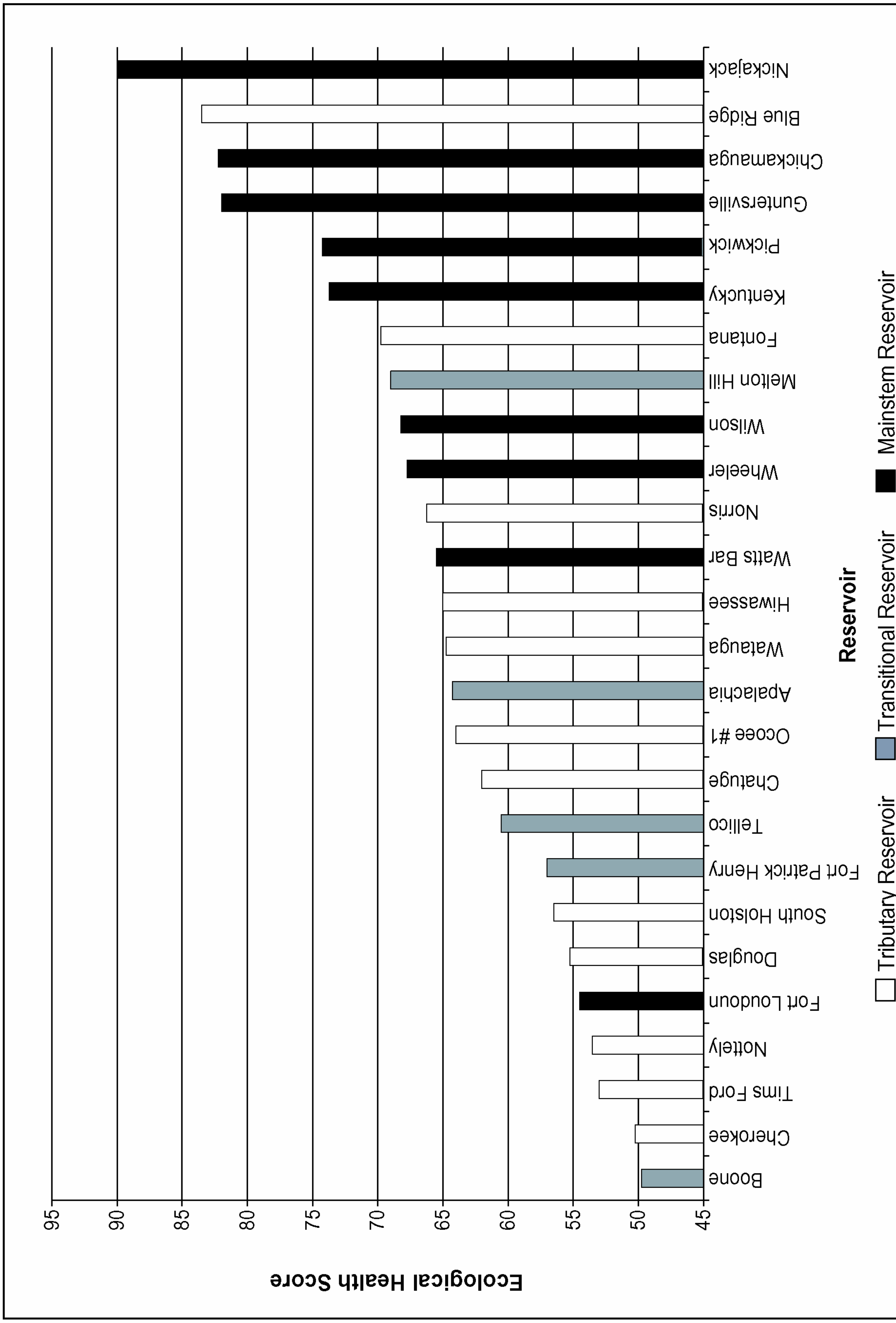
Scoring Ranges for All Reservoirs		
Poor	**Fair**	**Good**
<59	59-72	>72

The primary causes of low DO concentrations in tributary reservoirs are long residence time, depth, and nutrient loading (nutrients help algae grow). Shorter residence times in the mainstem reservoirs help prevent low DO concentrations by moving water through the reservoirs before decomposition consumes oxygen and allows for more mixing, more aeration, and lower algal growth (algal cells consume oxygen when they sink deeper than light can penetrate). However, Vital Signs monitoring data indicate lower DO concentrations in mainstem reservoirs during spring and summer periods of low flow, when the residence times are longer. Table 4.4-01 shows the ecological health indicators for affected reservoirs during the most recent monitoring cycle (2000 or 2001).

Shoreline Management Initiative

The SMI was designed to improve resource management and to refine existing permitting processes for activities on and near the shorelines of waters in the TVA system. The resultant plan established a policy to protect TVA-owned or controlled shoreland as well as private shoreland and aquatic resources, while allowing adjacent residents reasonable access to the water.

Through the Shoreline Treatment Program, TVA treats critical erosion sites (TVA 1998). This aspect of the SMI is discussed in Section 4.16, Shoreline Erosion.



Note: Transitional Reservoir = Reservoir with short retention, nominal winter drawdown, or is smaller than other tributary reservoirs.
Source: TVA Vital Signs Monitoring Program data.

Figure 4.4-01 Average Reservoir Ecological Health Score 1994 to 2001

Table 4.4-01 Ecological Health Indicators for TVA Reservoirs in the ROS (2000 and 2001)

Reservoir	Dissolved Oxygen[1]	Chlorophyll-a[2]	Year
Apalachia	Fair	Poor	2000
Bear Creek	Poor	Poor	2001
Beech	Poor	Poor	2000
Blue Ridge	Good	Good	2001
Boone	Poor	Fair	2001
Cedar Creek	Poor	Good	2001
Chatuge	Fair	Good	2001
Cherokee	Poor	Poor	2000
Chickamauga	Fair	Fair	2001
Douglas	Poor	Fair	2001
Fontana	Fair	Good	2000
Fort Loudoun	Poor	Poor	2001
Fort Patrick Henry	Good	Poor	2001
Guntersville	Good	Fair	2000
Hiwassee	Poor	Fair	2000
Kentucky	Good	Poor	2001
Little Bear Creek	Poor	Good	2001
Melton Hill	Fair	Good	2000
Nickajack	Good	Good	2001
Normandy	Poor	Poor	2000
Norris	Poor	Good	2001
Nottely	Good	Fair	2001
Parksville	Good	Good	2001
Pickwick	Good	Poor	2000
South Holston	Poor	Good	2000
Tellico	Poor	Good	2001
Tims Ford	Fair	Good	2000
Watauga	Poor	Poor	2000
Watts Bar	Poor	Poor	2000
Wheeler	Poor	Poor	2001
Wilson	Poor	Poor	2000

[1] A good rating indicates that water can support fish and aquatic life.

[2] A good rating indicates low to moderate algal growth.

Source: TVA 2002a.

Watershed Water Quality Improvement

In 1992, TVA began its watershed water quality Improvement effort to protect and improve water quality throughout the Tennessee Valley. TVA builds partnerships with community residents, businesses, and government agencies to promote watershed protection. It works with its partners to clearly define cause and sources of existing problems and to develop local capability to address and correct those problems. TVA's Watershed Teams are responsible for carrying out these efforts.

TVA evaluates water quality conditions in the 611 hydrologic units comprising the Tennessee Valley and uses this information to target locations where improvements are needed or where current conditions are likely to decline without intervention. Presently, TVA and partners are working at 47 targeted locations to control pollution sources that would otherwise affect streams and reservoirs.

4.4.3 Existing Conditions

Important reservoir processes that are potentially affected by reservoir operations include residence time, thermal stratification, DO depletion, algal growth, and sediment transport and anoxic products. The following sections examine these processes with respect to existing conditions, potential impacts from changes in reservoir operations, and the differences among the tributary and mainstem reservoirs.

Residence Time

By their name and function, reservoirs are constructed to retain flowing water. One of the primary mechanisms by which reservoirs and reservoir operations affect water quality is the residence time. Residence time is used to characterize the amount of time that is available for physical, chemical, and biological processes to occur within a reservoir. For example, a residence time of 300 days would suggest a reservoir with sufficient time for thermal stratification, algal growth, reduced DO, and a variety of related biological and chemical processes to show an effect. In contrast, a residence time of 10 days would suggest substantial water movement and little time for these processes to make a substantial change in water quality. Table 4.4-02 gives the average annual residence time and other physical characteristics in TVA reservoirs.

Thermal Stratification

Temperature is important because of its effect on aquatic life and reservoir mixing (Churchill and Nicholas 1967 and TVA 1978). The maximum summer temperature of a reservoir and the amount of cold water available influence the type of fish community that can exist, as well as the species and distribution of other biota. Temperature affects physical properties, such as DO, and influences the chemical and biological reactions that take place in aquatic systems (Wetzel 2001).

Table 4.4-02 Physical Characteristics of Selected TVA Reservoirs

Reservoir	River Basin	Drainage Area (sq km)	Mean Annual Flow (m^3/s)	Full Pool		Mean Depth (m)[1]	Residence Time (days)[1]
				Area (ha)	Volume (10^6 m^3)		
Mainstem Reservoirs							
Fort Loudoun	Tennessee	24,730	463	5,909	448	7.6	10
Watts Bar	Tennessee	44,830	778	15,783	1,246	7.9	17
Chickamauga	Tennessee	53,850	962	14,326	775	5.4	8
Nickajack	Tennessee	56,640	998	4,197	297	7.1	3
Guntersville	Tennessee	63,330	1,172	27,479	1,256	4.6	12
Wheeler	Tennessee	76,640	1,432	27,143	1,295	4.8	9
Wilson	Tennessee	79,640	1,489	6,273	782	12.5	6
Pickwick	Tennessee	85,000	1,573	17,443	1,140	6.5	8
Kentucky	Tennessee	104,120	1,754	64,873	3,502	5.4	19
Tributary Reservoirs							
Watauga	Watauga	1,210	20	2,602	702	27.0	325
Wilbur	Watauga	1,220	21	29	1	3.0	0
South Holston	Holston	1,820	27	3,068	811	26.4	262
Boone	Holston	4,770	70	1,744	233	13.4	30
Fort Patrick Henry	Holston	4,930	73	353	33	9.4	5
Cherokee	Holston	8,880	127	12,262	1,827	14.9	92
Douglas	French Broad	11,760	190	12,303	1,737	14.1	49
Fontana	Little Tennessee	4,070	112	4,306	1,752	40.7	124
Tellico	Little Tennessee	6,800	169	6,678	511	7.7	31
Norris	Clinch	7,540	115	13,841	2,517	18.2	169
Melton Hill	Clinch	8,660	137	2,303	148	6.4	11
Blue Ridge	Toccoa/Ocoee	600	17	1,331	238	17.9	117
Ocoee #1	Toccoa/Ocoee	1,540	39	765	105	13.7	28
Ocoee #2	Toccoa/Ocoee	1,330	36	0	0	0.0	0
Ocoee #3	Toccoa/Ocoee	1,270	32	194	4	1.8	1
Nottely	Hiwassee	550	11	1,692	210	12.4	134
Chatuge	Hiwassee	490	12	2,853	288	10.1	199
Hiwassee	Hiwassee	2,510	60	2,465	521	21.1	67
Apalachia	Hiwassee	2,640	60	445	71	16.0	13
Normandy	Duck	510	10	1,307	144	11.0	141
Tims Ford	Elk	1,370	27	4,836	654	13.5	240
Upper Bear Creek	Bear Creek	280	6	749	46	6.2	75
Bear Creek	Bear Creek	600	13	279	12	4.2	9
Little Bear Creek	Bear Creek	160	3	631	56	8.9	158
Cedar Creek	Bear Creek	460	9	1,700	116	6.8	113

[1] Mean depth and residence time are based on average, rather than full pool area and volume.

Source: TVA data.

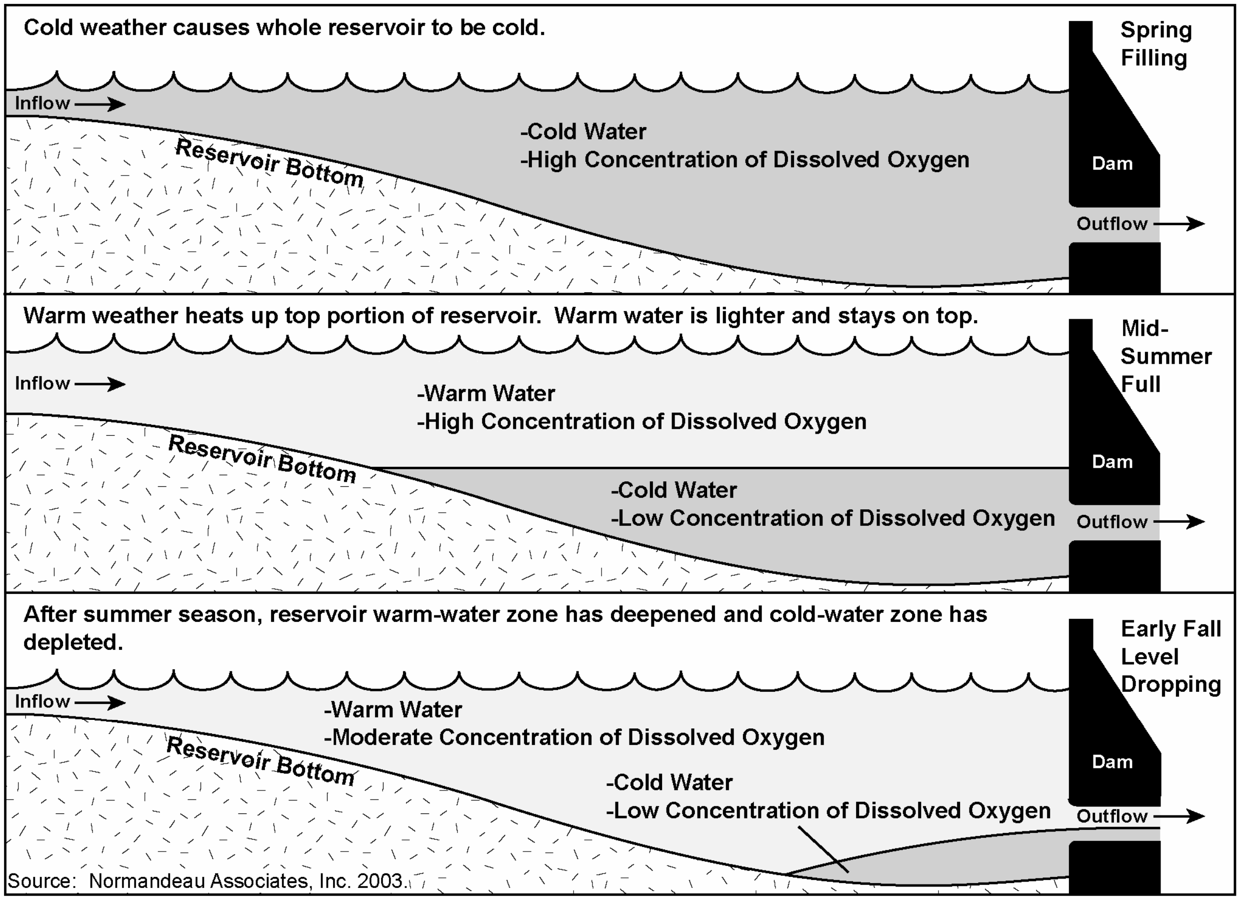


Figure 4.4-02 Reservoir Characteristics during Summer Pool Elevation from Spring to Early Fall

Water temperature in TVA reservoirs varies depending on the season and the amount and temperature of water entering each reservoir. During cooler weather, temperatures are uniform from the surface to the bottom. As the days get longer and hotter, the temperature of the surface water rises. Since warm water is less dense than cold water, it floats on top of the cooler water. This density difference inhibits mixing, resulting in thermal stratification which separates water into horizontal layers by temperature (Figure 4.4-02).

In TVA tributary reservoirs, thermal layering or stratification typically starts between April and July as the sun warms the surface layers. Stratification typically persists into late fall or early winter, when surface waters cool and the reservoir turns over or mixes from top to bottom. Surface waters in some reservoirs may approach or exceed 30°C in late summer. Releases of water from TVA dams are typically through low-level turbine intakes, resulting in cooler tailwater temperatures and a reduction in the volume of cold water in the reservoir as the summer progresses.

The low-level release results in colder tailwater temperatures and earlier fall turnover as the warmer surface waters replace the released water. As the cooler water is depleted, the temperature of the release water in the tailwater may rise, depending on the year, reservoir, or operations. Tailwater temperatures below tributary reservoirs can fluctuate during the summer stratification period as turbines are cycled on and off, periodically releasing cold reservoir water that is subsequently warmed as it moves downstream. During dry years, stratification is somewhat stronger and persists longer into fall. During wet years, stratification is weaker and breaks down earlier in the season. Late in the season, as air temperatures cool, inflow to the tributary reservoirs is often cooler than surface waters. Under these circumstances, inflows enter the reservoirs at mid-depth, creating an interflow. These relatively short-lived events can give rise to atypical DO and water chemistry profiles.

Shorter days and cooler air temperatures during fall cool the surface, gradually allowing it to mix with more and more of the water column. By late October to November, the mixing is complete, resulting in similar temperatures and DO concentrations from surface to bottom. Figure 4.4-02 shows a generalized figure of reservoir thermal stratification by season.

The mainstem TVA reservoirs do not stratify thermally to the extent of the tributary reservoirs, due to the mixing created by shallower depths, higher flows, and shorter residence times. Slight vertical temperature differences and weak thermal stratification occur, particularly during dry years when the upstream water is held back to fill the tributary reservoirs. The stratification that does occur is typically broken up when flows are increased progressively in June, July, and August.

DO Depletion

The importance of DO in rivers and reservoirs is twofold. First, DO is critical for the survival of aquatic organisms. Second, the amount of DO in the water affects many of the chemical reactions that take place in rivers and reservoirs. DO is added to reservoirs from the atmosphere and from oxygenated inflows. In addition, during daylight hours, algae produce oxygen in the surface waters where there is sufficient light. DO is removed from reservoirs by decaying organic materials, plant and animal respiration, and sediments. Oxygen is also lost when inflowing point sources of pollution (primarily from municipal wastewater and industrial discharges) and non-point sources (primarily from agriculture and stormwater runoff) enter the reservoirs and decay, using up DO in the process.

Once thermal stratification is established in a reservoir, DO in deeper water cannot be replenished from the air or from contact with the oxygen-rich surface water. Over time, DO is reduced as organic material sinks to the bottom and decays, potentially resulting in low DO concentrations in the lower layers. The bottom sediments also use oxygen in the decay of organic matter. As oxygen is depleted, iron, manganese, ammonia, and sulfide can be released from the sediments. The amount of nitrogen, phosphorus, and other nutrients entering the water through soil erosion, sewage treatment plant discharges, polluted runoff, and natural sources affects this process. The more nutrients increase, the more algae grow; the more algae grow, the more decaying organic matter is present and the lower the DO concentrations in the deep portions of the reservoir.

As described above, most TVA tributary reservoirs have water quality issues related to thermal stratification. Thermal stratification begins in May, with stronger stratification occurring as summer progresses. Most tributary reservoirs are deeper than mainstem reservoirs and have much greater residence times (notable exceptions are Melton Hill, Tellico, Boone, Fort Patrick Henry, and Apalachia, which have short residence times but are not on the mainstem). These characteristics tend to enhance stratification. The deeper sections of the TVA tributary reservoirs have little or no DO during thermal stratification in summer and late fall (Churchill and Nicholas 1967). Several tributary reservoirs exhibit very low DO concentrations during late summer. DO concentrations rise and fall in the tributary reservoirs. The two primary forces that break down thermal stratification and reintroduce oxygen to the deep waters in tributary reservoirs are drawdown and the cooler air temperatures during fall. The withdrawal zone for tributary reservoirs is usually deep, removing water from the mid to lower water strata and thereby removing some of the cooler, more dense water that has low DO concentrations. As drawdown proceeds in late summer and fall, the volume of cooler water with low DO concentrations is reduced (Figure 4.4-02).

DO concentrations in the mainstem reservoirs are generally higher than in the tributary reservoirs. The primary reason is the movement of water through the reservoirs, resulting in greater mixing, aeration, and less opportunity for thermal stratification and biochemical reactions. Nevertheless, reduced DO concentrations can occur in some mainstem reservoirs during hot, dry periods. The turbines that pass much of the outflow from the mainstem reservoirs generally pass some surface water with the deeper water, resulting in higher DO concentrations in the tailwaters when compared to the tailwaters of the tributary reservoirs. Two mainstem reservoirs—Fort Loudoun and Watts Bar—experience reduced DO in deeper layers in dry years, due to thermal stratification and low flows.

The release of water from the lower levels of a reservoir can result in low concentrations of DO in the tailwaters and downstream. This condition decreases aquatic habitat and stresses aquatic life. The implementation of the Lake Improvement Plan has significantly improved the DO downstream of TVA dams. As a result of the TVA commitment to maintain Lake Improvement Plan targets, none of the alternatives under consideration would change target DO concentrations in the tailwaters. Specific details on the effects of tailwater quality on aquatic life are presented in Section 4.7, Aquatic Resources.

Algal Growth

Algal growth in reservoirs is important because of its potential impact on recreation, water supply, and DO. As organic matter from dead and dying algae settles, it decomposes and consumes oxygen in the water column. Sediments in reservoirs with high algal growth accumulate rapidly; these sediments are thick and nutrient-rich. They consume large amounts of oxygen from the overlying waters as they decompose. A total loss of oxygen in the lower layers of reservoirs with high algal growth is common (Cooke et al. 1993).

Algal growth in TVA reservoirs is usually limited by a combination of three factors: nutrients (phosphorus and nitrogen), light, and residence time. In tributary reservoirs, residence time is rarely a limiting factor because most have a large volume relative to their inflow rate, which creates long retention times (100 to >300 days). Longer residence times allow suspended particles to settle, increasing water clarity. As a result, light availability (which often limits algal growth in mainstem reservoirs) is rarely a problem during summer in tributary reservoirs. Consequently, nutrient availability usually is the limiting factor in tributary reservoirs. Annual rainfall patterns that follow a boom or bust cycle (i.e., heavy rain followed by extended dry periods until the next downpour) enhance algal productivity in tributary reservoirs with long retention times because it tends to replenish nutrients. However, such rainfall patterns sometimes have the opposite effect on mainstem reservoirs because of decreased light availability and decreased retention times due to increased flows.

Although reservoir operations have little influence on nutrient inflows from the watershed, the way nutrients cycle in the reservoirs may change in response to operational changes. In addition, algal growth in the reservoirs may change in response to changes in the timing of water movement through the system. Internal nutrient cycling, residence time of water in impoundments, and the timing of reservoir releases are all processes controlled in part by reservoir operations. Each of these factors influences algal growth in the system.

Sediment Transport and Anoxic Products

Contaminated sediments are a water quality concern in some TVA reservoirs and tailwaters. Contaminants such as mercury, cesium, PCBs, and pesticides are often associated with sediments. Changes in reservoir operations under consideration are unlikely to disturb reservoir sediments and mobilize contaminants.

Other materials found in sediments (e.g., iron, manganese, sulfides, and ammonia) may be formed and mobilized in the lower waters of the reservoir when oxygen concentrations are low. These potential pollutants can adversely affect water supplies, recreation, and aquatic life. Changing reservoir elevations or reservoir residence times could affect the duration or severity of low DO conditions that, in turn, introduce iron, manganese, sulfides, and ammonia into the water column. In the tailwaters, monitoring data indicate that reaeration of water discharged quickly reduces the solubility of these compounds. The exception is manganese, which was found in elevated concentrations below the reaeration facilities at several dams. This could result in black-coating of the substrate. Because the occurrence of these compounds is so closely tied with low DO concentrations, DO is used as a surrogate for these parameters in the impact assessment.

4.4.4 Future Trends

Water quality throughout the Valley has the potential to be influenced by several trends in the future. These trends largely depend on political and economic factors that cannot be predicted with any reliability. Increased population growth will likely increase development pressure in the watershed, resulting in increases in nutrient and sediment loading to the TVA system. This will be balanced, in part, through the development and implementation of TMDL plans in the Tennessee River watershed, which may improve water quality in certain impaired segments by reducing inputs of pollutants. Programs targeting pollutant sources from agriculture and stormwater may result in some improvement in water quality in parts of the watershed. The number of industrial and municipal sources of pollution governed by permit may increase, but the amount of pollution contributed by each source may decrease as technology for treating wastes improves. In segments that are impaired, TMDLs may dictate a reduction in pollutant loads from all of these sources. The net impact of these potential changes on water quality constituents likely to be affected by the alternatives under consideration was assumed for purposes of this assessment to be minimal. This assumption applies to each of the alternatives under consideration equally. In other words, the potential future changes in water quality described above would occur regardless of which reservoir operations policy alternative is selected.

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4.5 Water Supply

4.5.1 Introduction

Extended dry periods during the last 15 years have heightened public awareness of water as a finite resource and have raised questions concerning the availability of surface water and groundwater resources in the Tennessee River watershed. Increasingly, water is seen as a scarce resource that must be protected and managed. An adequate and dependable water supply is one of the key factors needed for economic growth and regional development.

Resource Issues

- Availability of water supplies
- Changes in water supply delivery (costs)
- Changes in water supply quality (treatment)

Changing the reservoir operations policy can potentially affect three issues related to municipal and industrial water supplies:

- **Availability of Water Supplies.** Will implementation of a new reservoir operations policy change reservoir characteristics such that withdrawals for municipal and industrial uses are constrained?

- **Changes in Water Supply Delivery (Costs).** Will implementation of a new reservoir operations policy change reservoir characteristics in a manner that increases the cost of obtaining supplies, as expressed in pumping costs or costs for new or modified intake structures?

- **Changes in Water Supply Quality (Treatment).** Will implementation of a new reservoir operations policy change reservoir characteristics in a manner that degrades water supply quality and thereby limits water supply through increased treatment requirements?

Another issue indirectly related to the potential effects of policy alternatives on water supplies is the inter-basin transfer (IBT) of water supplies outside the Tennessee River watershed. Because IBTs can reduce water supplies through withdrawals, they can affect municipal, commercial, industrial, and private water supplies. Most requests for IBTs involve relatively small quantities of water. Some future IBTs could be of sufficient size to affect reservoir operations and water supplies. Because they are speculative, these future IBTs were not included in any of the policy alternatives. To better understand the possible impacts of future IBTs, TVA prepared a separate sensitivity analysis of several possible IBTs (see Appendix D9, Inter-Basin Transfers—A Sensitivity Analysis). Ongoing IBTs are included in the discussion of existing conditions for water supply.

The study area for the analysis of water supply is the Tennessee River watershed.

4.5.2 Regulatory Programs and TVA Management Activities

Regulatory and management policies that affect water supply include regulation of withdrawals, maintaining water quality, and drinking water standards.

- **Regulation of Withdrawals.** TVA regulates all structures, including intakes constructed at the shoreline of TVA reservoirs by issuing permits under Section 26a of the TVA Act. If dredging or fill is required, the USACE will become involved in the permitting process. State agencies in some cases also require permits for withdrawals. State agencies regulate return flows (discharges) associated with water withdrawals. Since future withdrawals could potentially affect minimum flows, reservoir levels, aquatic life, and other instream beneficial uses, a case-by-case environmental analysis would be required for new intake structures or expansion of existing ones. Tennessee has also adopted an act that regulates IBTs.

- **Maintaining Water Quality.** The CWA established water quality standards that are monitored and enforced by state agencies or USEPA. After completion of the Lake Improvement Plan (TVA 1990), TVA has provided minimum streamflows to improve water quality and aquatic habitat. TVA has also implemented other forms of water quality improvement, most notably oxygen enhancement of dam release waters at key locations on the system.

- **Drinking Water Standards.** Water withdrawn for municipal use is governed by national water quality standards that are enforced by the USEPA and state agencies. To the extent that river water does not meet these standards, additional water treatment must be applied to meet potable water standards before the water is distributed by municipal water agencies.

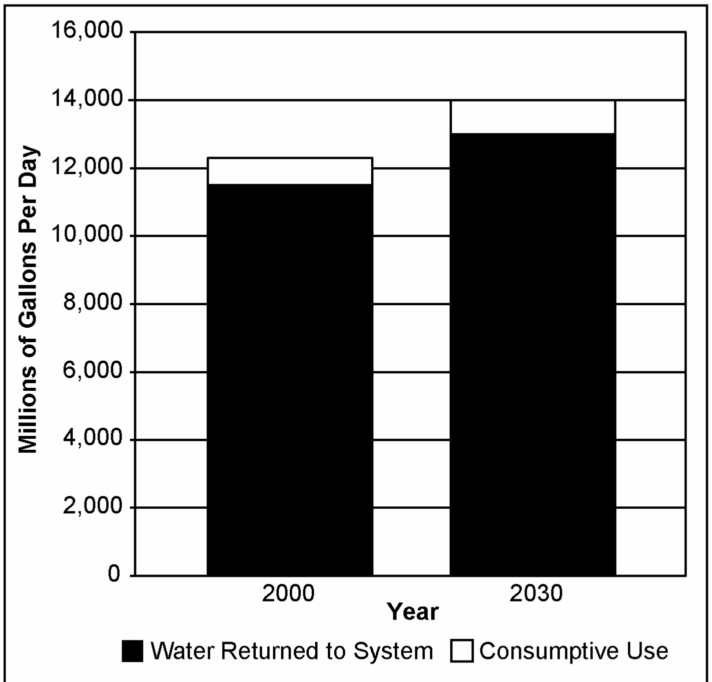
4.5.3 Water Supply Availability

Existing Conditions

Efficient water management and planning require reliable information on existing and future demands relative to the available supplies. TVA and the USGS cooperated in a 2-year study of water supply needs in the region to assist in providing this information (Bohac 2003). The study area included the entire state of Tennessee and those counties in surrounding states that drain to the Tennessee River watershed. The study involved an inventory of existing (year 2000) public and private water supplies and wastewater discharges, a projection of future (year 2030) demands, and comparison of the future demands with the capacity of the available water resources.

In the study, demand for each use was defined in the context of changes in trends in consumption between 2000 and 2030 for reservoirs, tailwaters downstream from reservoirs, unregulated streams, and groundwater. The affected environment for water supply also was defined in terms of existing IBTs into and out of the Tennessee River watershed to provide a base for determining whether future IBTs would result in environmental consequences.

Figure 4.5-01 shows total water use in the Tennessee River watershed. Ninety-eight percent of this water is derived from surface sources; groundwater is a minor component of most uses and is not used for cooling coal-fired and nuclear power plants (Bohac 2003).

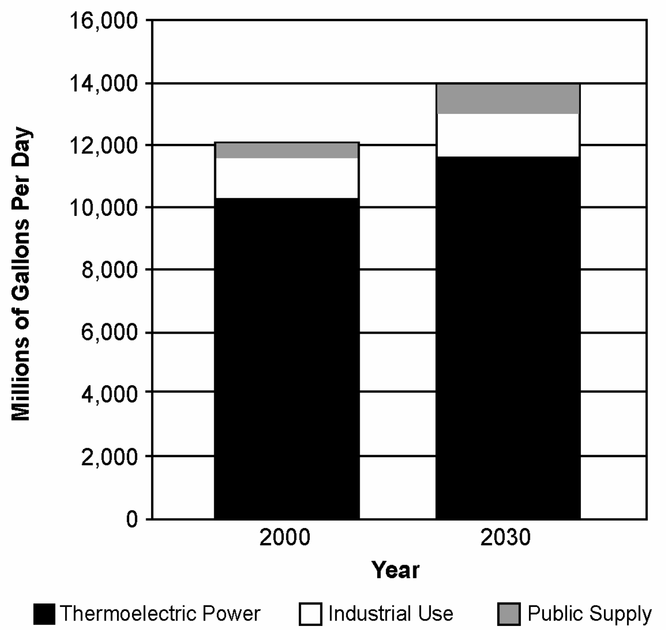


Source: Hutson et al. 2003.

Figure 4.5-01 Water Use in the Tennessee Valley Region for 2000 and 2030

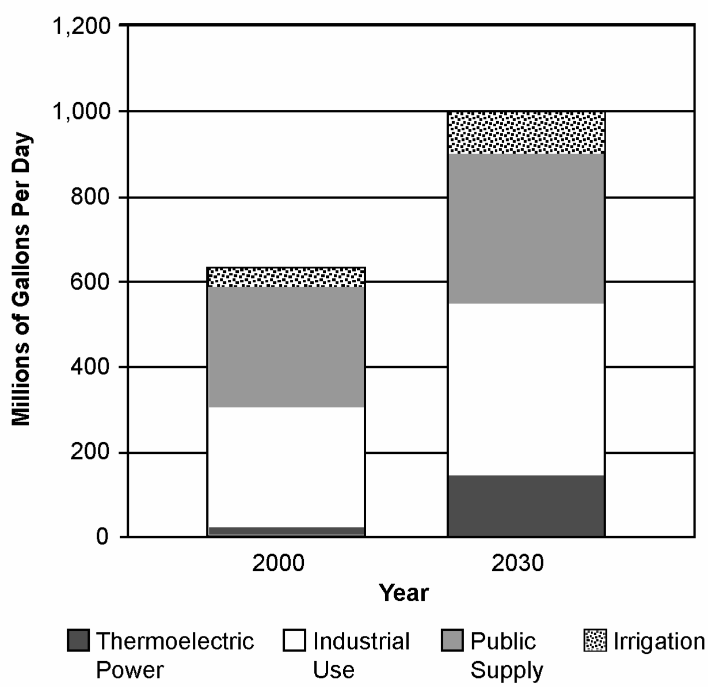
Figure 4.5-02 shows total water use in the Tennessee River watershed by category. Coal-fired and nuclear power generation used approximately 84 percent of the water in 2000; industrial use accounted for 10 percent; and public supply and irrigation accounted for 5 percent and 1 percent, respectively (Hutson et al. 2003, Bohac 2003).

Consumptive use is defined as the difference between withdrawals from and returns back to the river system. It is the water that may be evaporated in power plant and industrial cooling systems, released from plants to the atmosphere as a result of irrigation, consumed by humans or livestock, or otherwise used and not returned to surface water or groundwater (Hutson et al. 2003, Bohac 2003). Figure 4.5-03 shows consumptive use for 2000 and 2030.



Source: TVA data 2003.

Figure 4.5-02 Total Water Use for Thermoelectric Power, Industrial Use, and Public Supply for 2000 and 2030



Source: TVA data 2003.

Figure 4.5-03 Consumptive Water Use for Thermoelectric Power, Industrial Use, Public Supply, and Irrigation for 2000 and 2030

In addition to consumptive use, the USGS study inventoried water diversions—including IBTs. The largest diversion in the TVA system is flow from the Tennessee River to the Tennessee–Tombigbee Waterway, which was approximately 200 million gallons per day (mgd) in 2000. Current IBTs total approximately 5.6 mgd. These transfers are made to meet water supply needs in areas immediately adjacent to the watershed; they consist of suppliers meeting customer demands in existing service areas.

Future Trends

By the year 2030, total water use in the Tennessee River watershed is forecast to increase by 15 percent, from 12,211 to 13,990 mgd (Figure 4.5-01). The percentages of water use by category shown in Figure 4.5-02 are expected to change only slightly by 2030 (Hutson et al. 2003, Bohac 2003).

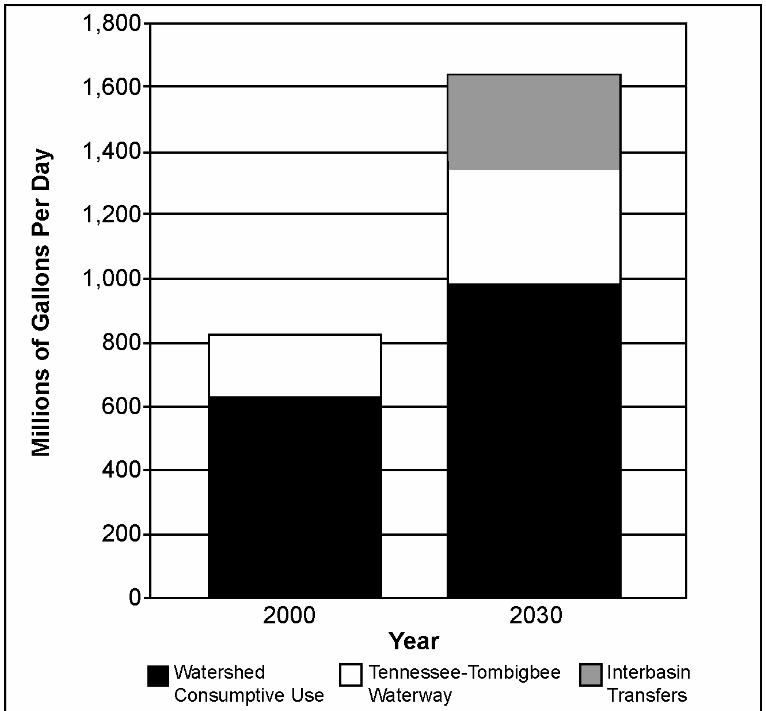
Consumptive use is expected to increase by 331 mgd (or 51 percent) over the next 30 years, as shown in Figure 4.5-03. This represents approximately 0.5 percent of total average winter river flow and 1.6 percent of average summer river flow (as measured at Kentucky dam). Almost 29 percent of the increase in consumptive use is due to the increase in water use by nuclear and fossil plants; an additional 29 percent of the increase is in the industrial sector, and 34 percent of the increase is due to increased demand in public supply (Hutson et al. 2003, Bohac 2003).

The projected increase in flow to the Tennessee–Tombigbee Waterway by 2030 ranges from 36 to 193 mgd, depending on assumed flows required for barge traffic. The increase could be as much as 600 mgd if traffic through the waterway reaches design capacity. Diversions included other IBTs. For the sensitivity analysis (Appendix D9), it was assumed that IBTs to areas such as Northeast Mississippi; Birmingham, Alabama; and Atlanta, Georgia could reach 461 mgd. Figure 4.5-04 compares the increased flows for the Tennessee–Tombigbee Waterway and existing IBTs to the increase in watershed consumptive use. IBTs to meet water supply requirements in areas adjacent to the watershed are expected to increase to approximately 27 mgd by 2030 (Bohac 2003).

4.5.4 Water Supply Pumping Requirements

Existing Conditions

Over 700 intake structures in the project area provide water to private, industrial, municipal, and commercial users. An estimated 390 million KWH/yr are required to pump water from rivers and reservoirs, with additional energy required to pump water to the point of treatment and use. Because an alternative reservoir operations policy can change the reservoir surface elevations, the amount of energy required to pump water out of the reservoir would vary under the different policy alternatives.



Note: No interbasin transfers occurred in 2000.
Source: TVA data 2003.

Figure 4.5-04 Consumptive Water Use Plus Water Transfers out of the Tennessee River Watershed

Future Trends

By 2030, approximately 460 million KWH/year will be needed to pump water from rivers and reservoirs assuming current reservoir surface elevations.

4.5.5 Water Supply Quality and Treatment

Existing Conditions

Public Supply

Water quality requirements for public supply systems are driven by water quality regulations. The current USEPA drinking water regulations, which are mirrored in the regulations for the Valley states, were reviewed. Current regulations for public water supply cover four types of contaminants: inorganics; organics; microbial contaminants; and secondary contaminants, which are not related to health.

Interviews were conducted at six major public supply treatment plants. These plants treat about 152 mgd of water, which constitutes 29 percent of the public supply water in the Tennessee River watershed. The locations ranged from Morristown, Tennessee (on Cherokee Reservoir) to Huntsville, Alabama (on Wheeler Reservoir). Plant sizes varied from 1.1 to 44 mgd. The interviews were used to define the public supply treatment systems that were used to achieve the parameter limits specified in the regulations.

Based on the interviews at the public supply treatment facilities, typical treatment processes for public supplies using water from the Tennessee River watershed included the following unit operations: Chemical coagulant addition and mixing, flocculation, sedimentation, pre-filtration disinfection, filtration, and post-filtration disinfection. The thrust of the treatment process was to remove suspended solids. Since suspended solids include contaminants such as soil, algae, bacteria, and other species—and chemicals that are adsorbed to the particulate matter, suspended solids removal is the key part of any treatment process. Disinfection is important to the operation to kill pathogenic organisms, and chlorine is a commonly used disinfectant.

Natural organic material (NOM) in the water can react with the chlorine used in the treatment process to produce chlorinated organics, collectively called disinfection by-products (DBPs). Because the concentration of DBPs is regulated in the finished drinking water, excessive NOM concentrations must be removed in the flocculation-sedimentation step and the concentrations of DBPs in finished water must not exceed specified limits. The surrogate measure of NOM is typically total organic carbon (TOC), and TOC is usually the regulated parameter.

The six public supply water treatment plants where interviews were conducted reported a range of TOC values from 2 to 5 mg/L. For comparison, samples collected quarterly from Chickamauga Reservoir for the years 1978 through 1986 averaged 2.8 mg/L. The Chickamauga data showed little seasonal variability and little variability with depth, but some variability between years. The minimum value was 1.2 mg/L, and the maximum value was 10 mg/L.

Total organic carbon in reservoirs originates from runoff into streams, wastewater discharges, and algae growth in which inorganic carbon is converted to organic carbon. Reservoirs can be either sources or sinks for TOC. Algae produced in the reservoir can remain suspended or settle to the bottom of the reservoir and accumulate in the reservoir sediments. Various processes (dissolution, diffusion, excretion, and decomposition of the algae) can result in increased TOC concentrations in the reservoir. Reservoir TOC concentrations can be reduced by being adsorbed onto settling particles, by microbial uptake and oxidation to carbon dioxide during respiration, or by degradation by sunlight. Reservoirs can either be net producers or consumers of TOC based on residence time and hydraulic loading.

Algae. Secretions from algae, particularly blue-green algae, are often the source of taste and odor problems at public supply water treatment plants. Several of the public supply treatment plants where interviews were conducted combine granular activated carbon in their filtration process or feed powdered activated carbon before the sedimentation step to remove the objectionable compounds. Other treatment plants add oxidants, such as potassium permanganate, to control taste and odor.

TVA has not conducted any studies to correlate reservoir operational conditions with the production of blue-green algae. Treatment plant operators interviewed also could not give guidance concerning when and how the blooms occur. There is some anecdotal evidence that stagnant water, during low-flow periods on isolated parts of the reservoirs and rivers feeding the reservoirs, might be the source of blooms. Treatment plant operators who add powdered activated carbon often trigger the start of the feeding season to water temperature.

Iron and Manganese. Drinking water standards for iron and manganese are classified as secondary standards, and are generally not considered to be health related. Iron and manganese in water supplies can cause taste and odor problems and also add color to water, which can stain fixtures and laundry. Iron and manganese, which are trapped in reservoir sediments, can become soluble and enter the water column when the reservoir bottom becomes anoxic (lacking oxygen). Because the soluble iron and manganese come out of the sediments, the high concentrations are confined to the deep reservoir water. Therefore, many public supply intakes, which are located in reservoirs, draw water from multiple levels so that elevated reservoir iron and manganese concentrations can be avoided. Reservoir releases can contain iron and manganese, but the iron and manganese are oxidized in the stream below the dam and may not affect intakes in tailwaters, if they are sufficiently downstream from dams. None of the treatment plants where interviews were conducted specifically treated for iron and manganese. Several plants do add potassium permanganate, which would oxidize iron and manganese if present in the water.

Industry

Interviews were conducted with 11 industries, representing eight standard industrial classification codes and 80 percent of the industrial water taken from the Tennessee River system.

It is estimated that over 80 percent of the water used in industry is used for non-contact cooling and is not treated. For water that is treated, however, the treatment processes of coagulant addition, flocculation, sedimentation, and filtration, which were discussed in relation to public water supply systems, are common to industrial process water treatment and boiler feed systems as well. In cases where high water quality is required, such as for boiler feed, the water is demineralized after filtration.

Thermoelectric Generation

Almost all of the water currently used in thermoelectric generation is used for non-contact once-through cooling and is not treated. However, a small portion of the water is treated to a very high degree for boiler feed and makeup water. Surface water that has been filtered is then subjected to demineralization processes to provide water for the boilers.

Future Trends

Public Supply

The current DBP rule requires treatment plants that serve more than 10,000 people to remove a specified amount of TOC through coagulation or softening and to meet concentration limits for DBPs (HDR Engineering 2001). The concentration limits are 0.08 mg/L for total trihalomethanes and 0.06 mg/L for haloacetic acids. In 2004, small systems will also be required to achieve the DBP limits. In 2005 or 2006, implementation of Stage 2 of the DBP rule is expected, which will no longer allow the use of averaging samples to meet the DBP limit. Consequently, water treatment plants will need to be modified to meet the limits. Expected changes include elimination of chlorine feed at the front of the treatment plant and the use of alternative disinfectants, such as chlorine dioxide. Coagulation will be enhanced, such as through the use of iron-based coagulants—especially during summer— to remove the required amount of TOC. Additional processes, such as ozone injection or activated carbon addition, might be required for plants to achieve the DBP concentration limits (Foster pers. comm.).

Because of the expected process changes and plant upgrades required for DBP compliance, even at today's levels of TOC, it is likely that almost all public supply water treatment plants using water from the Tennessee River watershed will soon have treatment systems for DBP control. Therefore, changing algae concentration through a modification of reservoir operation would likely change only the degree of treatment required and would not result in the need for any plant to add a new DBP treatment system.

To date, only the larger treatment plants have dealt with the DBP issue, and the impacts to treatment costs brought about by the Stage 2 rules have not been quantified. In addition, no studies have been performed to quantify what factors in the source waters affect the portion of TOC that can give rise to DBP (Volk and Lechevallier 2002). It is therefore not possible to quantify the changes to treatment cost brought about by changes in algae concentration. It is also considered that much of the difficulty in meeting DBP concentration limits under Stage 2 will arise, not from the raw water TOC concentration, but from the amount of time that the treated water spends in the distribution system (Foster pers. comm.). Distribution systems are, of course, unaffected by reservoir operational changes.

New drinking water regulations would be more complex and would generally require a greater degree of treatment, potentially exposing existing smaller systems to violations of standards. Small surface water systems and systems presently supplied by groundwater that are currently exempt from some treatment requirements would be subjected to new treatment standards for the first time. Many systems would be unable to afford the cost of upgrading in order to meet the new regulations. Consequently, many small water systems, particularly those using groundwater, would be consolidated into larger systems primarily supplied by surface water.

Industry

Industrial treatment requirements are driven by process demands, not regulations. If the current industrial mix remains constant, little change in industrial water treatment is expected.

Thermoelectric Generation

Most of the new generating units installed would not be able to use once-through cooling and would be required to use cooling towers. Although surface water can most often be used directly in cooling towers, some chemicals are customarily added to control biological growth and to reduce scaling.

4.6 Groundwater Resources

4.6.1 Introduction

Surface water and groundwater resources are interconnected within much of the TVA Power Service Area. Depending on the season, between 13 and 33 percent of precipitation percolates into the ground, recharging groundwater aquifers (Zurawski 1978). Changes in reservoir elevations can lead to changes in groundwater elevations; the aquifer response depends on the geology and hydrogeology of the shallow aquifers exposed to infiltration from surface waters. The key issue associated with changes in groundwater levels is their effects on groundwater use and wetland areas.

Resource Issues
▶ Changes in groundwater levels and their effects on groundwater use and wetland areas

This section provides an overview of conditions at reservoirs and tailwater areas, and a summary of existing groundwater use and its projected use to 2030. Impacts on the use of groundwater were evaluated for all groundwater resources within 1 mile of TVA reservoirs and tailwaters. The potential zone of groundwater influence from changes in TVA reservoir and tailwater elevations was calculated based on the properties of shallow aquifers within each physiographic region.

4.6.2 Regulatory Programs and TVA Management Activities

The Tennessee Water Quality Control Act of 1977 prohibits the "alteration of the physical, chemical, radiological, biological, or bacteriological properties of any waters of the state," including groundwater, by any person or entity without first obtaining a permit to do so. Permitting authority is given to the Tennessee Water Quality Control Board via the Division of Water Supply of the Tennessee Department of Environment and Conservation (TDEC).

TDEC is also responsible for enforcement of the Water Resources Information Act of 2002 and the Tennessee Safe Drinking Water Act of 2002. These acts require public notice for any groundwater withdrawals in the state and prohibit "heavy pumping or other heavy withdrawals of water from a public water system or its water supply source in a manner that would interfere with existing customers' normal and reasonable needs or threaten existing customers' health and safety." Similar programs exist in the other Valley states.

4.6.3 Hydrogeology of the Tennessee Valley

The six distinct physiographic regions of the Tennessee River region (Figure 4.1-02) can be used as a framework for discussing groundwater resources in the region (Zurawski 1978). The hydraulic properties of the aquifers in each physiographic region depend on the nature of the aquifer material, as summarized in Table 4.6-01.

Table 4.6-01 Summary of Aquifer Properties for the Physiographic Regions in the Tennessee River Region

Physiographic Region	Transmissivity (ft^2/day)[2]		Specific Yield[3]	
	Representative Value	Range	Representative Value	Range
Coastal Plain	500	10 to 10,000	0.2	0.1 to 0.3
Highland Rim	320	1 to 100	0.2	0.1 to 0.3
Central Basin	79	1 to 500	0.2	0.1 to 0.3
Cumberland Plateau	480	10 to 5,000	0.2	0.1 to 0.3
Sequatchie Valley [1]	79	1 to 100	0.2	0.1 to 0.3
Valley and Ridge	140	10 to 5,000	0.2	0.1 to 0.3
Blue Ridge	120	10 to 500	0.2	0.1 to 0.3

1 The Sequatchie Valley is a geologically distinct area located in the Cumberland Plateau Physiographic Region.

2 Values for transmissivity, a measure of resistance to groundwater flow, are taken from the following Tennessee-specific literature sources: Brahana and Broshears (2001), Broshears and Bradley (1992), Hoos (1990), Wolfe et al. (1997), and Zurawski (1978). In addition, wider-ranging data compilations were consulted to broaden the range of properties, including the following: Lohman (1979), Freeze and Cherry (1979), De Marsily (1986) and Kruseman and de Ridder (1990).

3 Values for specific yield, a measure of aquifer water storage volume, were obtained from Lohman (1979), Freeze and Cherry (1979), and Spitz and Moreno (1996).

Reservoirs and the associated tailwaters of the Tennessee River Valley span six physiographic regions, including the Highland Rim, Coastal Plain, Cumberland Plateau (including the geologically distinct Sequatchie Valley), Blue Ridge, Central Basin, and Valley and Ridge. The location, size, and ranges in water levels of the reservoirs and tailwaters of the Tennessee River system—and the reservoir characteristics—are identified in Table 2.1-01 and in Appendix A. Table 3.3-01 contains current operating guidelines, including flood levels, drawdown rates, and reservoir levels throughout the year. Minimum flows of the mainstem and tributary tailwaters are listed in Appendix A, Table A-03. Appendix D2 contains additional supporting information for this resource.

4.6.4 Groundwater Use

Existing Conditions

Groundwater supplies in the Tennessee River watershed are used for industry, public and domestic supplies, and irrigation. The median daily public use of groundwater in the Tennessee River watershed during the past 35 years is 245 million gallons per day (mgd); the daily public use in 2000 was 215 mgd (Hutson et al. 2003, Bohac 2003). In addition to the public groundwater wells identified in Hutson et al. (2003) and Bohac (2003), there could be other private wells that that are close to Tennessee Valley reservoirs and tailwaters and were not included in these inventories. Figure 4.6-01 depicts the intensity of groundwater use.

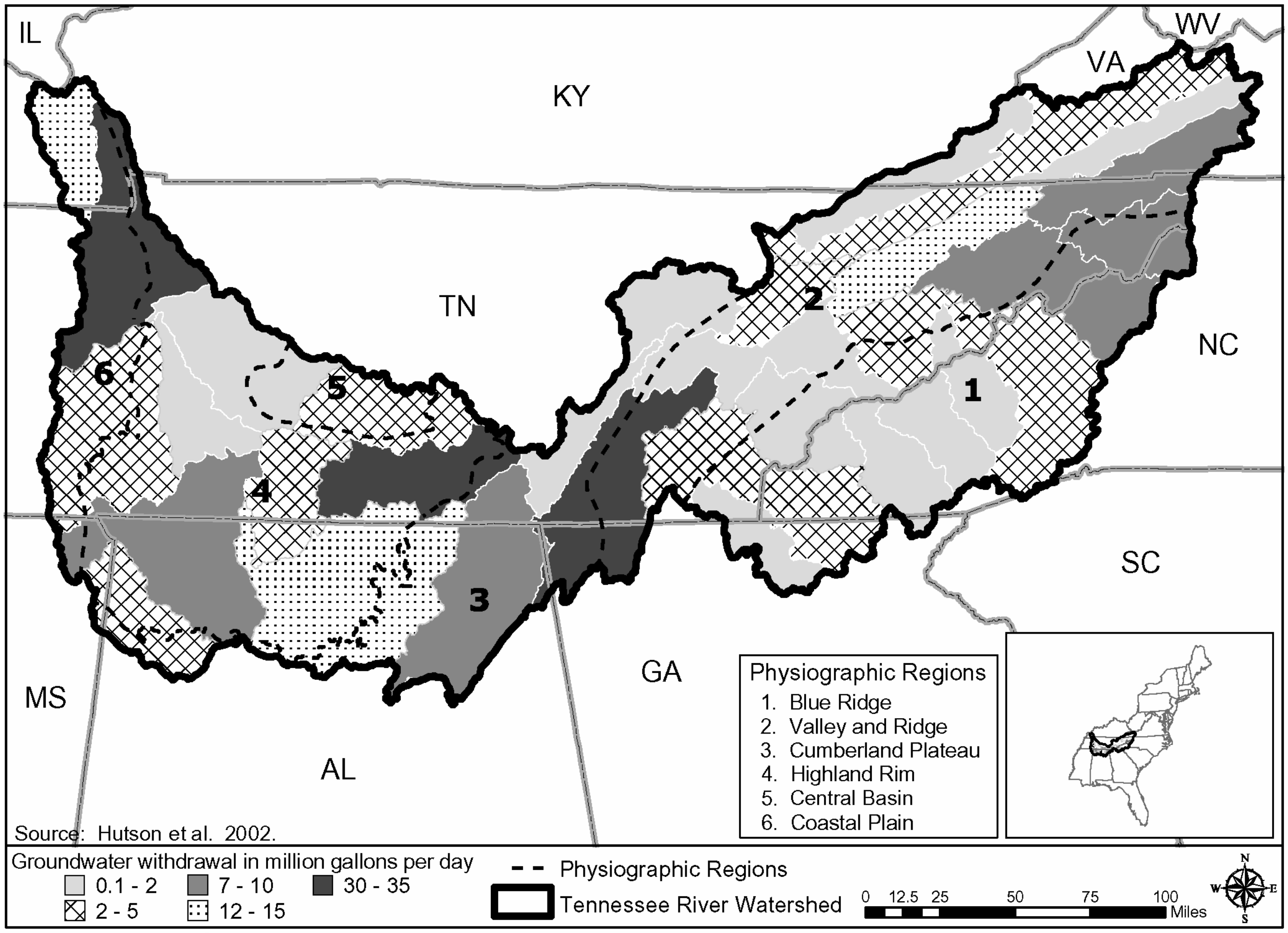


Figure 4.6-01 Groundwater Withdrawals by Hydrologic Unit in the Tennessee Valley Region in 2000

The greatest groundwater withdrawals occur near the major population centers of the Tennessee Valley region. Public groundwater withdrawals in 2000 within 1 mile of the reservoirs and tailwaters of the Tennessee River watershed are listed in Table 4.6-02 and totaled 7.04 mgd in 2000. These withdrawals represent approximately 3 percent of the total public groundwater use.

Table 4.6-02 Public Groundwater Supplies within 1 Mile of Reservoir and Tailwater Areas

Reservoir	Physio-graphic Region	2000 Groundwater Withdrawals for Wells Situated within 1 Mile of Reservoirs		2000 Groundwater Withdrawals for Wells within 1 Mile of Reservoir Tailwater Areas		2000 Groundwater Withdrawals for Reservoir Catchment Basin (mgd)
		Number of Wells	2000 Withdrawals (mgd)	Number of Wells	2000 Withdrawals (mgd)	
Mainstem Reservoirs						
Kentucky	HR/CP	1	0.015	0	–	54.94
Pickwick	HR/CP	0	–	2	2.372	5.41
Wilson	HR	0	–	0	–	3.36
Wheeler	HR/CU	1	1.44	0	–	45.82
Guntersville	CU	0	–	0	–	7.86
Nickajack	CU/SV/VR	0	–	0	–	9.86
Chickamauga	VR	2	0.266	1	0.004	24.02
Watts Bar	VR	2	0.57	2	0.584	1.11
Fort Loudoun	VR	2	0.007	1	0.039	1.6
Tributary Reservoirs						
Norris	VR	3	0.52	0	–	3.42
Melton Hill	VR	0	–	0	–	1.58
Douglas	VR	3	0.044	1	0.006	11.98
South Holston	VR	0	–	0	–	8.01
Boone	VR	0	–	0	–	–
Fort Patrick Henry	VR	1	0.004	0	–	–
Cherokee	VR	6	0.125	0	–	13.00
Watauga	BR	2	0.046	0	–	9.40
Wilbur	BR	0	–	0	–	–
Fontana	BR	0	–	0	–	1.13
Tellico	VR	0	–	0	–	0.57
Chatuge	BR	0	–	0	–	0.18
Nottely	BR	0	–	0	–	0.55
Hiwassee	BR	0	–	0	–	0
Apalachia	BR	0	–	0	–	0

Table 4.6-02 Public Groundwater Supplies within 1 Mile of Reservoir and Tailwater Areas (continued)

Reservoir	Physio-graphic Region	2000 Groundwater Withdrawals for Wells Situated within 1 Mile of Reservoirs		2000 Groundwater Withdrawals for Wells within 1 Mile of Reservoir Tailwater Areas		2000 Groundwater Withdrawals for Reservoir Catchment Basin (mgd)
		Number of Wells	2000 Withdrawals (mgd)	Number of Wells	2000 Withdrawals (mgd)	
Tributary Reservoirs (continued)						
Blue Ridge	BR	0	–	1	0	0.05
Ocoee #1	BR	0	–	0	–	1.11
Ocoee #2	BR	0	–	0	–	
Ocoee #3	BR	1	0.053	0	–	
Tims Ford	HR	2	0.945	0	–	2.8
Normandy	HR/CB	0	–	0	–	2.11
Great Falls	HR	0	–	0	–	–
Upper Bear	CU	0	–	0	–	0.16
Bear Creek	CU	0	–	0	–	
Little Bear Creek	HR	0	–	0	–	
Cedar Creek	HR	0	–	0	–	1.13
Total		**26**	**4.035**	**8**	**3.005**	**211.16**

Notes:

CU = Cumberland Plateau.
SV = Sequatchie Valley.
CP = Coastal Plain.
HR = Highland Rim.
VR = Valley and Ridge.
BR = Blue Ridge.
CB = Central Basin.

Future Trends

Groundwater use has been in decline for the past 10 years but is anticipated to remain constant over the next 30 years (Hutson et al. 2003, Bohac 2003). New drinking water regulations will require substantial capital improvements at existing water supply systems. These costs are anticipated to result in consolidation of small public supply water systems, which have historically sought out surface water supplies to replace existing groundwater supplies. This factor and recent declines in groundwater use in the region support the use projections for 2030.

4.7 Aquatic Resources

4.7.1 Introduction

Resource Issues
▶ Biodiversity
▶ Sport fisheries
▶ Commercial fisheries
▶ Biological conditions
▶ Fish spawning

Aquatic resources occurring in the TVA region are important from local, national, and global perspectives. Tennessee has approximately 319 fish species, including native and introduced species, and 129 freshwater mussels (Etnier and Starnes 1993, Parmalee and Bogan 1998). The Tennessee-Cumberland Rivers have the highest number of endemic fish, mussel, and crayfish species in North America (Schilling and Williams 2002). This is the most diverse temperate freshwater ecosystem in the world. In reservoirs, largemouth bass, crappie, and striped bass are highly sought game species. Trout provide popular tailwater fisheries below tributary cold-water discharge dams; sauger, white bass, striped bass, and catfish fisheries occur below tributary and mainstream warm-water discharge dams.

Prior to construction of the TVA reservoir system, aquatic communities were structured by water quality and physical habitat condition, which were driven by physiographic region and climate. Streamflow was proportional to rainfall, and flow regime followed the same trends as the annual rainfall pattern. Flow established physical habitat conditions (depth, velocity) within a stream and maintained stream shape and other habitat conditions (substrate). Relatively infrequent high-flow events (flows that only occur every 1 to 2 years) were responsible for maintaining large-scale habitat patterns such as the number of riffles or pools (Rosgen 1996). High flows clean substrate by flushing out fine sediments, which may suffocate fish eggs or mussels and fill in the spaces between rocks needed by aquatic insects. Because historical flow was proportional to rainfall, over short time intervals, such as days, flow was relatively predictable—meaning that yesterday's flow was likely to be similar to today's flow and from hour to hour there was little change, except during storm events.

Floods were common during spring, and flows decreased throughout the year with the lowest typically occurring August through October, the warmest part of the year. Spring flooding was an important component in the life cycles of some fish species that use flooded overbank areas for spawning or nursery areas. The Tennessee River was shallow, with expansive areas of rocky or gravel shoals—critical features contributing to the great diversity of aquatic life (Etnier and Starnes 1993). Two of the purposes of the TVA system of dams and reservoirs were to provide year-round navigation on the river and control flooding. Achieving these objectives required modifying the river environment described above to which the pre-impoundment aquatic community was adapted (see Chapter 2, The Water Control System). For example, most of the shoal habitat was eliminated by impoundments, and seasonal flow patterns were greatly modified by capturing high spring flows in upstream impoundments and increasing late summer/fall flows with drawdown releases from those reservoirs. Thermal regimes were also changed.

4.7 Aquatic Resources

The purpose of this section is to describe the aquatic communities of the regulated portion of the Tennessee River basin and the habitats in which they exist today. Changes in the way TVA operates its water control system could result in further modifications to the aquatic environment, with consequences to animals that now inhabit it. Three aspects of aquatic resources were identified as key areas of concern for this resource: biotic community quality (status of native fishes, mussels, and aquatic insect communities, including biodiversity), sport fisheries, and commercial fisheries (Table 4.7-01). These aquatic resources were chosen because they represent socially important resources and the broad spectrum of resources occurring in the system, and the potential for their status to change under different policy alternatives can be measured.

The ROS classifications shown in Table 4.1-02 were used to facilitate the assessment of potential impacts on aquatic resources. This classification system groups reservoirs by their mode of operation, physiographic region, and position in the stream network (mainstem or tributary). Tailwaters were grouped by their existing faunal types that related to maximum summer temperatures. Temporal scope was through year 2030. Data sources reviewed to characterize the status of aquatic resources were summarized by waterbody type in Table 4.7-02.

4.7.2 Regulatory Programs and TVA Management Activities

State and federal laws regulate actions that potentially affect aquatic species. These include limiting the harvest of non-rare species (e.g., sport fishing), regulating actions that affect individuals or habitats for rare species designated as threatened or endangered (see Section 4.13, Threatened and Endangered Species), and establishing water quality criteria (see Section 4.4, Water Quality). In addition, protected habitats (e.g., mussel sanctuaries) have been established under the supervision of various state agencies (see Section 4.14, Managed Areas and Ecologically Significant Sites).

TVA has also implemented a variety of programs to improve conditions for aquatic resources. TVA implemented the RRI Program to improve water quality and aquatic habitat in tributary tailwaters by providing minimum flows and increasing DO concentration (see Section 4.4, Water Quality). TVA's commitment to established minimum flows and minimum DO concentrations in tailwaters would not be changed among project alternatives. Another TVA activity attempts to stabilize reservoir levels for a 2-week period when water temperatures reach 65 °F at a depth of 5 feet. Stabilizing reservoir levels aids fish spawning success. This fish spawning operation minimizes water level fluctuations during the peak spawning period to avoid more than a 1-foot-per-week change (either lowering or rising) in pool levels. This program will be adjusted beginning spring 2004 to stabilize levels at 60 °F in order to better include crappie, smallmouth bass, and early largemouth and spotted bass spawning. TVA conducts regular ecological monitoring of reservoirs and tailwater fauna.

Table 4.7-01 Key Issues Identified for Assessment of Potential Impacts on Aquatic Resources in the TVA Reservoir System

Programmatic Issue	Component	Location	Species/Community Aspect
Biodiversity	Resident fish community	Reservoirs and tailwaters	Status of community
	Mussel community	Reservoirs and tailwaters	Status of community
	Resident aquatic insect community	Reservoirs and tailwaters	Status of community
Sport fisheries	Warm-water fisheries	Reservoirs	Largemouth bass, smallmouth bass, spotted bass, white crappie, and black crappie
		Tailwaters	Smallmouth bass
	Cool-water fisheries	Reservoirs	Striped bass, white crappie, sauger, and walleye
	Cold-water fisheries	Reservoirs	Rainbow, brown, and lake trout
		Tailwaters	Rainbow and brown trout
Commercial fisheries	Fishes	Reservoirs	Catfish (channel, blue, flathead), buffalo (smallmouth, bigmouth), freshwater drum, paddlefish, carp, and suckers
	Mussels	Reservoirs	Ebony shell, washboard, threeridge, southern mapleleaf, mapleleaf, and Wabash pigtoe

Table 4.7-02 Data Sources Used to Characterize Existing Conditions of Key Issues

Programmatic Issue	Components	Location	Data Sources Used to Characterize Existing Condition
Biodiversity	Aquatic habitat	Reservoirs	TVA Vital Signs Monitoring Program data: water quality (temperature, DO, and chlorophyll-a), benthic (bottom life) monitoring, Reservoir Fisheries Assemblage Index (RFAI); hydrology data (1991-2000); federal/state, university, or other research studies; TVA Shoreline Aquatic Habitat Index (SAHI)
		Tailwaters	TVA monitoring: fish Index of Biotic Integrity (IBI) and Benthic (bottom life) Index of Biotic Integrity (BIBI) data; federal/state, university, or other research studies
	Fish community	Reservoirs	TVA monitoring: RFAI; federal/state, university, or other research studies
		Tailwaters	TVA monitoring: fish IBI; federal/state, university, or other research studies
	Mussel community	Reservoirs	TVA and federal/state, university, or other research studies; TVA Vital Signs Monitoring Program data (bottom life assessment); consultation with academic researchers
		Tailwaters	TVA and federal/state, university, or other research studies; TVA BIBI; consultation with academic researchers
	Aquatic insect community	Reservoirs	TVA Vital Signs Monitoring Program data: benthic monitoring; federal/state, university, or other research studies
		Tailwaters	TVA monitoring: BIBI; federal/state, university, or other research studies

Table 4.7-02 Data Sources Used to Characterize Existing Conditions of Key Issues (continued)

Programmatic Issue	Components	Location	Data Sources used to Characterize Existing Condition
Sport fisheries	Warm-water fisheries	Reservoirs	TVA Sport Fish Index (SFI) data; federal/state, university, or other research studies; aquatic plant investigations; consultation with academic researchers
		Tailwaters	TVA monitoring: fish IBI; federal/state, university, or other research studies
	Cool-water fisheries	Reservoirs	TVA SFI data; federal/state, university, or other research studies
		Tailwaters	Federal/state, university, or other research studies
	Cold-water fisheries	Reservoirs	TVA SFI data; federal/state, university, or other research studies
		Tailwaters	Federal/state, university, or other research studies
Commercial fisheries	Fishes	Reservoirs	State commercial fisheries reports
	Mussels	Reservoirs	State commercial mussel reports

The Vital Signs Monitoring Program (described in Section 4.4, Water Quality) rates environmental conditions in reservoirs using fish and benthic Indices of Biotic Integrity (IBI) (Dycus and Meinert 1994). TVA also monitors sport fish populations using the Sport Fish Index (SFI), which incorporates the status of population quantity and quality along with available angler catch and use information (Hickman 2000). Within a reservoir, SFI scores monitor positive or negative trends in population status, relative to fishing experience. Beyond the SFI monitoring program, TVA operates certain hydropower operations in a manner that provides important flow levels for spring spawning grounds of certain fishes. For example, below Watts Bar reservoir, prescribed spring flows are provided to enhance sauger spawning.

4.7.3 General Description of Aquatic Resources

Construction of the TVA reservoir system significantly altered both the water quality and physical environment of the Tennessee River (Table 4.7-03), with little regard at the time for aquatic resources (Voigtlander and Poppe 1989). Aquatic resources were generally not a consideration for many types of river projects then because flood control, navigation, and hydroelectric power for economic stimulation were more highly valued.

The primary impact of the reservoir system was to convert free-flowing river habitat into reservoir pools and regulated stream reaches. Virtually all of the mainstem Tennessee River was impounded to maintain navigation channel depth. The dams became obstacles to migratory species. Differences in goals and, consequently, operation of reservoirs became important factors in determining water quality and associated impacts on resident aquatic communities in tributary and mainstem reservoirs and downstream tailwaters (see Section 4.4, Water Quality). Low concentrations of DO in summer and fall virtually eliminated aquatic communities from the pool area in the lowest layer of the reservoir that is characterized by relatively cool water. Before the RRI Program, similar impacts occurred in downstream tailwaters because water was released from the lower layer of the upstream reservoir.

The large differences between summer and winter pool levels of some tributary reservoirs also created environmental hardships for aquatic resources in these reservoirs. Benthic organisms requiring re-colonization each summer cannot survive in bottom areas exposed to drying during winter. This exposure, in association with DO stratification impacts, severely limits benthic communities in many tributary reservoirs. Aquatic communities in and downstream of mainstem reservoirs are also affected by poor water quality conditions, but impacts are less severe. Taking advantage of modified habitat conditions (reservoir pools and dam tailwaters), state agencies introduced numerous sport and some prey fishes, including rainbow trout *(Oncorhynchus mykiss)*, brown trout *(Salmo trutta)*, lake trout *(Salvelinus namaycush)*, cutthroat trout *(Salmo clarki)*, kokanee *(Oncorhynchus nerka)*, striped bass, striped bass hybrids, muskellunge *(Essox masquinongy)*, northern pike *(Esox lucius)*, cisco *(Coreogonus artedii)*, rainbow smelt *(Osmerus mordax)*, alewife *(Alosa pseudoharengus)*, yellow perch *(Perca flavescens)*, and walleye (northern strains) *(Stizostedion vitreum)* (Voigtlander and Poppe 1989). Not all introductions have led to self-sustaining populations, and state agencies continue stocking many popular fishes. Stocking has in itself led to changes to aquatic communities or created new community types in areas they did not exist (e.g., trout in tailwater river reaches).

Table 4.7-03 Potential Impacts of Reservoirs on Aquatic Environment of Regulated Rivers

Location	Environmental Component	Effect	Environmental Impact
Reservoir	Habitat	Conversion of riverine habitat to reservoir pool habitat	Loss of riverine habitat and associated species
		Conversion of floodplain to reservoir pool	Loss of seasonal floodplain habitat and associated species
		River sections become fragmented	Migrations not possible or limited
		Seasonal fluctuations of pool levels	Seasonal drying of habitat reduces abundance and diversity of species
	Temperature	Stratification (layering) of temperature for certain dam types	Stress or mortality of organisms or sensitive life stages
	DO	Seasonal DO depletion in temperature stratified water	Stress or mortality of organisms or sensitive life stages
	Ammonia	Release created by presence of DO-depleted water	Stress or mortality of organisms or sensitive life stages
	Substrate	Trapping of sediment	Disruption of stream transport of sediment
			Captures toxic substances associated with substrate
	Toxic substances	Release created by presence of DO-depleted water	Stress or mortality of organisms or sensitive life stages
	Nutrients	Cultural enrichment of nutrients (eutrophication)	Increases productivity, increases plant and algae growth, changes habitat quality and associated species

Table 4.7-03 Potential Impacts of Reservoirs on Aquatic Environment of Regulated Rivers (continued)

Location	Environmental Component	Effect	Environmental Impact
Tailwater	Temperature: average	Deep-water dam discharges lower water temperature	Loss of warm-water streams, creation of cold- and cool-water streams
	Temperature: pattern	Hydropower peaking operation results in strong daily fluctuations	Stress or mortality or organisms
	Flow alteration: average	Flows are no longer proportional to rainfall	Habitat loss, loss of flow cues for migration
		Generally more low-flow days, less high-flow days	Habitat loss, loss of flow cues for migration
	Flow alteration: frequency	Hydropower peaking operation results in large flow changes daily	Habitat loss, stranding of species, flushing of small-bodied species, bed scour
	Flow alteration: duration	Duration of flow is compressed (more rapid)	Length of events does not match life cycle needs of species
	Flow alteration: timing	Flows no longer match historical pattern	Habitat changes, interference with life cycles of species
		Low flows occur in summer, high releases in fall	Habitat changes, interference with life cycles of species
	Flow: diversion	Some power generation structures divert water from streambed	Habitat loss
	Substrate	Bed scoured in areas closer to dam	Poor substrate habitat leads to lowered diversity and abundances
	DO: average	Deep-water dam discharges are seasonally DO-depleted	Poor water quality causes loss of diversity and lowers species abundance
			DO-depleted waters may allow formation of toxic compounds
	DO: pattern	Seasonal large daily fluctuation caused by hydropower peaking operation	Stress or mortality of organisms or sensitive life stages.
	Nutrients	Nutrient-enriched water	Stimulates growth of algae and plants, changes habitat

Beyond changes in water quality, flood control activities and hydropower generation have purposefully altered the flow regime (the master variable in aquatic systems) to benefit human demands (Cushman 1985). These changes have not been beneficial to many native aquatic resources. Flow is no longer proportional to rainfall, and it fluctuates rapidly and largely over short time periods. High flow in winter and spring is captured to fill reservoir pools. Hydropower peaking operations cause unnatural extremes in daily flow levels, from flood to drought conditions. Generally, only minimal releases occur during summer when not generating power (June and July), with high discharges occurring during periods of naturally low flow (August to October) as reservoir pools are lowered to prepare for capturing winter/spring precipitation. Typically, water quality and physical habitat conditions are worst at the dam and improve with increasing distance downstream. It may take many river miles for changes to reach levels approaching no change. In a system with multiple reservoirs like the Tennessee River, impacts may propagate downstream without returning to natural conditions.

Many riverine species could not adapt to the changes brought about by the switch to reservoir environments and became locally extinct from impounded river sections and tailwaters, especially mussels, minnows, and darters (Garner and McGregor 2001, Voigtlander and Poppe 1989). For a number of species, habitat alterations affected species abundance such that they become rare and are now listed as threatened or endangered species under state or federal law (see Section 4.13, Threatened and Endangered Species). Some riverine species continue to live in remnant river-like habitats (i.e., the flooded river channel and riverine sections with adequate water quality), although their abundances and distributions have been reduced. In contrast, other species that prefer pond conditions have increased their abundances and expanded ranges in the system—primarily shad, sunfishes, and basses. In addition, popular sport fisheries were created in both reservoirs and cold-water tailwaters. Recent improvements by TVA's RRI Program have positively affected tailwater water quality conditions and the status of aquatic communities in affected river reaches (see Section 4.4, Water Quality) (Scott and Yeager 1997). In some areas, state agencies are reintroducing rare native species (Kirk pers. comm.). The specific conditions of the key issue areas in the reservoir system are described below.

4.7.4 Reservoir Biodiversity

Existing Conditions

Reservoir aquatic communities were primarily characterized using the Reservoir Fish Assemblage Index (RFAI) and the reservoir benthic community index of TVA. Both indices are components of the Vital Signs Monitoring Program (see Section 4.4, Water Quality). These methods are described in Appendix D3.

Tributary Reservoirs

Benthic aquatic insect and mussel communities are strongly affected by seasonal thermal stratification and resulting low DO concentration, and by large water level fluctuations

(Table 4.7-04). Aquatic insect communities are low in diversity and comprised of only tolerant taxa. Mussel communities virtually do not exist because of water quality conditions and pool fluctuations. Benthic communities were rated an average of poor in Blue Ridge and Interior Plateau waterbodies and for Ridge and Valley tributary reservoirs. However, these conditions are typical of tributary reservoir projects, and improvements would probably require substantial changes in reservoir operations.

Fish communities of tributary reservoirs generally rate fair or good on the RFAI, depending on sampling location in reservoirs (Table 4.7-05). However, 11 percent of samples scored poor or very poor. Tributary reservoir inflows are monitored in feeder streams just above the confluence with reservoir, using IBI methods.

Table 4.7-05 Summary of Scores for the Reservoir Fish Assemblage Index Samples (1993 to 2001)

Waterbody Type	Zone	Reservoir Fish Assemblage Index Rating					Number of Samples
		Very Poor	Poor	Fair	Good	Excellent	
Mainstem	Inflow	0	4	17	25	4	50
	Transition	0	3	14	22	3	42
	Forebay	0	1	13	33	0	47
	Embayment	0	3	7	12	2	24
Tributary	Transition	0	3	31	35	3	72
	Forebay	0	13	38	26	5	82
	Embayment	0	1	2	1	0	4
Total		**0**	**28**	**122**	**154**	**17**	**321**

Mainstem Reservoirs

Aquatic insect communities generally rated fair for inflow, transition, and forebay zones (Table 4.7-05). Index ratings for forebays of Fort Loudoun, Melton Hill, Watts Bar, and Wilson Reservoirs since the TVA monitoring program began have averaged poor. On average, good scores were obtained for the forebay of Chickamauga, Guntersville, and Nickajack Reservoirs. Six different reservoirs scored good ratings for inflow, transition, or forebay zones.
Figure 4.7-01 shows the flow zones used in the reservoir ecological monitoring. Overall, aquatic insect communities were fair.

The status of mussels is considered poor in the mainstem, with the status of individual populations varying by species. Mussel species adapted to pool conditions (including many commercial species) have been doing well, while those adapted to riverine conditions were doing poorly. Previously mentioned water quality impairments and loss of necessary fish hosts (needed to complete the life cycle) have contributed to the decline of mussel populations.

Table 4.7-04 Average Benthic Metric Score for Reservoir Samples Collected (1994 through 2001)

Waterbody Type	Reservoir	Forebay	Forebay Rating	Mid-Reservoir	Mid-Reservoir Rating	Inflow	Inflow Rating
Blue Ridge	Apalachia	19.8	Fair				
	Blue Ridge	24.3	Fair				
	Chatuge	15.6	Poor				
	Fontana	7.5	Poor	15.0	Poor		
	Hiwassee	10.6	Poor	12.3	Poor		
	Nottely	15.4	Poor	25.5	Fair		
	Parksville	9.9	Poor				
	Watauga	8.2	Poor	17.3	Fair		
	Group average	**13.9**	**Poor**	**17.5**	**Fair**		
Ridge and Valley	Boone	14.0	Poor	12.1	Poor		
	Cherokee	20.7	Fair	18.3	Fair		
	Douglas	17.7	Fair	18.3	Fair		
	Fort Patrick Henry	18.1	Fair				
	Norris	20.3	Fair	25.7	Fair		
	South Holston	10.6	Poor	10.6	Poor		
	Group average	**16.9**	**Fair**	**17.0**	**Fair**		

Table 4.7-04 Average Benthic Metric Score for Reservoir Samples Collected (1994 through 2001) (continued)

Waterbody Type	Reservoir	Forebay	Forebay Rating	Mid-Reservoir	Mid-Reservoir Rating	Inflow	Inflow Rating
Interior Plateau	Tims Ford	9.0	Poor	8.6	Poor		
	Bear Creek	18.4	Fair				
	Cedar Creek	18.7	Fair				
	Little Bear Creek	15.5	Poor				
	Normandy	13.0	Poor				
	Upper Bear Creek	23.0	Fair				
	Group average	**16.3**	**Poor**				
Mainstem	Chickamauga	27.9	Good	25.1	Fair	25.0	Fair
	Fort Loudoun	12.3	Poor	21.9	Fair	9.3	Poor
	Guntersville	31.0	Good	32.5	Good	24.3	Fair
	Kentucky	23.2	Fair	31.0	Good	23.0	Fair
	Melton Hill	15.4	Poor			9.5	Poor
	Nickajack	30.7	Good	16.0	Poor	31.0	Good
	Pickwick	21.9	Fair	29.8	Good	23.4	Fair
	Watts Bar	13.3	Poor	23.0	Fair	14.3	Poor
	Wheeler	18.3	Fair	23.1	Fair	24.7	Fair
	Wilson	15.5	Poor			27.8	Good
	Group average	**21.0**	**Fair**	**25.3**	**Fair**	**21.2**	**Fair**

Note: Blank entries reflect that some reservoirs do not have all possible pool zones. The number of macroinvertebrate samples per reservoir varied but not usually less than five samples per year. Rating categories represent a tri-section of the total range of possible scores.

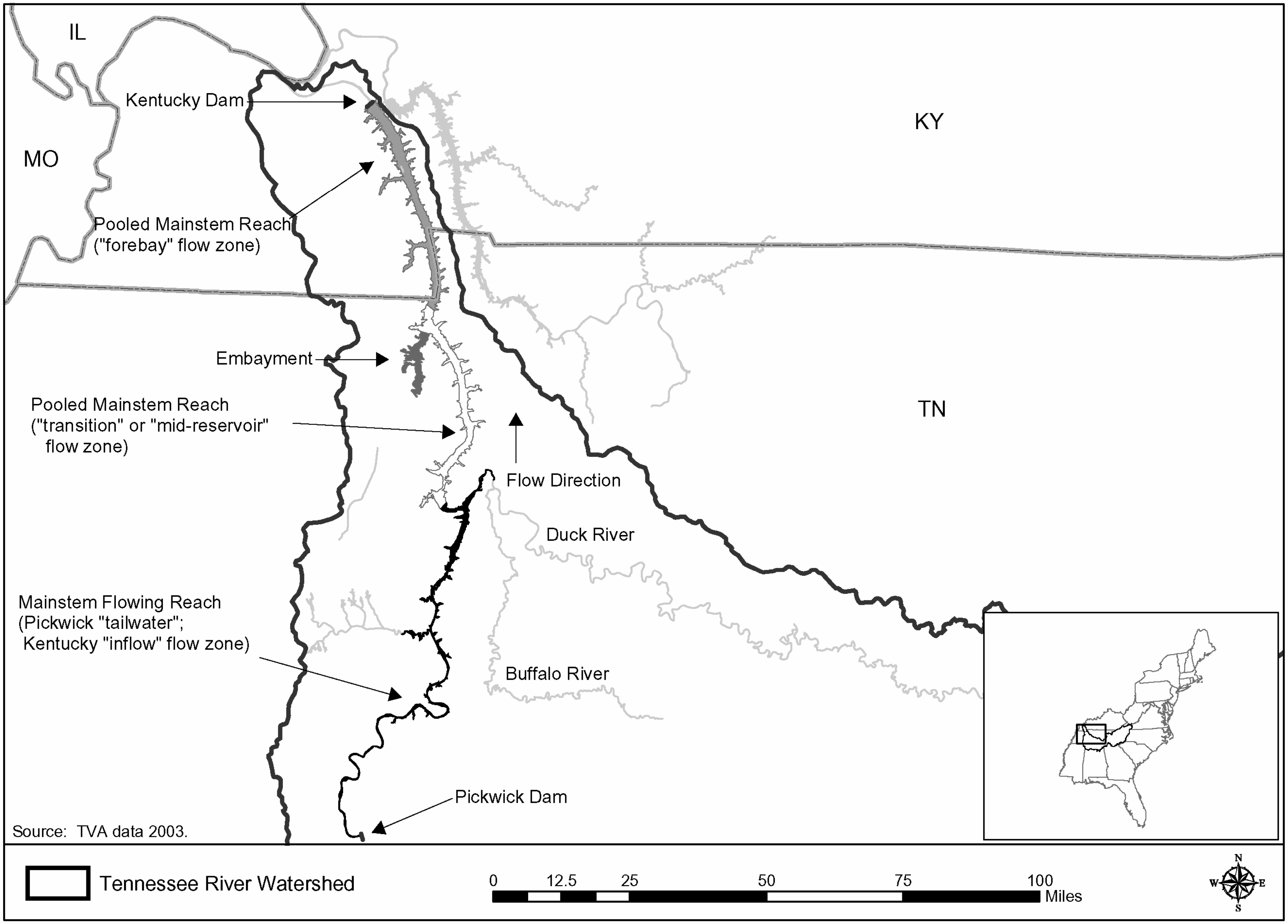


Figure 4.7-01 Diagram of Flow Zones Used in TVA Reservoir Ecological Monitoring

Fish communities of mainstem reservoirs generally rated good or fair based on attained RFAI scores. In general, more than one-half of all samples scored good or excellent for inflow, transition, forebay, and embayment areas. There were roughly an equal number of both poor (7 percent of samples) and excellent (5 percent of samples) scores.

Future Trends

Biodiversity of tributary reservoirs is not anticipated to change because of strong seasonal stratification and operational differences between summer and winter pool levels. Mussel communities would remain relatively nonexistent in tributary reservoirs. In mainstem reservoirs, degraded biodiversity may occur during dry years when stratification of the reservoirs becomes more severe. Under current operations, the biodiversity of benthic invertebrate and fish communities is not expected to change. However, the biodiversity of mussel communities in mainstem reservoirs is anticipated to continue the long-term trend of decline in abundance and diversity.

4.7.5 Tailwater Biodiversity

Existing Conditions

Tributary tailwater biodiversity improved for both fish and aquatic insect communities after the RRI Program. Prior to implementation, most tailwaters scored poor or very poor for fish and insect communities. With maintenance of established minimum flows and DO levels, more fair and good ratings were obtained (Tables 4.7-06 and 4.7-07). Poor ratings after implementation were generally at sites closest to dams with factors other than minimum flow or DO concentrations affecting aquatic communities, such as large flow fluctuations due to hydropower generation. Recovery was most pronounced in warm tailwaters.

Cold-Water Tailwaters

Downstream from dams with cold-water discharges, conditions for native fish communities were always rated poor. State fisheries agencies took advantage of the unnatural conditions and created cold-water fisheries by introducing cold-water-tolerant sport fish such as rainbow and brown trout (see Section 4.7.8). For benthic invertebrates, conditions varied by dam tailwater and by distance from the dam, but generally status was improved at least to fair after implementation of the RRI Program. Mussel communities in these areas were also poor or non-existent. Native mussels were adapted to the natural warm-water conditions and could not maintain diverse populations.

In the cool-to-warm tailwaters, fish communities close to dams were rated poor. Fish community ratings were mostly good or fair farther downstream from these dams since 1997, which indicates improvement in flow and DO concentration of tailwaters. The status of benthic invertebrates in recent years was fair for all sites in cool-water tailwaters. The status of mussel communities is rated poor in cool-to-warm tailwaters.

Table 4.7-06 Number of Sites in Each Scoring Category in Tailwaters Using the Fish Index of Biotic Integrity

Reservoir Release Improvement Program Phase	Year	Index of Biotic Integrity Rating					
		Samples	Very Poor	Poor	Fair	Good	Excellent
Pre-Program	1987	1		1			
	1988	3	1	2			
	1989	3	1	2			
	1990	3	1	1		1	
	1991	3		2	1		
	1992	2		2			
	Total	**15**	**3**	**10**	**1**	**1**	**0**
Transition: Implementation of Reservoir Release Improvement Program	1993	8		5	3		
	1994	5		2	1	1	1
	1995	7	2	4	1		
	1996	6		5	1		
	Total	**26**	**2**	**16**	**6**	**1**	**1**
Post-Reservoir Release Improvement Program	1997	13		8	5		
	1998	7	1	4	2		
	1999	9	1	2	5	1	
	2000	9		3	3	3	
	2001	6		2	3	1	
	2002	14		6	3	5	
	Total	**58**	**2**	**25**	**21**	**10**	**0**

Note: Samples classified at the edge of two categories were assigned to the lower category.

Table 4.7-07 Number of Sites in Each Scoring Category of the Tailwater Benthic Index Samples

Reservoir Release Improvement Program Phase	Year	Index of Biotic Integrity Rating					
		Samples	Very Poor	Poor	Fair	Good	Excellent
Pre-Program	1987	0					
	1988	3	1	2			
	1989	3	1	2			
	1990	3	1	1		1	
	1991	3		2	1		
	1992	2		2			
	Total	**14**	**3**	**9**	**1**	**1**	**0**
Transition: Implementation of Reservoir Release Improvement Program	1993	10	1	6	3		
	1994	7		4	1	1	1
	1995	7	2	4	1		
	1996	8		7	1		
	Total	**32**	**3**	**21**	**6**	**1**	**1**
Post-Reservoir Release Improvement Program	1997	14		7	7		
	1998	8	1	5	2		
	1999	8	1	2	5		
	2000	9		3	3	3	
	2001	6		2	3	1	
	2002	15	1	6	3	5	
	Total	**60**	**3**	**25**	**23**	**9**	**0**

Note: Samples classified at the edge of two categories were assigned to the lower category.

Tributary Warm-Water Tailwaters

Both before and after tailwater improvements, sites close to dams were generally poor, with sites farther from dams being fair or good, and sites furthest downstream rated good. The distances downstream from the dam where fish communities rated poor decreased considerably after implementation of the RRI Program. The best surviving mussel communities below tributary dams occur in warm-water tailwaters.

Flowing Mainstem Reaches

For this discussion, the flowing mainstem reaches below dams were considered as tailwaters. Fish and benthic communities in these reaches were good and fair, respectively (Tables 4.7-06 and 4.7-07). This was to be expected as riverine conditions provide a variety of habitat for fish not available in the main body of the reservoir. Lower water quality has limited the less mobile invertebrate community. Mainstem tailwaters were areas of highest mussel diversity in the regulated TVA system. Riverine mussel species reach greater abundance and diversity in flowing mainstem reaches, but their status remains only fair due to overall low diversity, low abundances, and low reproductive success for some species. Pool-adapted mussels still occur but with lower abundance than in pooled mainstem areas. Because of the complexity of mussel life cycles, the status of flowing mainstem mussel communities was driven by a complex set of environmental changes imposed by reservoir operations. These include flow peaking, habitat alteration, and shifts in fish communities that also were added to prior impacts of overharvesting prior to dam construction (Anthony and Downing 2001).

Future Trends

Given the status of fish, benthic invertebrates, and mussel communities, overall conditions in tailwaters were generally fair, and in some places good. Fish and benthic invertebrate communities rated good to fair, and the status of mussel communities was fair to poor. The anticipated trend for mussels was continued change in the composition of mussel communities (higher numbers of tolerant species with a reduction of riverine specialist species). Recent improvements in aquatic biodiversity and abundance in several tributary tailwaters achieved by the RRI Program and reintroductions of both fish and mussel species in some tailwaters suggested that these trends were continuing to improve in the modified habitats.

4.7.6 Commercial Fishing Operations

Existing Conditions

Jobs are provided directly by commercial fisheries for mussels, fish, and turtles, and indirectly through many services related to recreational or commercial activities. Commercial fishing operations consist of one or more commercially licensed fishers (or helpers) using a small boat to set and retrieve various permitted traps or nets. Gill nets, trotlines, slat baskets, trammel nets, and hoop nets have been common gear types (TWRA 1993) used to harvest the commercial fish species listed in Table 4.7-01. Few commercial fishers worked full time, and some portion of fishers did not work for one or more yearly quarters (TWRA 1993). License sales varied from nearly 1,250 commercial licenses issued in 1990 (TWRA 1993) to 435 licenses in 2000, not including helpers (TWRA 2002). In Tennessee, portions of 14 reservoirs and 14 major rivers were open to commercial fishing. Permitted reservoirs included Barkley (15,900 acres), Cherokee (30,200 acres), Chickamauga (34,500 acres), Douglas (30,400 acres), Fort Loudoun (14,600 acres), Guntersville (2,170 acres), Kentucky (108,040 acres), Nickajack (10,800 acres), and Pickwick (6,160 acres).

Based on recent harvest data, the populations of commercial fish populations were good. The estimated commercial fish harvest in 2000 was 8,021,129 pounds (24.1 pounds per acre). Catfishes comprised a majority of catch followed by buffalo, fresh-water drum, carp, paddlefish, yellow bass, gar, suckers, and other fishes (TWRA 2003a). Kentucky Reservoir produced 41 percent of the 2000 harvest; Douglas Reservoir, 20 percent; Fort Loudoun, 16 percent; and Barkley Reservoir (located on the Cumberland River) contributed 6 percent to the total harvest. The composition of harvest and location of commercial fishing activity throughout the 1990s was similar to data for 2000.

Future Trends

Based on recent harvest data, the populations of commercial fish were healthy. Status of species important to commercial fishing operations is not expected to change through 2030; populations would primarily respond to interannual climatic variation that drives mainstem reservoir stratification. Under the Base Case, fisheries potentially could experience declines only following dry years when mainstem stratification would be more likely to occur. Wet years that create more mainstem flow would produce better conditions for commercial fish populations.

4.7.7 Commercial Mussel Operations

Existing Conditions

Commercial mussels are harvested by a few individuals working as a team and using permitted gear types to catch targeted species. Commercial harvest of mussels has been permitted by Tennessee, Kentucky, and Alabama in the Tennessee and Cumberland Rivers. Combined size of harvest reported in Alabama was small relative to harvest in Tennessee. No commercial harvest was permitted by Virginia, North Carolina, or Mississippi. Because most harvest occurs in Tennessee, this assessment focused on its waters as representative.

Since 1988, harvest pressure was variable and showed dramatic changes (Hubbs 2002). Harvest decreased in 1996 due to market influences on demand and has remained low (below 2,000 tons). Mussel harvest (total harvest weight) in Tennessee declined in 2002, ending an upward 3-year trend. The only quality commercial shell stocks were located in Kentucky Reservoir, as evidenced by the annual harvest from Kentucky Reservoir representing over 98 percent of total weight for the industry (Hubbs 2003).

Future Trends

Commercial mussel stocks primarily occur in mainstem reservoirs, and harvest of commercial species is driven by market influences—not environmental conditions. The abundance of commercial species also is determined more by harvest pressure than environmental conditions. These trends are not expected to change through 2030 under the existing harvest regulations and reservoir operations policy.

4.7.8 Sport Fisheries

Existing Conditions

Sport fish populations in tributary reservoirs experience highly variable recruitment related to complex habitat and species interactions. Changes in the reservoir operations policy could affect pool levels and water quality, two habitat-related issues that could potentially influence recruitment success. Factors controlling recruitment vary by species.

Wilson, Douglas, Great Falls, Watts Bar, Wheeler, Guntersville, and Cherokee Reservoirs all averaged high Sport Fishing Index (SFI) scores for largemouth bass (Table 4.7-08). Smallmouth bass populations averaged higher SFI scores in mainstem reservoirs and in Ridge and Valley tributary reservoirs. However, the best smallmouth bass reservoirs were spread out across waterbody categories and included Watauga, Boone, South Holston, Wilson, Fort Patrick Henry, Wheeler, Pickwick, and Fontana Reservoirs.

Striped bass populations, an introduced non-native sport species, were maintained by stocking in selected mainstem and tributary reservoirs. Stocking success was a major factor influencing striped bass populations. Populations were limited by habitat availability due to stratification during late summer as they seek cool water with higher DO concentration (Crance 1984). Reservoir stratification forced striped bass into physiologically stressful habitat, which may result in mortality—especially under severe low flow conditions (Schaffler et al. 2002). Stratification mostly depended on annual rainfall under the present operations policy; therefore, population status presently depended on climatic variation and impacts of fishing (harvest) on the population. Average SFI scores for striped bass were highest in Cherokee, Nottely, Boone, Watts Barr, and Tims Ford Reservoirs, respectively (Table 4.7-08). Tributary reservoirs averaged higher scores than mainstem reservoirs, which was not unexpected since tributary reservoirs typically have cooler summer water temperatures due to their deeper pools.

Although walleye were present prior to reservoir construction, walleye populations in some tributary reservoirs have been maintained by stocking. Introduction of alewife in several TVA reservoirs degraded natural reproduction of walleye (O'Bara et al. 1999). Walleye year-class strength was highly variable prior to annual stocking efforts in recent years. Like striped bass, walleye in reservoirs were mostly limited by late summer habitat quality, which varied depending on climatic variation. High walleye SFI scores were attained at Fontana, Watauga, and Hiwassee Reservoirs—all in the Blue Ridge ecoregion (Table 4.7-08).

Table 4.7-08 Average Reservoir Scores for Sport Fishing Index Based on Samples from 1997 to 2000

Waterbody Type	Reservoir	Largemouth Bass	Smallmouth Bass	Crappie	Striped Bass	Walleye	Sauger
Mainstem	Chickamauga	34.5	21.5	31.0	27.5	20.0	33.5
	Fort Loudoun	35.5	32.3		30.0	20.0	38.5
	Guntersville	36.3	27.5		20.0	25.0	37.7
	Kentucky	33.8	30.8	48.5	20.0	20.0	40.0
	Melton Hill	31.0	20.5		22.0	20.0	15.0
	Nickajack	37.0	20.0		20.0		19.0
	Pickwick	32.3	39.8	21.0	20.0		42.0
	Tellico	29.5	27.5	35.0	32.0	30.0	20.0
	Watts Bar	37.5	30.3	36.8	32.8		31.5
	Wheeler	36.5	42.0		20.0		28.0
	Wilson	42.0	44.7				20.0
Average		**35.1**	**30.6**	**34.5**	**24.4**	**22.5**	**29.6**
Blue Ridge	Apalachia	20.0	20.0			20.0	
	Blue Ridge	20.0	30.0			27.0	
	Chatuge	25.5	20.0			23.5	
	Fontana	33.0	39.0			47.0	
	Hiwassee	28.0	25.0			34.0	
	Nottely	25.5	21.5		39.0	25.3	
	Parksville	25.0					
	Watauga	33.5	46.5	21.7		40.3	
Average		**26.3**	**28.9**	**21.7**	**29.5**	**31.0**	

Table 4.7-08 Average Reservoir Scores for Sport Fishing Index Based on Samples from 1997 to 2000 (continued)

Waterbody Type	Reservoir	Largemouth Bass	Smallmouth Bass	Crappie	Striped Bass	Walleye	Sauger
Ridge and Valley	Boone	30.0	46.0		37.0	20.0	20.0
	Cherokee	35.8	26.0	37.5	49.3	29.6	24.0
	Douglas	40.8	25.0	38.0		20.7	27.3
	Fort Patrick Henry	26.0	42.0		20.0		
	Norris	26.0	29.3	28.5	26.3	26.8	20.8
	South Holston	33.0	45.8	21.8	10.0	28.5	20.0
Average		**31.9**	**35.7**	**31.5**	**28.5**	**25.1**	**22.4**
Interior Plateau	Bear Creek	28.0					
	Cedar Creek	20.0					
	Great Falls	38.0					
	Little Bear	20.0	20.0				
	Normandy	32.8	22.5	28.7		23.0	22.5
	Tims Ford	25.7	24.8	22.0	28.0	25.3	20.0
	Upper Bear						
Average		**27.4**	**22.4**	**25.4**	**28.0**	**24.2**	**21.3**
All	**Average**	**30.7**	**30.4**	**30.9**	**26.3**	**26.3**	**23.0**

Note: Higher numbers represent relatively better sport fishing.

Mainstem reservoirs were most important to sauger populations. Important spawning sites were located on historical shoal areas downstream of mainstem dams. Recruitment was highly variable for these populations and largely depended on flow conditions in tailwaters during March and April (Hickman and Buchanan 1996) and habitat quality in late summer (flow and water quality). Most importantly, sauger abundance was strongly correlated to increased tailwater discharge during March and April. During low-flow conditions, sauger experience potentially limiting late-summer habitat conditions. High rating reservoirs on the SFI system include Pickwick, Kentucky, Fort Loudoun, Guntersville, and Chickamauga (Table 4.7-08).

Excellent trout fisheries have been created in several cool- and cold-water tailwaters through stocking programs (Bettinger and Bettoli 2002). Programs were put-and-take or put-grow-and-take fisheries, mostly for brown trout and rainbow trout. In 2001, the TWRA stocked 1.3 million fingerlings in 13 tailwaters (TWRA 2003b). The major concern for trout fisheries was summer/fall water quality (temperature and DO). Since institution of minimum flow and minimum DO levels under the RRI Program, river conditions have improved and trout populations have positively responded (Bettinger and Bettoli 2000). Hence, DO should be a minimal concern for tailwater fisheries, although incidental increases in DO levels above present minimums due to ROS alternatives may benefit trout fisheries, as trout in natural cold-water streams prefer relatively higher DO levels (Raleigh et al. 1986). Water temperatures in some tailwaters presently exceed temperature ranges beneficial for growth or survival during summer (Bettoli 2000, Luisi and Bettoli 2001), but other factors were also contributing to poor trout conditions at these sites. In the Hiwassee River, low productivity of the system, stocking mortality from transfer, over-stocking, and physical habitat conditions were also identified as contributing to poor growth and survival (Luisi and Bettoli 2001). In contrast, environmental conditions in a minimum of three cold-water tailwater fisheries were sufficient to support high growth rates or high biomass (TWRA 2002). Improvements in summer water temperature (decreases in temperature) would benefit cold-water tailwater fisheries; conversely, actions leading to increases in water temperature could adversely affect trout populations.

Factors Affecting Fish Spawning Success

Adult crappie may positively respond to conditions similar to natural flooding in unaltered river environments (i.e., nutrient levels increased) that would provide beneficial habitat to juvenile fish in reservoirs (Maceina 2003). High late winter/early spring flow also provides good spawning and juvenile fish habitat in reservoirs. However, Maceina (2003) also showed that decreased recruitment may result from high reservoir inflows that are not retained (probably from increased turbidity, which reduces food availability and feeding efficiency) and may physically remove young fish from reservoirs. Maceina and Stimpert (1998) found that higher water levels due to wet winters before crappie spawning (at water temperatures ranging from 16 to 20 °C) resulted in strong crappie year-classes in Alabama reservoirs, but only when followed by a post-winter reservoir retention time of 11 days or longer.

Sammons et al. (2002) reported crappie year-class strength varied significantly with reservoir hydrology, and their status in tributary reservoirs has been poor in recent years. Spring hydrology, specifically high flow and low retention time during pre-spawn periods (January to

March), has been identified as strongly correlated with recruitment of crappie in tributary reservoirs. Allen and Miranda (1998) reported that climatic conditions influencing annual flow regime appear to be the driving factor of crappie abundance in tributary reservoirs, with recruitment varying in boom or bust cycles—wet years as booms and dry years as busts. Sammons et al. (2002) suggested that rarely will strong crappie populations simultaneously occur over a wide geographic area or single watershed. In mainstem reservoirs, late summer water quality and change in aquatic plant abundance influenced abundance more than hydrology (Buchanan and McDonough 1990). Crappie received their highest average SFI scores in Kentucky, Watts Bar, Douglas, and Cherokee Reservoirs (Table 4.7-08).

Black bass can also benefit from high water levels during and after the spawning season. When water levels are high, more of the floodplain is made accessible—thereby providing expanded spawning and nursery habitat, providing more foraging opportunities, and reducing mortality due to predation (Raibley et al. 1997, Sammons et al. 1999, Yeager et al. 1992). Aggus and Elliott (1975) determined that the relationship between the duration of flooded terrestrial vegetation and the survival of largemouth young during the first summer is highly correlated. They suggested that the inundated vegetation provides essential protective cover that can significantly reduce mortality due to predation. During a year of stable water levels with no flooding on Bull Shoals Lake in Arkansas and Missouri, only 38 largemouth were collected per acre in cove samples. During a wet year in which 20,000 acres of vegetation were flooded for most of the summer, 1,789 largemouth per acre were collected. Increased survival as a result of high summer water levels has been shown in a variety of other studies (Bross 1967, Jackson 1957, von Geldern 1971, Keith 1975). Gutreuter and Anderson (1985), Olson (1996), Pine et al. (2000), and Sammons et al. (1999) found that early-hatched fish generally make an earlier change in diet to fish and grow faster than late-hatched fish, in effect ensuring their recruitment into the population. Heidinger (1975) suggested that these faster-growing bass are likely to reach sexual maturity sooner. Sammons and Bettoli (2000) reported that black bass survival appeared limited by the length of the summer growing season and suitable refuge habitat for young fishes. Water quality also affected black bass survival, especially smallmouth and spotted bass.

The rate at which reservoirs are raised and lowered can also affect fish survival. Rapidly falling water during the spawning season may force bass to abandon their nests or cause fish that have hatched successfully to be carried away from the nest (Kohler et al. 1993, Raibley et al. 1997). The wave action of receding water also deposits sand and silt in the nests, and can even completely remove the eggs from the nest (Summerfelt 1975). Rapidly rising water over nests causes the water temperature on the nest to drop, resulting in reduced protective behavior, increased predation, and nest abandonment (Mitchell 1982). However, Maceina and Bettoli (1998) found that water level fluctuations during April-May in four TVA mainstem reservoirs while largemouth were spawning were not related to subsequent recruitment.

Some researchers (Aggus and Colvin pers. comms.) stress that water levels in themselves are not the key to enhancing development of good numbers of fish that ultimately reach catchable sizes. Increased nutrient inflow caused by flood flows in the late winter/early spring is of high importance as these floods provide productivity increases necessary for good food production, starting with microscopic animals. Simply raising water levels without nutrient increases, such as would occur if water levels are kept artificially high during dry winter/early spring periods, would not provide the necessary productivity boost to support large numbers of juvenile fish. Keith (1975) indicated that flooding of terrestrial vegetation on the shoreline increases the water's productivity by initiating the decomposition of the vegetation and release of nutrients. If water levels are kept high late into the year in storage reservoirs, the amount of vegetation capable of establishing in the ultimately exposed shoreline area is greatly reduced. Drawing water levels down in the late summer is necessary for terrestrial vegetation to re-establish on shoreline areas (Yeager et al. 1992). Without a sufficient period of regrowth, the vegetation would not be present the following spring to benefit coming year-classes and would likely result in increased shoreline erosion problems.

Future Trends

Reservoir hydrology (stratification and spring flow rates) is a complex driving factor in determining recruitment of sport fishes. Wet late winter/early spring periods produce a higher abundance of juvenile fish, and their survival increases when the shallow zone incorporates various forms of cover during summer. Lower recruitment rates of a number of littoral or shoreline zone spawners are expected in dry years when little suitable habitat is flooded during and after the spawning period. However, dry years that increase aquatic plant production in warm-water tailwaters and mainstem reservoirs would benefit warm-water sport fish populations, except when mainstem reservoirs stratify such that poor water quality (low DO) degrades conditions. Dry years, depending on individual reservoir operations, could also reduce preferred habitat for cool-water species in large tributary reservoirs—as increased stratification can cause summer/fall water quality problems. During dry spring periods, less water would be discharged from mainstem reservoirs, which could decrease migratory spawning recruitment. Warm tailwaters would benefit from reduced peaking flows during dry years, as more stable flow would be provided. Cold-water tailwaters would be degraded during dry years due to higher water temperatures during summer and fall. In tailwaters, minimum flows and DO concentrations provided through the RRI Program would continue to prevent poor water quality in dam releases such that sport fisheries would have available habitat. In general, sport fish would show variable responses to inter-annual variation in rainfall, depending on species water temperature preference (cold or warm) and habitat type (reservoir or tailwater). These trends are not expected to change under the existing reservoir operations policy.

4.8 Wetlands

4.8.1 Introduction

Resource Issues
▶ Wetland location
▶ Wetland type
▶ Wetland function

Wetlands are lands where saturation with water is the dominant factor in determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface (Cowardin et al. 1979). Wetlands exist within and adjacent to TVA reservoirs and tailwaters, and are influenced by surface water and groundwater connections to the water levels in these reservoirs and tailwaters. Wetlands depend on the timing and duration of the presence of water; consequently, they may be affected by reservoir operations. These changes can be measured by the following issues:

- **Wetland location—**Wetland locations may be altered by changes that affect the extents and geographic distributions of the wetlands, the rate of formation of new wetlands, or the connections between wetlands.
- **Wetland type—**Changes in the types of wetland water regimes present (the timing and duration of the presence of water) can result in changes in the types of wetland vegetation, as individual wetland plant species generally depend on specific types of water regimes.
- **Wetland function—**Changes in the wetland types present will change the overall environmental, social, and economic values of the functions provided by these wetlands.

The study area for measuring changes in wetland systems is the area of groundwater influence surrounding mainstem and tributary reservoirs and mainstem and tributary tailwaters. The groundwater area of influence was projected based on geologic modeling of the distance at which reservoir water levels cease to affect groundwater levels in the physiographic regions in the study area (see Appendices D2 and D4a). The types and acreages of potentially affected wetlands were estimated based on data selected from the National Wetlands Inventory (NWI). The NWI data include information on the type of vegetation, water regime, and setting. The wetlands included as potentially affected in this study meet the wetland definition used by the USFWS (Cowardin et al. 1979). This definition is the national standard for wetland mapping, monitoring, and data reporting as determined by the Federal Geographic Data Committee. The NWI data were compiled using high-altitude aerial photography with limited field verification. Some of the data are now over 15 years old. Because of their age and manner of acquisition, the data were not strictly interpreted in terms of changes in acreage.

4.8.2 Regulatory Programs and TVA Management Activities

Activities that affect wetlands in the TVA region are regulated under the CWA and state water quality programs. Any action that proposes discharge of dredge or fill materials in waters of the United States must apply to the USACE to receive a Section 404 permit. Some wetland systems are considered waters of the United States. A state has authority to grant water quality certification for a new federally permitted activity that may affect waterbodies under Section 401 of the CWA. The state performs a review of the activity to ensure that water quality standards are maintained and then approves or denies water quality certification. Denial of the certification results in denial of any CWA permit application.

Executive Order 11990—Protection of Wetlands requires all federal agencies to avoid construction in wetlands to the extent practicable and to mitigate potential impacts as appropriate.

4.8.3 Wetland Location

Existing Conditions

Wetland locations may be altered by any change that affects the extent and geographic distribution of the wetlands, the rate of formation of new wetlands, or the connections between wetlands. If there is a reduction in the water level or duration of the presence of water, wetlands may shrink, shift into areas with adequate water, or dry up and be lost entirely. When the duration of water is increased, wetlands may shift or expand upland where topography permits. New wetlands may form where suitable low-lying areas exist. Wetland habitat connectivity is an important function of wetland location. Natural habitat connections between wetlands and other adjacent natural habitats support biological diversity by serving as migration corridors for wetland plants and animals. These corridors allow native wetland species to move into new habitats as conditions change. Reduced habitat connectivity between wetlands and other adjacent natural habitats may reduce other wetland functions over time. Because of their proximity to the water, development and recreation pressures influence the location and connectivity of wetlands. As human populations associated with development have increased, many wetlands have become imperiled.

Based on the NWI, approximately 197,000 acres of wetlands are within the projected groundwater influence area of the TVA reservoir system[1] (Table 4.8-01). Approximately 55 percent of the wetlands in the projected groundwater influence area are found to occur along mainstem reservoirs, approximately 11 percent occur along tributary reservoirs, approximately 30 percent occur along mainstem tailwaters, and approximately 4 percent occur along tributary

[1] This total acreage includes wetlands on Lake Barkley. Although it is not a TVA reservoir, Lake Barkley was included because it is hydrologically connected with Kentucky Lake. The Weekly Scheduling Model information shows that Lake Barkley and Kentucky Lake respond similarly under each policy alternative.

tailwaters (Table 4.8-01). Some of these potentially affected wetlands are present in local, state, and federally managed areas—including wildlife refuges, wildlife management areas, national forests, parks, and recreation areas—and TVA-designated sites, including small wild areas, habitat protection areas, and ecological study areas (Table 4.8-02 and Section 4.14, Managed Areas and Ecologically Significant Sites).

State and federal agencies have invested in infrastructure for controlling water levels to enhance and provide additional wetland functions in over 22,000 acres of wetlands associated with TVA reservoirs (Table 4.8-02). These controlled wetlands include national wildlife refuges (NWRs), wildlife management areas (WMAs), a waterfowl refuge, and a greentree reservoir (a forest that is flooded in winter for migratory bird use). In addition to water control structures, these wetlands contain improvements such as levees, access roads, signage, large-capacity hydraulic pumps, and monitoring equipment. These controlled wetlands and their associated improvements may be affected by changes in the timing and duration of reservoir water levels, which would affect the values and returns on the investments made by the state and federal agencies involved.

Potentially affected wetlands occur on flats between summer and winter pool elevations, on islands, along reservoir shorelines, in dewatering areas, in floodplains, on river terraces, along connecting rivers and streams, around springs and seeps, in natural depressions, in areas dammed by beaver, in and around constructed reservoirs and ponds (diked and/or excavated), and in additional areas that are isolated from other surface waters. In general, vegetated wetlands occur with greater frequency and size along the mainstem reservoirs and tailwaters than along the tributary reservoirs and tailwaters. This is due in part to the larger sized watersheds of mainstem reservoirs resulting in a greater volume of water; greater predictability of the annual hydrologic regime; shoreline and drawdown zone topography (wider and flatter floodplains, riparian zones, and drawdown zones and large areas of shallow water); and larger areas of relatively still, shallow-water areas. Wetlands tend to be smaller and do not occur as frequently on tributary reservoirs because of the relatively steep drawdown zones, the rolling to steep topography of adjacent lands, shoreline disturbance caused by wave action, and the lower predictability and shorter duration of summer pool levels.

Future Trends

While the CWA and TVA's SMI and Section 26a Permit Program would continue to influence activities that may encroach into wetlands on TVA reservoir lands, the wetlands surrounding TVA reservoirs would likely continue to face development and recreational pressures due to their proximity to the water. Large waterfront acreages may be fragmented by suburban development. Wetlands adjacent to TVA reservoirs may be affected by development on adjacent uplands. The remaining wetlands would likely play an increasingly important role in providing wetland functions, such as storing floodwaters, retaining sediments and stabilizing shorelines, protecting water quality, providing wildlife habitat, and enhancing the aesthetics of the shoreline.

Table 4.8-01 Wetland Amounts for Reservoirs and Tailwaters in the ROS EIS

Reservoirs	Combined Aquatic Beds and Flats (acres)	Emergent (acres)	Ponds (acres)	Forested (acres)	Scrub/ Shrub (acres)	All Types (acres)
Mainstem Reservoirs						
Barkley[1]	1,246	1,376	248	5,431	2,433	10,733
Chickamauga	5,756	115	213	426	430	6,940
Fort Loudoun	197	74	70	152	5	498
Guntersville	7,348	937	3,227	3,694	400	15,606
Kentucky	3,539	3,492	417	32,783	3,361	43,592
Nickajack	1,281	9	2,073	4	38	3,405
Pickwick	275	443	2,377	1,968	216	5,279
Watts Bar	610	19	52	285	85	1,051
Wheeler	2,523	1,811	9,533	4,593	1,700	20,160
Wilson	29	661	1,081	1,479	656	3,906
Subtotal	**22,804**	**8,937**	**19,291**	**50,815**	**4,324**	**111,182**
Tributary Reservoirs						
Apalachia	0	0	0	2	4	6
Bear Creek	17	8	100	146	0	271
Blue Ridge	2	2	3	1	0	8
Boone	2	7	8	28	11	56
Cedar Creek	1,238	23	177	315	40	1,793
Chatuge	581	11	14	48	14	668
Cherokee	2,995	89	43	43	53	3,223
Douglas	3,656	281	66	270	477	4,750
Fontana	6	4	6	39	8	63
Fort Patrick Henry	0	1	3	40	1	45
Great Falls	33	17	10	22	7	89
Hiwasee	23	15	1	21	106	166
Little Bear Creek	263	7	26	52	0	348
Melton Hill	158	73	101	48	10	390
Normandy	3	10	13	205	6	237
Norris	187	93	59	132	35	506
Nottely	4,329	17	88	106	11	4,551
Ocoee #1	0	115	0	5	2	122
Ocoee #2	0	0	0	0	0	0
Ocoee #3	20		9	1	101	131
South Holston	9	32	7	7	4	59

Table 4.8-01 Wetland Amounts for Reservoirs and Tailwaters in the ROS EIS (continued)

Reservoirs	Combined Aquatic Beds and Flats (acres)	Emergent (acres)	Ponds (acres)	Forested (acres)	Scrub/ Shrub (acres)	All Types (acres)
Tributary Reservoirs (continued)						
Tellico	17	155	75	350	83	680
Tims Ford	143	163	46	324	54	730
Upper Bear Creek	0	5	264	71	0	340
Watauga	752	2	1	13	16	784
Wilbur	21	7	0	0	0	27
Subtotal	**14,456**	**1,136**	**1,118**	**2,289**	**1,042**	**20,075**
Reservoir total	**37,260**	**10,073**	**20,427**	**53,104**	**10,366**	**131,257**
Tailwaters	**Combined Aquatic Beds and Flats (acres)**	**Emergent (acres)**	**Ponds (acres)**	**Forested (acres)**	**Scrub/ Shrub (acres)**	**All Types (acres)**
Mainstem Reservoirs						
Barkley[1]	14	393	101	2,540	151	3,199
Chickamauga	9	9	87	218	21	344
Fort Loudoun	131	17	5	62	26	241
Guntersville	21	1,221	5,370	5,333	2,209	14,154
Kentucky	64	288	356	13,200	497	14,405
Pickwick	290	1,852	209	12,921	2,099	17,371
Nickajack	498	632	190	44	976	2,340
Watts Bar	1,379	143	40	443	138	2,143
Wheeler	0	0	0	0	0	0
Wilson	527	94	1594	1,288	98	3,601
Subtotal	**2,933**	**4,649**	**7,952**	**36,049**	**6,215**	**57,814**
Tributary Reservoirs						
Apalachia	0	0	0	3	202	205
Bear Creek	5	372	2,452	2,227	145	5,201
Blue Ridge	2	8	2	2	6	20
Boone	0	0	0	0	0	0
Cedar Creek	81	0	29	117	9	236
Chatuge	0	18	19	22	5	64
Cherokee	71	18	3	13	2	107
Douglas	3	10	27	215	9	264

Table 4.8-01 Wetland Amounts for Reservoirs and Tailwaters in the ROS EIS (continued)

Tailwaters	Combined Aquatic Beds and Flats (acres)	Emergent (acres)	Ponds (acres)	Forested (acres)	Scrub/ Shrub (acres)	All Types (acres)
Tributary Reservoirs (continued)						
Fontana	0	0	0	0	3	3
Fort Patrick Henry	0	3	61	35	2	101
Great Falls	0	16	1	0	7	24
Hiwasee	0	0	0	0	0	0
Little Bear Creek	0	45	72	130	3	250
Melton Hill	2	10	72	101	30	215
Normandy	10	22	31	203	1	267
Norris	0	0	15	8	0	23
Nottely	4	3	16	19	10	52
Ocoee #1	1	2	0	31	0	34
Ocoee #2	0	0	0	0	0	0
Ocoee #3	0	0	0	0	0	0
South Holston	0	6	1	35	2	44
Tellico	0	0	0	0	0	0
Tims Ford	20	31	31	342	4	428
Upper Bear Creek	0	1	83	166	0	250
Watauga	0	0	0	0	0	0
Wilbur	0	6	7	123	6	142
Subtotal	**199**	**571**	**2,922**	**3,792**	**446**	**7,934**
Tailwater total	**3,132**	**5,220**	**10,874**	**39,841**	**6,661**	**65,748**
System total	**40,392**	**15,293**	**31,301**	**92,945**	**17,027**	**196,958**

[1] This table includes wetlands on Lake Barkley. Although not a TVA reservoir, Lake Barkley was included because it is hydrologically connected with Kentucky Lake. The Weekly Scheduling Model information shows that Lake Barkley and Kentucky Lake respond similarly under each policy alternative.

Source: National Wetland Inventory.

Table 4.8-02 Wetlands with Water-Level Control Structures

Wetland Name	Reservoir	Invested Agencies	Acres
Rankin WMA	Douglas	TWRA	1,255
Chota Waterfowl Refuge	Tellico	TWRA	100
Mud Creek Greentree Reservoir	Guntersville	ADCNR-JCWMA	290
Wannville Dewatering Unit	Guntersville	ADCNR-JCWMA	384
Raccoon Creek Dewatering Unit	Guntersville	ADCNR-JCWMA	1,040
Swan Creek Dewatering Unit	Wheeler	ADCNR	1,100
White Springs Dewatering Unit	Wheeler	USFWS-Wheeler NWR	1,700
Rockhouse Dewatering Unit	Wheeler	USFWS-Wheeler NWR	1,100
Penney Bottoms Dewatering Unit	Wheeler	USFWS-Wheeler NWR	50
Crabtree Slough Dewatering Unit	Wheeler	USFWS-Wheeler NWR	180
Devaney Impoundment	Wheeler	USFWS-Wheeler NWR	60
Dinsmore Slough Dewatering Unit	Wheeler	USFWS-Wheeler NWR	130
Display Pool	Wheeler	USFWS-Wheeler NWR	13
Duck River Dewatering Unit	Kentucky	USFWS-Tennessee NWR	4,688
Busseltown Dewatering Unit	Kentucky	USFWS-Tennessee NWR	204
Camden Dewatering Unit	Kentucky	TWRA/TVA	3,937
West Sandy Dewatering Unit	Kentucky	TWRA/TVA	3,730
Big Sandy Dewatering Unit	Kentucky	TWRA/TVA	1,738
Perryville Dewatering Unit	Kentucky	TVA	308
Gumdale Dewatering Unit	Kentucky	TVA	152
Yellow Creek WMA	Chickamauga	TWRA	35
Washington Ferry WMA	Chickamauga	TWRA	50
McKinley Branch	Chickamauga	TVA	75
Big Slough (Hiwassee Refuge)	Chickamauga	TWRA	15
Rogers Creek (Chickamauga WMA)	Chickamauga	TWRA	30
Johnson Bottoms	Chickamauga	TWRA	22
Candies Creek (Chickamauga WMA)	Chickamauga	TWRA	60
Total			**22,359**

Notes:

ADCNR-JCWMA = Alabama Department of Conservation and Natural Resources-Jackson County WildlifeManagement Areas.
NWR = National wildlife refuge.
TVA = Tennessee Valley Authority.
TWRA = Tennessee Wildlife Resources Agency.
USFWS = U.S. Fish and Wildlife Service.
WMA = Wildlife management area.

Source: TVA Natural Heritage Database.

4.8.4 Wetland Type

Existing Conditions

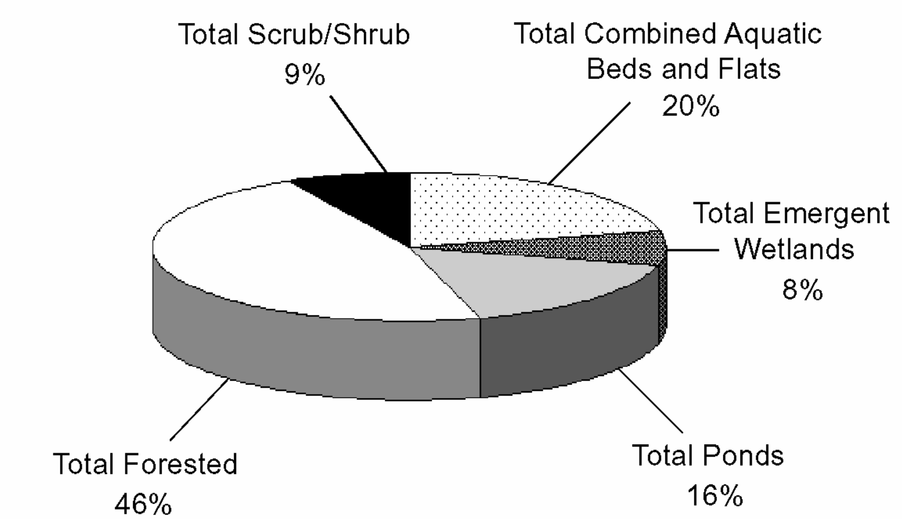
Vegetation Classes

Specific categories of wetland types were chosen for evaluation based on their sensitivity to potential changes and their association with critical wetland functions described in the next section. These categories include vegetation type (Figure 4.8-01) (the dominant form of plant life) and water-regime type (the timing and duration of the presence of water). Schematics of these wetland vegetation types and water regimes are shown in Figures 4.8-02, 4.8-03, and 4.8-04, as described in Classification of Wetlands and Deep Water Habitats (Cowardin et al. 1979). A summary of the wetland vegetation types and acreages associated with each hydropower project is presented in Table 4.8-01. Additional categories of wetlands were identified as areas of concern in public comments due to the high-profile functions and values they provide. These additional functional categories include shoreline wetlands, island wetlands, wetlands that are isolated from other surface waters, and wetlands with investments in infrastructure for controlling water levels to enhance and provide additional wetland functions (Table 4.8-02).

The potentially affected wetland types include:

- Aquatic beds—submersed areas supporting aquatic vegetation.
- Seasonally exposed flats—areas of non-persistently vegetated and non-vegetated mudflats, as well as flats of other natural and artificial substrate types such as mixtures of sand, silt, cobble, and gravel.
- Emergent wetlands—areas of low-growing marshes and wet meadows.
- Scrub/shrub wetlands—areas with shrubs and or saplings.
- Forested wetlands—swamp and bottomland areas with hardwood and other wetland tree species.
- Ponds—areas of constructed ponds, beaver ponds, and other naturally occurring ponds and seasonal pools.

A wide range of dominance types, water regimes, and special modifiers exist within these vegetation types. Descriptions and lists of the commonly occurring vegetation species in the ROS area wetlands can be found in Section 4.9 (Aquatic Plants) and Section 4.10 (Terrestrial Ecology). Almost half (47 percent) of the wetlands associated with the TVA reservoir system are classified as forested wetlands, approximately 20 percent are aquatic beds and flats, approximately 16 percent are ponds, approximately 8 percent are emergent wetlands, and approximately 9 percent are scrub/shrub (Figure 4.8-01). The locations and extents of aquatic beds and flats are combined for the purposes of this assessment since these categories overlap in nature. When aquatic beds are exposed, they function as flats; likewise, while flats are submersed, they sometimes develop aquatic bed vegetation.



Note: Total acreage is approximately 197,000.
Source: TVA data.

Figure 4.8-01 Wetlands of the TVA Reservoir System by Vegetation Class

Water Regimes

The water-regime types of wetlands associated with the TVA reservoir system include:

- Temporarily flooded wetlands—normally have standing surface water for less than 2.5 weeks during the growing season;
- Seasonally flooded wetlands—may have standing water present for much of the growing season but normally dry up during late summer and fall;
- Semipermanently flooded wetlands—normally have standing water for most of the year;
- Permanently flooded wetlands—normally have standing water year round; and,
- Intermittently exposed wetlands—may experience up to a few weeks exposure a year during dry conditions.

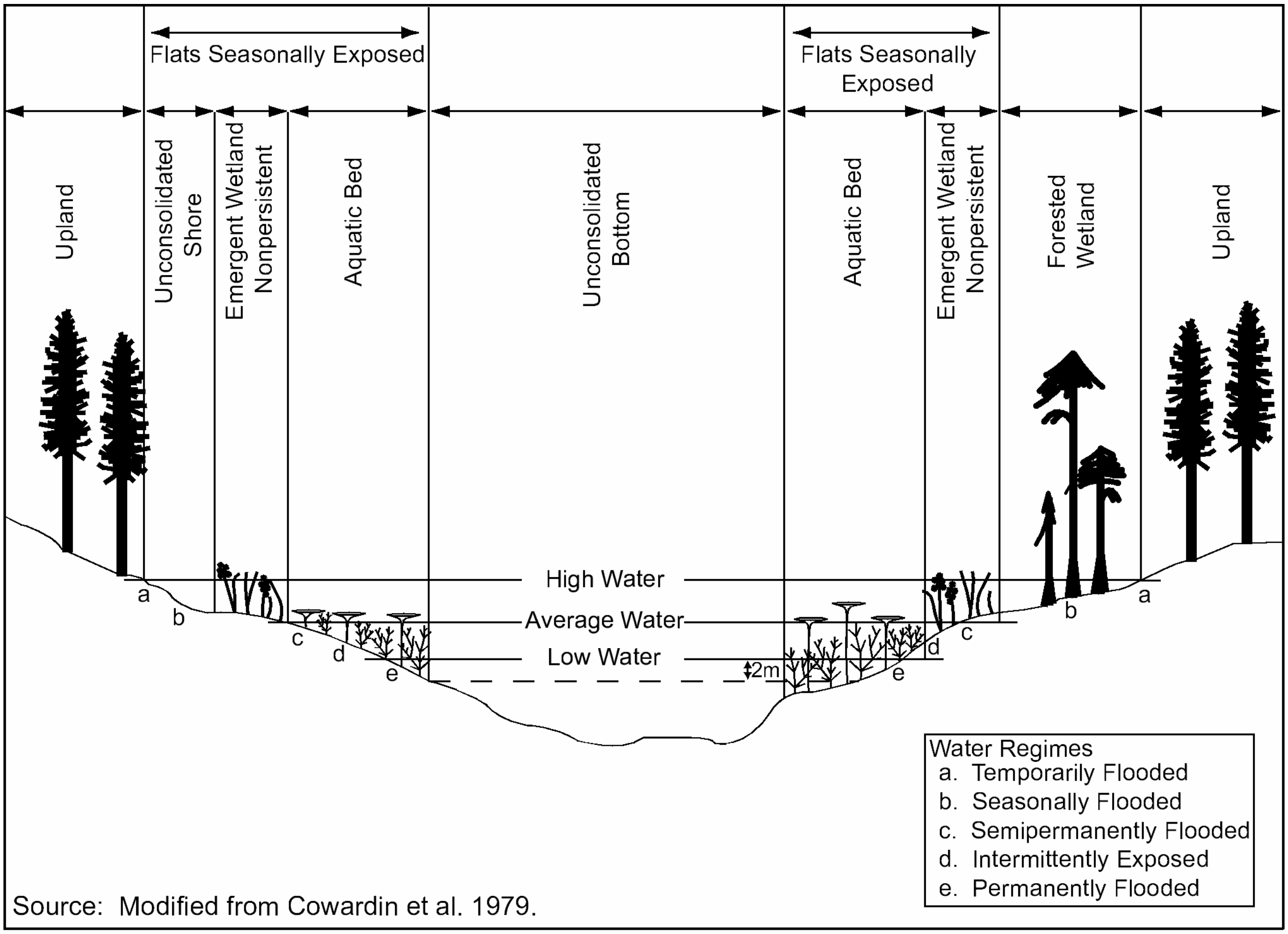


Figure 4.8-02 Wetland Reservoir Types and Locations (Lacustrine Wetlands)

A total of 37 percent of the wetlands associated with the TVA reservoir system are temporarily flooded, 41 percent are seasonally flooded, 10 percent are semipermanently flooded, 9 percent are permanently flooded, less than 1 percent are intermittently exposed, and 2 percent are artificially flooded (Figure 4.8-05).

Wetlands that are particularly sensitive to reservoir operations are shoreline wetlands, island wetlands, and isolated wetlands. Isolated wetlands are separated from other surface waters but influenced by groundwater. Only wetlands entirely isolated from all surface waters were identified as isolated in this study; the actual extent of wetlands in the groundwater influence area that may be considered isolated from a regulatory standpoint may be greater. Increasing rates of loss of isolated wetlands are being seen as a result of ongoing changes in the regulation of this type of wetland under the CWA. Following a Supreme Court ruling (SWANCC 2000), various estimates (USFWS, USEPA, USACE, the Association of State Wetland Managers [ASWM]) suggest that anywhere between 20 and 79 percent of the existing wetlands in the United States may lose protection under the CWA (Meltz and Copeland 2001, Paranteau 2002, Kusler 2002).

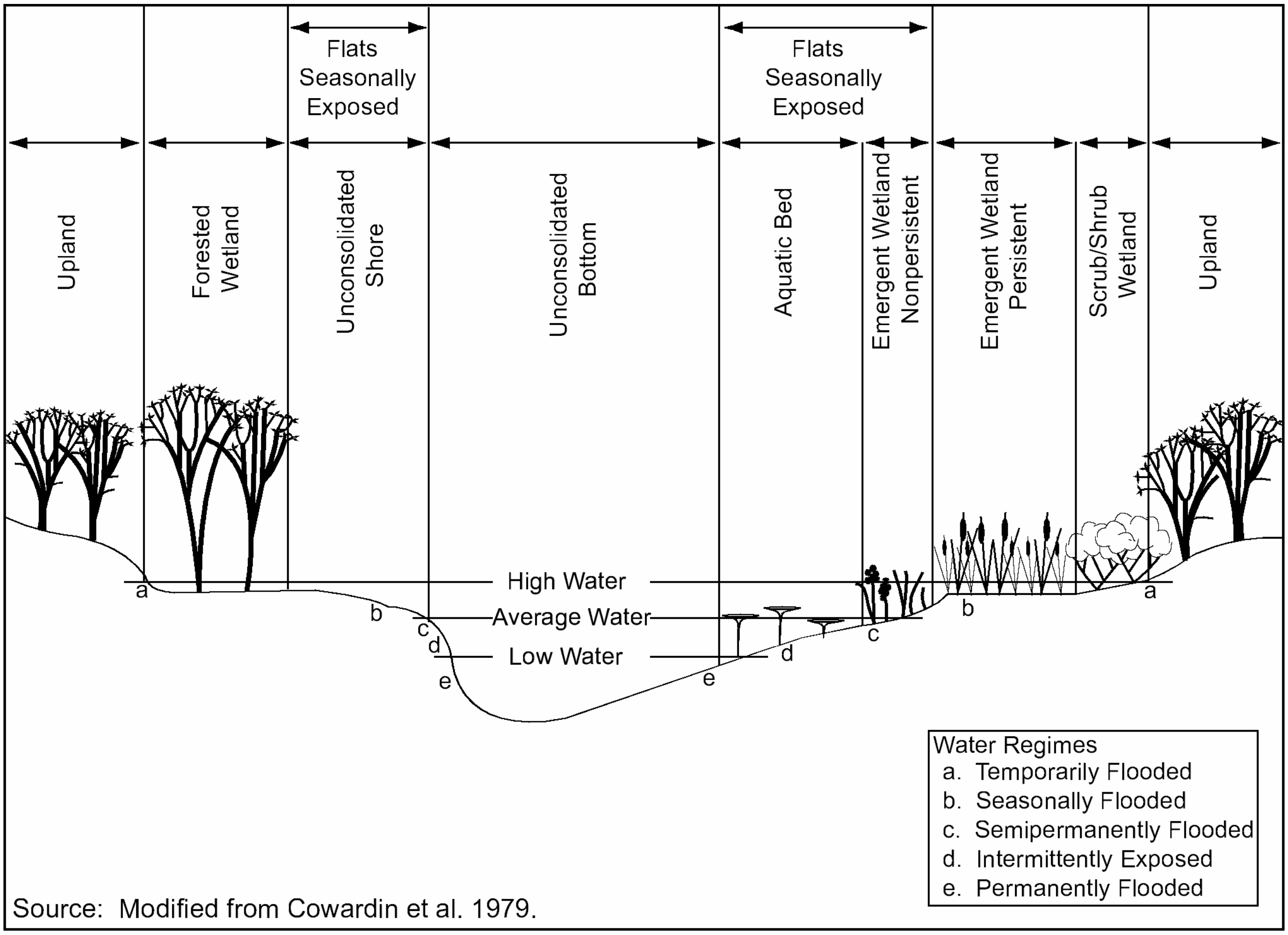


Figure 4.8-03 Tailwater Reservoir Types and Locations (Riverine Wetlands)

Future Trends

National wetlands trends studies (Dahl 2000) indicate that, between 1986 and 1997, fresh-water forested wetlands declined 2.3 percent, and fresh-water emergent declined 4.6 percent. Parts of these declines were due to conversion of forested and emergent wetlands to shrub wetlands (a gain of 6.6 percent) and fresh-water ponds (a gain of 13 percent) during the study period. Timber harvesting, agriculture, natural succession, beaver activity, changes in land use (including urban and rural development, mining, and recreation such as golf courses), and conversion of bottomland forests to managed pine plantations, played a role in these trends in wetland change. These trends are likely to continue to various degrees over the next 30 years.

National trend data do not include analyses of flats and aquatic bed coverage; however, TVA data indicate an increase in coverage of aquatic beds between the 1960s and 2000s.

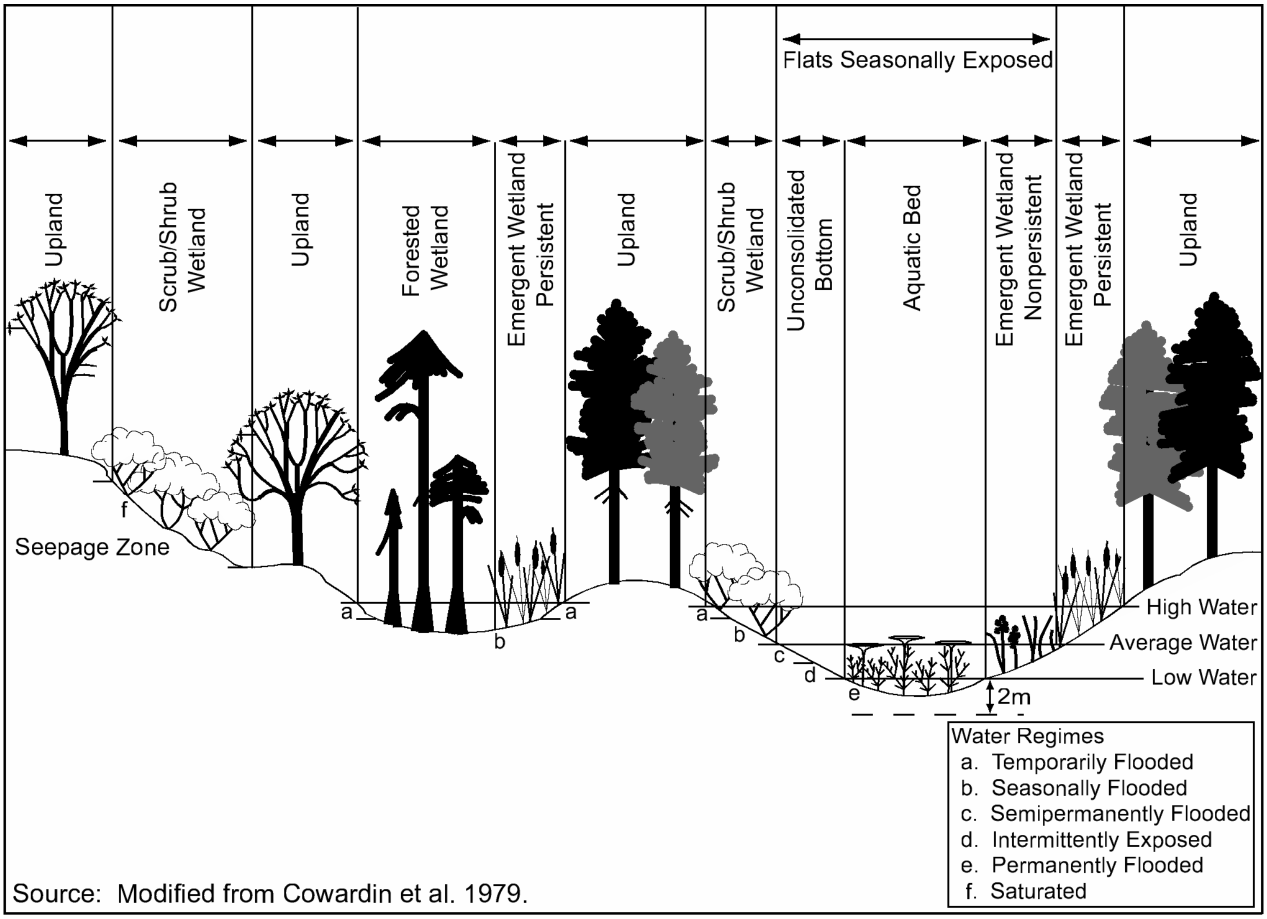
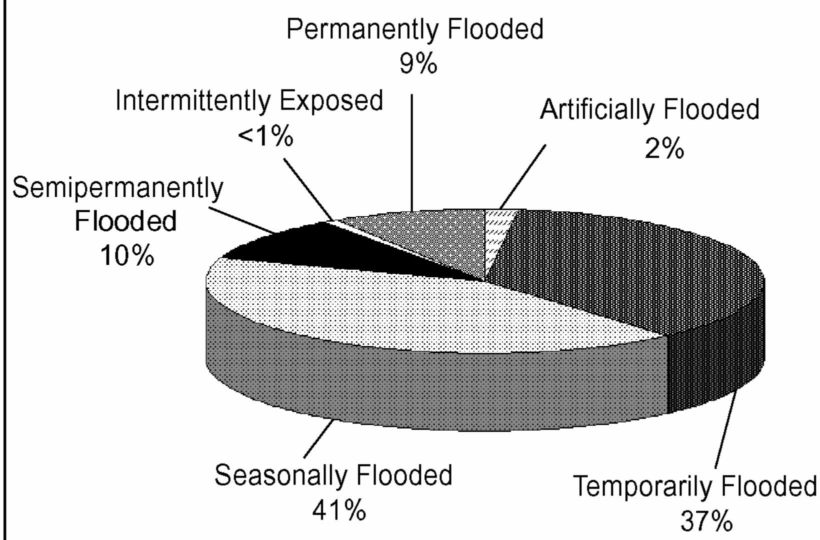


Figure 4.8-04 Other Wetland Types and Positions within the Area of Groundwater Influence (Palustrine System)

4.8.5 Wetland Functions

The environmental quality of rivers, watersheds, estuaries, and water supplies is closely tied to the functions of wetlands. The functions provided by the wetlands associated with the TVA reservoir system include stormwater storage, shoreline stabilization, sediment retention, removal and transformation of contaminants, carbon storage, nutrient cycling, food web support through the production of plants and invertebrates, water temperature modification, wildlife habitat, and support for biological and landscape diversity (Mitsch and Gosselink 1993, Tiner et al. 2002). Just as wetland types vary, the functions of individual wetlands also vary. Not all wetlands perform all wetland functions to the same degree. These functions are performed at different intensities, depending on the wetland type, its watershed position, its location in relation to the reservoir and adjacent land uses, and the level of environmental disturbance.



Note: Total acreage is approximately 197,000.
Source: TVA data.

Figure 4.8-05 Wetlands of the TVA Reservoir System by Water Regime

These wetland functions provide numerous benefits to the public, including floodwater reduction, water quality improvement, and aesthetic enhancement of the shoreline. Wetlands provide recreational opportunities to the public, including hunting, fishing, boating, hiking, wildflower and wildlife viewing, photography, educational use, and scientific study. Individual states gain economic benefits from recreational opportunities in wetlands that attract visitors from other states (U.S. Congress 1993). A disproportionately high number of rare species depend on wetlands. USFWS estimates that up to 43 percent of threatened and endangered species rely directly or indirectly on wetlands for their survival (http://www.epa.gov/watertrain/wetlands/text.html).

Certain wetland functions may be attributed to wetlands based on wetland type. All vegetated wetlands function to enhance water quality. Wetlands that are not permanently flooded may provide additional water storage during floods and storms. Vegetated shoreline fringe wetlands help stabilize streambanks and shorelines from floodwaters, wave action, and soil erosion and sedimentation. All vegetated wetlands that are permanently or semi-permanently flooded may serve to store carbon. Areas that store carbon help to prevent gases that promote global warming from entering the atmosphere. The continuous presence of water slows the rate of decomposition in these wetlands by reducing the availability of oxygen to organisms of decay; consequently, carbon-rich organic matter is stored in wetland soils. In similar ways, wetlands may help with nutrient cycling and food web support.

Scrub/shrub and forested wetlands are particularly well suited to bank protection and stabilization. All types of wetlands may provide habitat for plants and animals for breeding, nesting, refuge, or as a source of food. Surface-isolated and seasonally flooded wetlands are especially important in providing wetland and upland habitat interspersion functions. These wetlands are either never connected to other aquatic systems or they are not continuously connected. This lack or reduction in connection to other aquatic systems is a controlling factor in the development of unique biological communities in these wetlands. These habitat interspersion functions make these types of wetlands critical as breeding habitats for certain species of amphibians (salamanders and frogs) because certain predatory fish species are not able to establish populations. They also provide critical transient habitats for migratory birds. All types of wetlands provide opportunities for aesthetic and educational pursuits, hunting and fishing, hiking and exploring, boating, wildflower and wildlife viewing, and nature photography and filming. Section 4.7 (Aquatic Resources), Section 4.10 (Terrestrial Ecology), Section 4.13 (Threatened and Endangered Species), and Section 4.14 (Managed Areas and Ecologically Significant Sites) have additional discussion about wetland resources, functions, and values.

4.9 Aquatic Plants

4.9.1 Introduction

Resource Issues

- Coverage of non-invasive and invasive aquatic plants

Changes in the reservoir operations policy have the potential to affect invasive and non-invasive aquatic plants. Because they are rooted in shallow water (usually less than 15 feet deep), aquatic plant communities in reservoirs are affected by the amount, timing, and duration of reservoir water fill and drawdown. The volume and flow rate of water releases from TVA dams affect aquatic plants in tailwaters. The effect of reservoir operations policy alternatives on aquatic plants (both invasive and non-invasive) was evaluated by analyzing the coverage and composition of these plant communities in TVA reservoirs and tailwaters.

Aquatic plants are often referred to as aquatic macrophytes and include aquatic vascular plants, a few mosses, and macroscopic algae. Aquatic macrophytes are divided into four classes (free-floating, submersed, floating-leaved, and emergent) based on whether they are rooted in the substrate and their leaf locations in relation to the water surface. The term aquatic plants in this section of the EIS refers to submersed and floating-leaved plants; this term includes coontail (*Ceratophyllum demersum L.*) although it is typically classified as free-floating. Free-floating plants other than coontail are not major components of the aquatic plant community in the TVA system and are not included in the analysis. Emergent wetland communities are discussed in Section 4.8, Wetlands.

Algal biomass (discussed in Section 4.4, Water Quality) can alter the light available to aquatic plants. Increase or decline of aquatic plants and aquatic invasive plants can be measured in acres of substrate colonized or coverage. This value can then be compared from year to year or season-to-season to determine variations.

For this EIS, aquatic invasive plants are defined as those species of plants that spread rapidly and can crowd or out-compete native, indigenous species so thoroughly or grow so densely that the ecosystem is negatively affected. This definition includes those plants that are exotic, or non-native, to the Southeastern United States, as well as some native species that are capable of growing at sufficiently high levels to substantially alter the environment.

Since the 1960s, the most abundant submersed macrophyte in mainstem TVA reservoirs has been Eurasian watermilfoil (*Myriophyllum spicatum*). This plant can grow densely at depths below minimum winter pool water levels or in shallow embayments where soil moisture prevents freezing and drying of the rootcrowns (Webb and Bates 1989).

Spinyleaf naiad (*Najas minor*) and hydrilla (*Hydrilla verticillata*) are submersed invasive aquatic plant species that are also prevalent in several mainstem reservoirs. Several other species of aquatic plants are either presently invasive within the TVA system or have the potential to be invasive based on examination of the species' reproductive modes or habitat requirements. Table 4.9-01 lists the invasive aquatic plants that occur or potentially could become established in the TVA reservoir system. The table groups the species based on the severity of their threat to TVA and on whether they are exotic or native. In some mainstem reservoirs, 80 to 90 percent of aquatic plant coverage includes invasive species. Several of the invasive or nuisance species in Table 4.9-01 are emergent species. While most of the emergents in the table occur in small populations, others such as alligatorweed, Uruguayan water-primrose, water smartweed, giant cutgrass, and American lotus grow in large colonies in several TVA mainstem reservoirs.

Aquatic plants, both invasive and non-invasive, can be beneficial to several aspects of water quality and to wildlife, waterfowl, and fisheries that depend on plant density and coverage. Floating-leaved plants and submersed vegetation provide sediment stabilization and food, shelter, and reproductive habitat for fish, insects, and other aquatic fauna. At the same time, aquatic plants at high densities can impede boating, marina, and dock operations; shoreline access; and water contact activities, such as swimming and water skiing. The presence of aquatic plants also provides habitat for mosquitoes.

Seasonal or cyclical changes in weather, water flow, nutrient cycling, and light availability are the factors that primarily affect the coverage of aquatic plants and aquatic invasive plants. Because these natural events and conditions can fluctuate widely, TVA cannot predict or control the effects of natural environmental factors on aquatic and invasive aquatic plant resources.

On the mainstem reservoirs, the natural environmental factors that affect aquatic plant growth and decline tend to surpass the effects of reservoir operational activities, which affect aquatic plant growth and decline predominantly by manipulation of water levels. For example, TVA has observed colonies of Eurasian watermilfoil within embayments on Guntersville Reservoir and found that they increase or decrease in size independently of one another despite similarities in topographic elevation, frequency, and duration of inundation and soil/sediment composition.

Although changes in reservoir operations may affect aquatic plant coverage, potential changes may not override the effects of the natural cycles on plant growth or decline. This is apparent upon reviewing the historical coverage data maintained by TVA from 1976 to 2002 (Table 4.9-02, Figure 4.9-01). Several years of drought during the mid-1980s led to increasing plant coverage on mainstem reservoirs systemwide, to a maximum of slightly over 46,000 acres in 1988. Several consecutive years of low flow due to reduced rainfall led to clear waters and increases in coverage. Unfavorable growing conditions during the flood years of 1989, 1990, and 1991 (such as high stream flows, high turbidity, cold winter temperatures, and an unusual phytoplankton bloom in 1990) resulted in a decrease of coverage to about 13,500 acres in 1991. This decrease was not clearly related to TVA reservoir operational changes and was considered to be a direct result of natural events.

Table 4.9-01 Invasive or Nuisance Aquatic Plants of Concern to TVA

Group	Common Name	Scientific Name
Highly invasive, exotic species–severely problematic to reservoir use	Eurasian watermilfoil [1]	*Myriophyllum spicatum*
	Hydrilla [1]	*Hydrilla verticillata*
	Spinyleaf naiad [1]	*Najas minor*
Moderately invasive, exotic species–nuisance at a small scale or have potential to be highly invasive in the future	Alligatorweed [4]	*Alternanthera philoxeroides* (Mart.) Griseb.
	Parrotfeather [1]	*Myriophyllum aquaticum*
	Purple loosestrife [4]	*Lythrum salicaria* and *Lythrum Virgatum*
	Common reed [4]	*Phragmites australis*
	Curly-leaf pondweed [1]	*Potamogeton crispus*
	Uruguayan water-primrose [4]	*Ludwigia uruguayensis*
	Floating waterhyacinth [3]	*Eichhornia crassipes*
	Asian spiderwort [4]	*Murdannia keisak*
	Yellow flag [4]	*Iris pseudacoris*
	Torpedograss [4]	*Panicum repens*
	Giant salvinia [3]	*Salvinia molesta*
	Brazilian elodea [1]	*Egeria densa*
	Water lettuce [3]	*Pistia stratoides*
	Hyek watercress [4]	*Rorippa nasturtium-aquaticum*
	Mint [4]	*Mentha piperata*
Invasive native plant species–generally considered beneficial species but sometimes reach nuisance levels	American lotus [4]	*Nelumbo lutea*
	Southern naiad [1]	*Najas guadalupensis*
	Coontail [3]	*Ceratophyllum demersum*
	American pondweed [2]	*Potamogeton nodosus*
	Water smartweed [4]	*Polygonum amphibium* var. *emersum*/ *Polygonum coccineum*
	Small pondweed [1]	*Potamogeton pusillus*
	Giant cutgrass [4]	*Zizaniopsis miliacea*
	Reed canary grass [4]	*Phalaris arundinacea*
	Muskgrass [1]	*Chara zeylandica*
	Fragrant water lily [2]	*Nymphaea odorata*
	Duckweeds [3]	*Lemna* spp., *Spirodela* sp.
	Water paspalum [4]	*Paspalum fluitans*
	Water primrose [4]	*Ludwigia peploides* var. *glabrescens*
	Canadian elodea [1]	*Elodea canadensis*

[1] Submersed.
[2] Floating-leaved.
[3] Free-floating.
[4] Emergent.

Source: Webb pers. comm.

Table 4.9-02 Aquatic Plant Coverage on TVA Mainstem Reservoirs (1976 to 2002)

Reservoir Category	Reservoir	1976		1977		1978		1979		1980		1981	
		Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]
Mainstem storage	Kentucky	200	TR	250	TR	300	TR	350	TR	400	TR	450	TR
Mainstem storage	Pickwick	0[4]	0	0	0	0	0	0	0	0	0	0	0
Mainstem run-of-river	Wilson	150	1	175	1	20	TR	5	TR	15	TR	30	TR
Mainstem storage	Wheeler	20	TR	20	TR	20	TR	100	TR	325	TR	758	1
Mainstem storage	Guntersville	6,700	10	6,800	10	6,493	10	7,708	11	10,200	15	14,441	21
Mainstem run-of-river	Nickajack	950	9	1,000	10	1,078	10	734	7	1,025	10	1,200	12
Mainstem storage	Chickamauga	125	TR	1,042	3	1,981	6	1,570	4	3,280	9	5,407	15
Mainstem storage	Watts Bar	10	TR	10	TR	10	TR	59	TR	125	TR	903	3
Tributary run-of-river	Melton Hill	182	3	175	3	113	2	261	5	200	4	396	7
Mainstem storage	Fort Loudoun	140	1	150	1	138	1	200	1	215	2	126	TR
Tributary storage	Tellico[4]	0	0	0	0	0	0	0	0	11	TR	20	1
Total		**8,477**		**9,622**		**10,153**		**10,987**		**15,796**		**23,731**	

Table 4.9-02 Aquatic Plant Coverage on TVA Mainstem Reservoirs (1976 to 2002) (continued)

Reservoir Category	Reservoir	1982		1983		1984		1985		1986		1987	
		Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]
Mainstem storage	Kentucky	1,478	1	1,633	1	1,633	1	316	TR	2,067	1	7,112	4
Mainstem storage	Pickwick	0	0	0	0	0	0	85	TR	231	1	121	TR
Mainstem run-of-river	Wilson	25	TR	25	TR	25	TR	25	TR	30	TR	30	TR
Mainstem storage	Wheeler	800	1	800	1	2,466	4	3,105	5	6,901	10	9,650	14
Mainstem storage	Guntersville	14,363	21	12,055	17	11,343	16	13,798	20	16,460	24	15,909	23
Mainstem run-of-river	Nickajack	1,150	12	1,150	12	1,166	12	1,166	11	1,485	14	1,200	11
Mainstem storage	Chickamauga	6,488	18	6,896	19	5,341	15	5,621	16	6,865	19	6,845	19
Mainstem storage	Watts Bar	712	2	1,334	3	547	1	405	1	450	1	613	2
Tributary run-of-river	Melton Hill	231	4	209	4	209	4	208	4	250	4	150	3
Mainstem storage	Fort Loudoun	135	TR	139	1	139	1	50	TR	130	1	50	1
Tributary storage	Tellico[4]	25	1	25	1	35	1	35	TR	150	TR	44	TR
Total		**25,407**		**24,266**		**22,904**		**24,814**		**35,019**		**41,724**	

Table 4.9-02 Aquatic Plant Coverage on TVA Mainstem Reservoirs (1976 to 2002) (continued)

Reservoir Category	Reservoir	1988		1989		1990		1991		1992		1993	
		Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[2]
Mainstem storage	Kentucky	6,145	4	5,718	4	2,106	1	2,813	2	2,616	2	3,467	2
Mainstem storage	Pickwick	120	TR	120	TR	25	TR	25	TR	105	TR	105	TR
Mainstem run-of-river	Wilson	30	TR	30	TR	30	TR	0	TR	5	TR	55	TR
Mainstem storage	Wheeler	9,843	14	5,991	9	1,981	3	3,462	5	4,412	6	6,597	10
Mainstem storage	Guntersville	20,242	29	14,166	21	7,891	12	5,166	7	5,993	8	7,613	11
Mainstem run-of-river	Nickajack	1,200	11	1,111	11	800	8	832	8	583	5	1,001	10
Mainstem storage	Chickamauga	7,455	21	3,492	10	2,127	6	680	2	387	1	1,186	3
Mainstem storage	Watts Bar	675	2	675	2	80	TR	10	TR	10	TR	10	TR
Tributary run-of-river	Melton Hill	150	3	150	3	100	2	240	2	240	2	240	2
Mainstem storage	Fort Loudoun	50	1	50	1	25	TR	25	TR	25	TR	25	TR
Tributary storage	Tellico[4]	103	1	941	6	368	3	340	3	228	2	246	2
Total		**46,013**		**32,444**		**15,533**		**13,593**		**14,604**		**20,545**	

Table 4.9-02 Aquatic Plant Coverage on TVA Mainstem Reservoirs (1976 to 2002) (continued)

Reservoir Category	Reservoir	1994		1995		1996		1997		1998		1999	
		Coverage (acres)[1]	% Area[2]	Coverage (acres)[1]	% Area[3]	Coverage (acres)[1]	% Area[3]	Coverage (acres)[1]	% Area[3]	Coverage (acres)[1]	% Area[3]	Coverage (acres)[1]	% Area[3]
Mainstem storage	Kentucky	415	TR	1,150	1	200	TR	150	TR	100	TR	100	TR
Mainstem storage	Pickwick	15	TR	15	TR	15	TR	15	TR	15	TR	60	TR
Mainstem run-of-river	Wilson	10	TR	10	TR	10	TR	10	TR	10	TR	10	TR
Mainstem storage	Wheeler	6,597	10	6,500	10	6,500	10	5,500	8	6,000	9	5,000	7
Mainstem storage	Guntersville	9,584	14	8,843	13	10,485	15	13,000	18	15,203	22	15,337	22
Mainstem run-of-river	Nickajack	1,001	10	600	6	900	9	800	8	850	8	1,377	13
Mainstem storage	Chickamauga	1,186	3	700	2	1,000	3	900	2	900	2	2,500	7
Mainstem storage	Watts Bar	10	TR	10	TR	10	TR	10	TR	10	TR	25	TR
Tributary run-of-river	Melton Hill	240	2	240	2	240	2	50	TR	5	TR	10	TR
Mainstem storage	Fort Loudoun	25	TR	25	TR	25	TR	25	TR	25	TR	25	TR
Tributary storage	Tellico[4]	246	2	240	2	240	2	240	2	100	1	125	1
Total		**19,329**		**18,333**		**19,625**		**20,700**		**23,218**		**24,569**	**50**

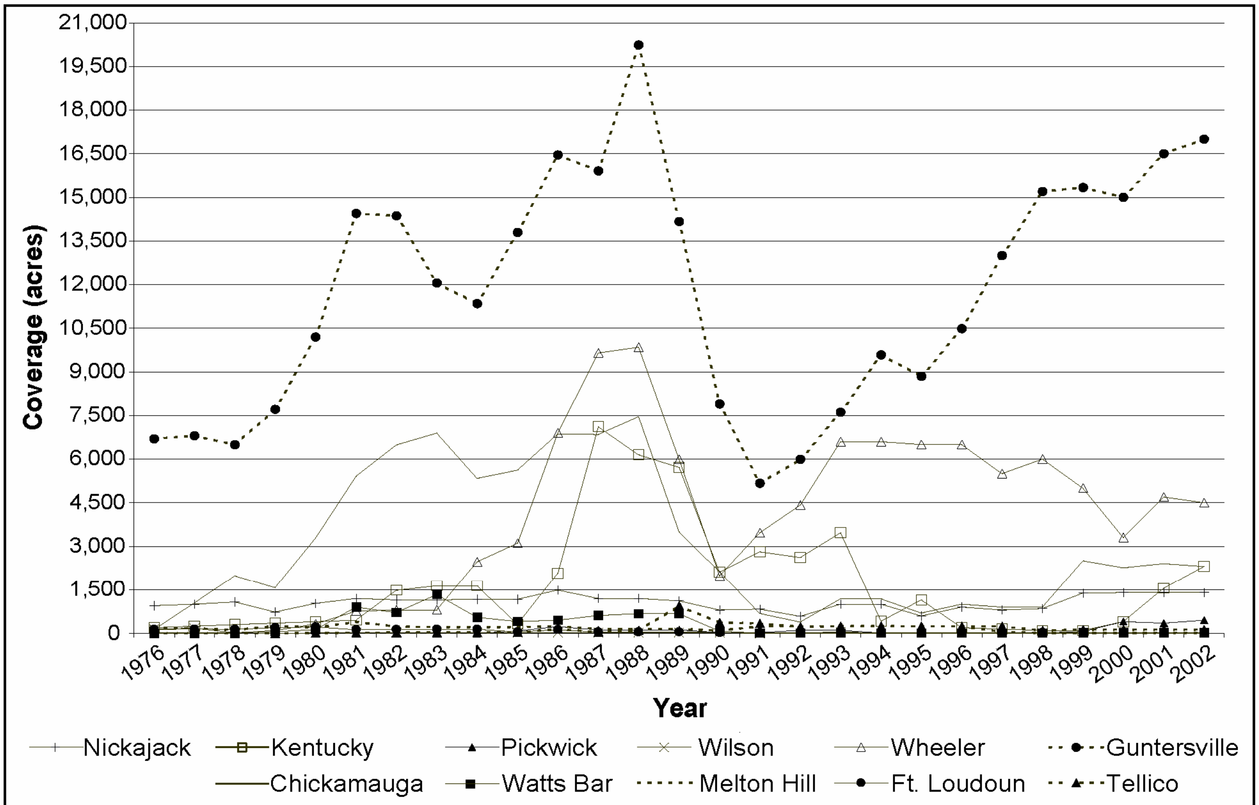
Table 4.9-02 Aquatic Plant Coverage on TVA Mainstem Reservoirs (1976 to 2002) (continued)

Reservoir Category	Reservoir	2000		2001		2002	
		Coverage (acres)[1]	% Area[3]	Coverage (acres)[1]	% Area[3]	Coverage (acres)[1]	% Area[3]
Mainstem storage	Kentucky	400	TR	1,550	1	2,300	2
Mainstem storage	Pickwick	400	2	350	2	450	2
Mainstem run-of-river	Wilson	10	TR	10	TR	10	TR
Mainstem storage	Wheeler	3,300	5	4,700	7	4,500	7
Mainstem storage	Guntersville	15,000	21	16,500	23	17,000	24
Mainstem run-of-river	Nickajack	1,400	13	1,400	13	1,400	13
Mainstem storage	Chickamauga	2,261	6	2,400	7	2,300	6
Mainstem storage	Watts Bar	25	TR	25	TR	25	TR
Tributary run-of-river	Melton Hill	10	TR	15	TR	15	TR
Mainstem storage	Fort Loudoun	25	TR	25	TR	25	TR
Tributary storage	Tellico[4]	125	1	125	1	125	1
Total		**22,956**		**27,100**		**28,150**	

Notes:

TR = Trace or less than 1 percent area.
0 = No or negligible plant coverage.

1 "Coverage" values are in acres and are based on data from the TVA Aquatic Plant Management Program (Webb pers. comm.).
2 Percent area for 1976 to 1995 was based on data from the TVA Aquatic Plant Management Program (TVA 1995, TVA 1994, Burns et al. 1983–1993).
3 Percent area for 1995 to 2001 was calculated by Normandeau based on data provided by TVA from the Aquatic Plant Management Program.
4 In the analysis, Tellico was treated as a mainstem storage reservoir because of its connection and similar operation with Fort Loudoun Reservoir.



Source: TVA data.

Figure 4.9-01 Aquatic Plant Coverage on TVA Mainstem Reservoirs (1976 to 2002)

Three representative mainstem and five tributary reservoirs and two tailwaters were selected for analysis to characterize the aquatic and invasive aquatic plant resources throughout the Tennessee River watershed. These representative reservoirs and tailwaters were chosen based on several factors, including data availability and similarity of operation to other mainstem and tributary reservoirs. The reservoirs selected were Kentucky (mainstem storage), Guntersville (mainstem storage), Chickamauga (mainstem storage), Douglas (tributary storage), Fort Patrick Henry (tributary run-of-river), Tims Ford (tributary storage), Chatuge (tributary storage), and South Holston (tributary storage). Available information for reservoirs other than those listed above was included in the data analyses where it assisted in creating a more complete assessment of the present status of aquatic plants in the region. Selected tailwaters included the Holston River downstream of Cherokee Reservoir and the French Broad River downstream of Douglas Reservoir. These river stretches were chosen because the best documented data on riverine aquatic plant communities were available for them.

4.9.2 Regulatory Programs and TVA Management Activities

Regulatory Programs

Executive Order 13112—Invasive Species (National Invasive Species Council 1999) requires federal agencies to: (1) prevent the introduction of invasive species, (2) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner, (3) monitor invasive species populations accurately and reliably, and (4) provide for restoration of native species and habitat conditions in ecosystems that have been invaded. TVA's Aquatic Plant Management Program supports compliance with Executive Order 13112.

TVA Management Activities

Aquatic plant populations have become large enough on several TVA mainstem reservoirs to interfere with multiple uses of the reservoirs. TVA initially tried to eradicate aquatic plants such as Eurasian watermilfoil with large-scale herbicide applications. Since the 1970s, however, TVA's Aquatic Plant Management Program has limited management efforts to control only excessive infestations of aquatic plants in areas subject to the greatest public and private use. This approach allows for a balance between meeting the desires of stakeholder groups for aquatic plant control in developed shoreline areas and preserving the ecological benefits of aquatic plants with a minimum of conflict. On Guntersville Reservoir, for example, TVA manages only between 5 and 10 percent of total vegetation cover by herbicide application and mechanical harvesting.

The Aquatic Plant Management Program coupled fall and winter drawdowns with carefully applied herbicides for a majority of their vegetation management efforts (TVA 1993). Because of growth from seed and recolonization of the drawdown zone by vegetative fragments of Eurasian watermilfoil, hydrilla, and other species, herbicides were required to suppress aquatic plants in near-shore areas during summer. TVA has also used biological control methods, such as the single stocking of Guntersville Reservoir with sterile grass carp (*Ctenopharyngodon idella*) in 1990. In selected reservoirs, TVA manages plants on a smaller scale according to reservoir-specific aquatic plant management plans developed by local stakeholder groups. Management methods include application of herbicides in near-shore areas along developed shoreline and the use of mechanical harvesters to cut and maintain access lanes.

4.9.3 Coverage of Aquatic Plants

Mainstem Reservoirs

Existing Conditions

In both storage and run-of-river mainstem reservoirs, common groups of vegetation are found due to similarities among the reservoirs relative to configuration (their width and area), depth, water level fluctuation, and substrate. Much of the vegetation of these reservoirs occurs in embayments, overbanks, and shallow cove areas.

In a majority of the storage mainstem reservoirs, submersed/ floating-leaved plant communities that are dominated by annual species colonize the drawdown zone; this zone is exposed and dewatered during late fall and winter (Figure 4.9-02). Eurasian watermilfoil, hydrilla, and coontail are invasive species that can invade the drawdown zone when water levels come up in late spring and early summer or colonize areas that remain wet or inundated during fall and winter.

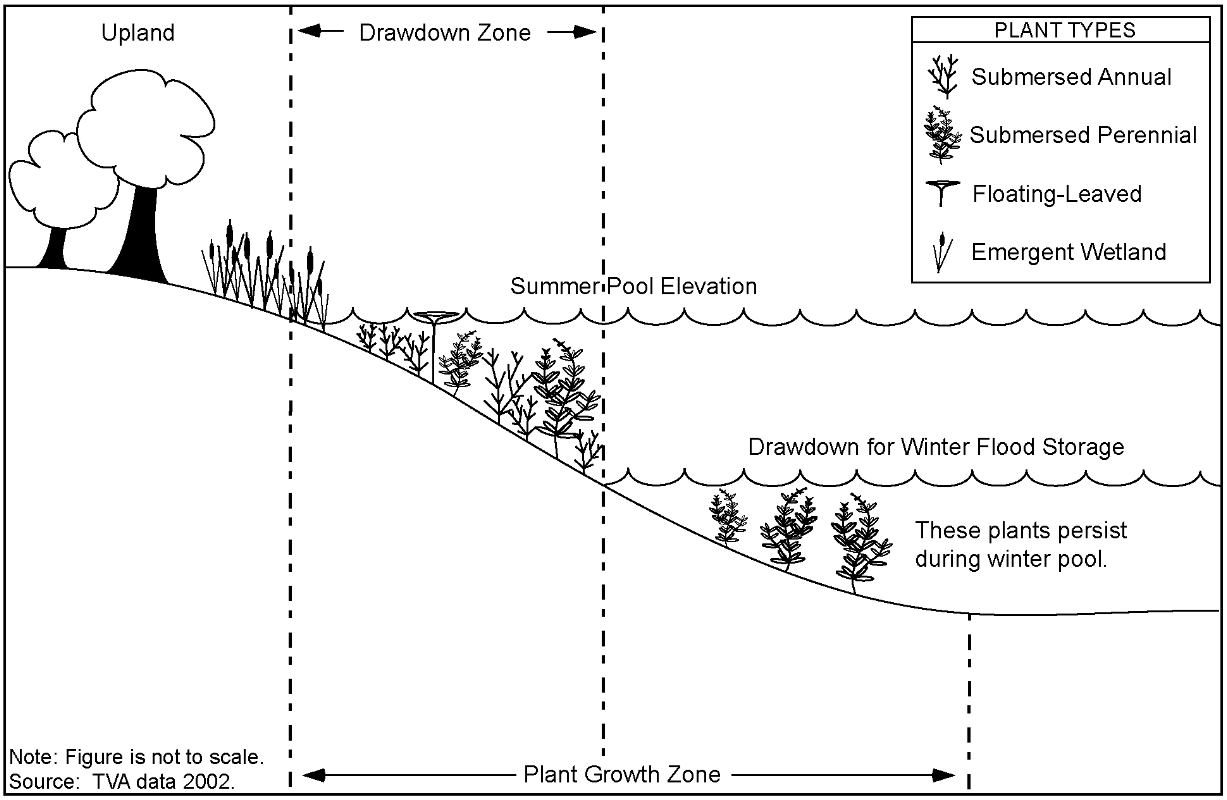


Figure 4.9-02 Generalized Diagram of Aquatic Plant Zones in a TVA Mainstem Storage Reservoir

Run-of-river mainstem reservoirs do not have a winter drawdown zone. Water levels generally fluctuate daily for hydrogeneration and slightly from season to season based on natural factors, primarily rainfall, that affect the water level in the Tennessee River. This allows for a mix of submersed/floating-leaved annual (naiads, some pondweeds, and muskgrass) and perennial species (Eurasian watermilfoil, hydrilla, and some pondweeds). Total aquatic plant coverage on run-of-river reservoirs is generally less than on most storage reservoirs because of their smaller size and lack of numerous large, shallow embayments. Like the storage mainstem reservoirs, aquatic plant coverage on run-of-river mainstem reservoirs fluctuates with climatic conditions, but the decline in the early 1990s was not as large as on most of the storage mainstem reservoirs.

Table 4.9-03 containes a list of typical aquatic plant species found in mainstem reservoirs.

Table 4.9-03 Submersed, Floating-Leaved, and Free-Floating Aquatic Plant Species on TVA Mainstem Reservoirs

Common Name	Scientific Name
Eurasian watermilfoil[1, 3]	*Myriophyllum spicatum*
Hydrilla[1, 3]	*Hydrilla verticillata*
Southern naiad[1, 3]	*Najas guadalupensis*
Spinyleaf naiad[1, 3]	*Najas minor*
Small pondweed[1, 3]	*Potamogeton pusillus*
Coontail [1, 5]	*Ceratophyllum demersum*
Muskgrass[1, 3]	*Chara zeylandica*
American pondweed[1, 4]	*Potamogeton nodosus*
Waterthread pondweed[2, 4]	*Potamogeton diversifolius*
Horned pondweed[2, 3]	*Zannichellia palustris*
Water stargrass[2, 3]	*Heteranthera dubia*
Canadian elodea[2, 3]	*Elodea canadensis*
Curly-leaf pondweed[1, 3]	*Potamogeton crispus*
Brazilian elodea[2, 3]	*Egeria densa*
Sago pondweed[2, 3]	*Potamogeton pectinatus*
Eelgrass[2, 3]	*Vallisneria americana*
Parrotfeather[2, 3]	*Myriophyllum aquaticum*
Ribbonleaf pondweed[2, 4]	*Potamogeton epihydrus*
Tennessee pondweed[2, 4]	*Potamogeton tennesseensis*
Fanwort[2, 4]	*Cabomba caroliniana*
Duckweeds[1, 5]	*Lemna* spp., *Spirodela* sp.
Mosquito fern[2, 5]	*Azolla caroliniana*

[1] Common in several reservoirs.
[2] Uncommon or only in a few reservoirs.
[3] Submersed.
[4] Floating-leaved.
[5] Free-floating.

Sources: Webb and Bates 1989, TVA data.

Future Trends

A review of total coverage of plants for each year from 1976 to 2002 (Table 4.9-02) reveals that, overall, plant acreage increased gradually from approximately 8,500 acres in 1976 to a maximum coverage of slightly over 46,000 acres in 1988 (Burns et al. 1991), then declined to about 13,500 acres in the early 1990s. Acres of plant coverage have been slowly increasing since then, but in 2002 were 60 percent of the maximum levels of the late 1980s, which can be attributed to natural variability as previously discussed. Aquatic plant coverage is expected to continue to fluctuate based on natural conditions, predominately rainfall.

Tributary Reservoirs

Existing Conditions

Most tributary reservoirs are located in mountainous areas and are characterized by steep shorelines and compacted substrate. Storage tributary reservoirs have larger winter drawdowns than mainstem reservoirs. Natural changes in the hydrologic cycle result in annual fluctuations in water elevations and durations of inundation on these reservoirs. Summer pool levels are not always met in some dry years, and water elevations decline earlier in a dry year than in normal and wet years. This wide fluctuation leads to a drawdown zone that is less habitable for plants than on the mainstem reservoirs and, in combination with the steep shorelines and compacted substrate, creates an environment in which little or no submersed or floating-leaved aquatic vegetation exists.

Run-of-river tributary reservoirs have fairly stable water levels that fluctuate a few feet on a daily basis for hydropower generation and slightly from season to season based on natural factors, primarily rainfall, that affect the water level in the corresponding tributary. These reservoirs also often contain an inhospitable environment for aquatic plants due to sloping and substrate challenges.

In locations where rivers or tributary streams enter the reservoirs—or along the upstream portions of backwater embayments, coves, and sloughs—substrate types and soil moisture are adequate to support aquatic plants. When present, typical aquatic species include American pondweed, spinyleaf naiad, and the emergent water smartweed.

Future Trends

Unlike the mainstem reservoirs, data are not collected annually for the tributary reservoirs, largely due to the lack of submersed and floating-leaved plants on tributary reservoirs. Overall trends of drought and flood that have affected the mainstem reservoirs probably have similarly affected the tributary reservoirs but on a much smaller scale due to the limited coverage of vegetation. Variation of natural factors will continue to influence the future trends related to coverage of aquatic plants and aquatic invasive plants in tributary reservoirs. Drought years can result in decreasing coverage due to dewatering of suitable habitat, while high rainfall years can result in increasing or decreasing coverage, depending on the species colonizing the reservoirs and the extent of the rainfall (which influences water elevation and duration).

Tailwaters

Existing Conditions

Aquatic riverine plants in the Tennessee River watershed are mostly rooted species that occur in cobble/gravel shoals. With a few exceptions (for example, the Holston River below Cherokee Dam), plant communities are dominated by native species. Aquatic plants are most abundant in quiet stretches where the slowing current has allowed fine sediments to deposit (Haslam and Wolseley 1978). The exceptions are species that can attach to rocks, such as riverweed; or species that efficiently utilize niches of fine sediments in bedrock, cobble, and gravel to gain a root hold in moderate current (for example, several of the pondweeds and eelgrass). The deeper pools with a sand and silt bottom are mostly unvegetated. See Table 4.9-04 for examples of aquatic plants observed in various rivers of the Tennessee Valley.

Future Trends

Data are not available concerning trends in coverage of riverine plants of the Tennessee Valley. Aquatic plant coverage in tailwaters is expected to continue to fluctuate based on natural conditions, predominately rainfall.

Table 4.9-04 Submersed and Floating-Leaved Aquatic Macrophytes Occurring along Rivers of the Tennessee River System

Scientific Name	Common Name	Duck	Elk	Clinch	French Broad	Holston[1]	Hiwassee	Little Tennessee[2]
Callitriche heterophylla	Water starwort		■			■		■
Elodea canadensis	Canadian elodea	■		■		■		
Heteranthera dubia	Water stargrass	■		■	■	■		
Isoetes macrospora	Large quillwort						■	■
Myriophyllum spicatum	Eurasian watermilfoil		■			■		
Podostemum ceratophyllum	Riverweed	■	■		■		■	■
Potamogeton amplifolius	Large-leaved pondweed							■
Potamogeton crispus	Curly-leaf pondweed			■	■	■		
Potamogeton diversifolius	Waterthread pondweed				■			■
Potamogeton epihydrus	Ribbonleaf pondweed						■	■
Potamogeton foliosus	Leafy pondweed	■	■		■	■		■
Potamogeton nodosus	American pondweed	■		■	■	■		■
Potamogeton pectinatus	Sago pondweed			■		■		
Potamogeton pulcher	Spotted pondweed						■	
Potamogeton pusillus	Small pondweed							■
Potamogeton tennesseensis	Tennessee pondweed						■	■
Vallisneria americana	Eelgrass			■		■		
Zannichellia palustris	Horned pondweed		■	■		■		

[1] Includes the North and South Forks of the Holston River.
[2] Most of downstream portion is now impounded (Tellico Reservoir).

Source: Webb and Bates 1989.

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4.10 Terrestrial Ecology

4.10.1 Introduction

The terrestrial ecology of the Tennessee River Valley is unique in its diversity. Braun (1950) recognized four forest regions in the Valley: oak-chestnut, mixed mesophytic, western mesophytic, and oak-pine. Approximately 60 species of reptiles, 70 species of amphibians, 180 species of breeding birds, and 60 species of mammals occur in these forested regions and other habitats throughout the Valley (adapted from Ricketts et al. 1999).

Resource Issues

- Distribution and species composition of lowland plant communities
- Distribution and species composition of upland plant communities
- Diversity and abundance of associated wildlife communities
- Shorebirds and waterfowl

The area of the Tennessee River system within 0.25 mile of reservoir shorelines was the study area for terrestrial ecology, since this zone contains several plant and animal communities that depend on or are otherwise associated with existing reservoir conditions. Vegetative communities of the Valley can be grouped into two broad categories: lowland and upland. Lowland communities are associated with creeks, streams, rivers, and reservoirs and are most likely to be influenced by changes in reservoir operations. Upland communities include all other communities lacking an aboveground hydrologic connection to a waterbody. These areas are typically situated at or above maximum summer pool levels.

Many plant communities, such as bottomland hardwood forest, scrub/shrub wetlands, and flats are widespread in the Valley. Changes in the elevation, duration, and timing of flooding of lowland communities may affect their distribution and species composition. Upland communities may be affected by loss of shoreline from erosion, conversion of land to residential development, and changes in groundwater levels.

Changes in the reservoir operations policy could affect the:

- Distribution and species composition of lowland communities;
- Distribution and species composition of upland communities;
- Diversity and abundance of associated wildlife communities; and,
- Shorebirds and waterfowl.

Throughout the Valley and surrounding region, the primary threats to plant and animal communities are loss of habitat and the introduction of invasive exotic species (Stein et al. 2000). As human populations and associated development have increased throughout the region, many communities have become increasingly rare. More than 30 percent of all ecological communities throughout the Southeast are considered imperiled or critically imperiled on a global scale (Stein et al. 2000). Globally imperiled wetland plant communities that are known from or with potential to occur in the study area are listed in Tables 4.10-01 and 4.10-02, respectively.

Wildlife dependent on flats, wetlands, or other lowland community types would potentially be affected by the proposed changes in reservoir operations. These groups of wildlife contain a variety of migratory waterfowl, wading birds, shorebirds, songbirds, and other non-game animals—including reptiles, amphibians, and small mammals. (See Section 4.14, Managed Areas and Ecologically Significant Sites, for discussions about bird-watching.)

4.10.2 Regulatory Programs and TVA Management Activities

Regulatory Programs

Federal legal authorities that apply to the terrestrial ecology on TVA lands and reservoirs include the Migratory Bird Treaty Act of 1918 and Executive Order 13186—Responsibilities of Federal Agencies to Protect Migratory Birds. The Migratory Bird Treaty Act decreed that all migratory birds and their parts (including eggs, nests, and feathers) are fully protected. Executive Order 13186 requires federal agencies implementing or planning actions that could affect migratory birds and their habitats to “support the conservation intent of the migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities and by avoiding or minimizing, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions.” The executive order requires federal agencies whose actions may negatively affect migratory birds to develop memoranda of understanding with the USFWS to promote migratory bird conservation.

Generally, these legal authorities establish policies for the conservation of all native birds of the United States, except species that are managed by the states, such as northern bobwhite (*Colinus virginianus*) and wild turkey (*Meleagris gallopavo*). Furthermore, state and federal agencies provide for planned management activities designed to protect and enhance natural resources along the reservoir system (see Section 4.14, Managed Areas and Ecologically Significant Sites).

TVA Management Activities

TVA uses a variety of land management activities to identify and protect natural resources on TVA lands. TVA’s Regional Natural Heritage Program maintains a database to track populations of rare and protected plants and animals and significant natural areas throughout the TVA Power Service Area. Once significant populations of protected species are identified on TVA lands, TVA actively monitors these populations of rare plants and animals and takes actions to conserve them.

Table 4.10-01 Globally Imperiled Wetland Plant Communities Known to Occur in the Study Area

Common Name	Global Rank[1]
Appalachian montane alluvial forest: sycamore–tuliptree–(yellow birch, sweet birch)/smooth alder–mountain doghobble forest	G2U
Beech-mixed hardwood floodplain forest: American beech–oak species–red maple–black walnut forest	G2G3
Eastern Highland Rim rich floodplain terrace forest: sweetgum–swamp chestnut oak–kingnut hickory/American beech–(yellow buckeye) forest	G2G3Q
Maple-hickory mesic floodplain forest: sugar maple–bitternut hickory/common pawpaw floodplain forest	G2
Swamp forest-bog complex (typic type): eastern hemlock–red maple–(tuliptree, blackgum)/great rhododendron/peatmoss species forest	G2
Floodplain canebrake: giant cane shrubland	G2U
Cumberland Plateau rockhouse: cave alumroot–rockhouse meadowrue–(rockhouse white snakeroot, rockhouse goldenrod) herbaceous vegetation	G2
Cumberland Plateau wet sandstone cliff: cinnamon fern–northern beaksedge–rockhouse meadowrue Cumberland seepage cliff herbaceous vegetation	G1G2Q
Cumberland River limestone seep cliff: southern maidenhair–false nettle–great blue lobelia herbaceous vegetation	G2G3
Duck River scour prairie: big bluestem–river-oats–willowleaf bluestar herbaceous vegetation	G2G3
Hiwassee/Ocoee bedrock scour vegetation: little bluestem–chairmaker's bulrush–grassleaf rush–late thoroughwort herbaceous vegetation	G2
Limestone seep glade: flat spikerush–yellow sunnybell–crawe's sedge–nodding onion herbaceous vegetation	G2U
Limestone glade streamside meadow: leafy prairie-clover–axil-flower–caribbean miterwort herbaceous vegetation	G2U

[1] Global rank definitions:

- G1 = Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction.
- G2 = Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction or elimination.
- G3 = Vulnerable globally either because very rare and local throughout its range, found only in restricted range (even abundant in some locations), or because of other factors making it vulnerable to extinction or elimination.

Qualifiers:

- U = Unranked (current rank is tentative, global rank not yet assessed).
- Q = Questionable taxonomy that may reduce conservation priority.

Source: NatureServe Explorer 2001.

Table 4.10-02 Globally Imperiled Wetland Plant Communities not Known but with Potential to Occur in the Study Area

Common Name	Scientific Name	Global Rank[1]	Distribution in United States[2]	Expected Distribution in Study Area	
				Associated Habitat	Physiographic Region
Forests					
Interior forested acid seep: Carolina red maple–blackgum/wild azalea–southern wild raisin/netted chainfern forest	*Acer rubrum* var. *trilobum–Nyssa sylvatica/ Rhododendron canescens–Viburnum nudum* var. *nudum/ Woodwardia areolata*	G2G3	IL*, KY, TN	Floodplains, seeps	Coastal Plain
Montane floodplain slough forest: Carolina red maple–green ash/fringed sedge–green arrow-arum forest	*Acer rubrum* var. *trilobum–Fraxinus pennsylvanica/Carex crinita–Peltandra virginica*	G1	NC	Floodplains	Blue Ridge
Pin oak – post oak lowland flatwoods: pin oak–(post oak)–cherrybark oak/ quillwort species forest	*Quercus palustris*–(*Quercus stellata*)–*Quercus pagoda/ Isoetes* spp.	G2G3	AR*, IL, IN, KY*, MO, TN*	Floodplains	Highland Rim, Coastal Plain
Upland sweetgum – red maple pond: sweetgum–red maple/sedge species–peatmoss species forest	*Liquidambar styraciflua–Acer rubrum*/*Carex* spp.–*Sphagnum* spp.	G2Q	AL, GA, NC, TN	Upland depressions, floodplains, seeps	Blue Ridge
Water tupelo sinkhole pond swamp: water tupelo/ buttonbush pond forest	*Nyssa aquatica/ Cephalanthus occidentalis*	G1U	AR, MO, TN*	Upland depressions	Highland Rim
White oak sandstone ridgetop depression forest: white oak–blackgum sandstone ridgetop depression forest	*Quercus alba–Nyssa sylvatica*	G2U	AL, TN*	Upland depressions, vernal pools	Cumberland Plateau
Scrub/Shrub Vegetation					
Southern Appalachian bog (rhododendron type): great rhododendron/ peatmoss species shrubland	*Rhododendron maximum*/*Sphagnum* spp.	G2G3Q	NC, TN, VA	Seeps, floodplains of small streams	Blue Ridge

Table 4.10-02 Globally Imperiled Wetland Plant Communities not Known but with Potential to Occur in the Study Area (continued)

Common Name	Scientific Name	Global Rank[1]	Distribution in United States[2]	Expected Distribution in Study Area	
				Associated Habitat	Physiographic Region
Herbaceous Vegetation					
Cumberland sandstone flatrock glade: elf orpine–smooth sandwort sandstone herbaceous vegetation	*Diamorpha smallii–Minuartia glabra*	G2G3	AL*, GA*, TN	Glades (sandstone)	Nashville Basin
Floodplain pool: green arrow-arum–lizard's-tail–fringed sedge/tree moss herbaceous vegetation	*Peltandra virginica–Saururus cernuus–Carex crinita/ Climacium americanum*	G2U	DE*, MD*, NC, NJ*, TN*, VA	Floodplains, seeps	Blue Ridge
Kentucky prairie cordgrass marsh: prairie cordgrass western Kentucky herbaceous vegetation	*Spartina pectinata*	G1Q	KY, TN*	Seeps, wet prairies	Highland Rim
Midwest acid seep: fringed sedge–royal fern species/peatmoss species herbaceous vegetation	*Carex crinita–Osmunda* spp./ *Sphagnum* spp.	G2G3	AR, IL, IN, KY*, MO, OH*, TN	Seeps, headwaters of small ravines	Highland Rim, Coastal Plain
Southern Appalachian acid seep: fowl mannagrass–mountain fringed sedge–white turtlehead–purple-stem aster/peatmoss species herbaceous vegetation	*Glyceria striata–Carex gynandra–Chelone glabra–Symphyotrichum puniceum/Sphagnum* spp.	G2G3	AL*, GA, NC, SC*, TN	Seeps	Blue Ridge

[1] Global rank definitions:

- G1 = Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction.
- G2 = Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction or elimination.
- G3 = Vulnerable globally either because very rare and local throughout its range, found only in restricted range (even abundant in some locations), or because of other factors making it vulnerable to extinction or elimination.

Qualifiers:

- U = Unranked (current rank is tentative, global rank not yet assessed).
- Q = Questionable taxonomy that may reduce conservation priority.

[2] Distribution as reported by NatureServe. Asterisks (*) indicate that the presence of this community type is unconfirmed in that state.

Source: NatureServe Explorer 2001.

4.10.3 Lowland Plant Communities

Existing Conditions

Tables 4.10-01 and 4.10-02 present the names, global ranks, and distribution of the imperiled lowland communities known to occur or with potential to occur in the study area. Although specific locations have not been identified in the study area for some imperiled wetland plant communities, Table 4.10-02 provides information on the expected distribution of these communities, including the associated habitat and physiographic region.

Bottomland hardwood forests occur in floodplains as well as along terraces, natural levees, and back-lying sloughs associated with reservoirs. Representative tree species found in these forests are listed in Table 4.10-03. Five globally imperiled floodplain forest communities are known from the study area. Four other globally imperiled floodplain or riparian communities are not known from the study area but could occur there. More detailed information on lowland plant communities can be found in Appendix D5, Terrestrial Ecology.

Table 4.10-03 Representative Tree Species Found in Bottomland Hardwood Forests

Common Name	Scientific Name
Bald cypress	*Taxodium distichum*
Black gum	*Nyssa sylvatica*
Black willow	*Salix nigra*
Box elder	*Acer negundo*
Cottonwood	*Populus deltoides*
Green ash	*Fraxinus pennsylvanica*
Hackberry	*Celtis occidentalis*
Red maple	*Acer rubrum*
River birch	*Betula nigra*
Silver maple	*Acer saccharinum*
Sugarberry	*Celtis laevigata*
Sweet gum	*Liquidambar styraciflua*
Sycamore	*Platanus occidentalis*
Water oak	*Quercus nigra*
Water tupelo	*Nyssa aquatica*
White oak	*Quercus alba*
Willow oak	*Quercus phellos*

Scrub/shrub and herbaceous communities also occur in floodplains, terraces, and other saturated to temporarily flooded riparian habitats. Tree and shrub species commonly occurring in these habitats are listed in Table 4.10-04. Three globally imperiled riparian plant communities occur in the study area. A globally imperiled herbaceous community (the floodplain pool) potentially occurs in the Blue Ridge Physiographic Region.

Reservoir flats occur in the drawdown zone between maximum summer and minimum winter pool elevations. These habitats tend to be dominated by plant species capable of completing their life cycle between the start of each annual winter drawdown and frost (Webb et al. 1988, Amundsen 1994). Table 4.10-05 lists representative plant species found on reservoir flats. No globally imperiled plant communities are known to be associated with reservoir flats in the study area.

Table 4.10-04 Representative Tree and Shrub Species Found in Scrub/Shrub Wetlands

Common Name	Scientific Name
Black willow	*Salix nigra*
Box elder	*Acer negundo*
Buttonbush	*Cephalanthus occidentalis*
Green ash	*Fraxinus pennsylvanica*
Red maple	*Acer rubrum*
Silky dogwood	*Cornus amomum*
Silver maple	*Acer saccharinum*
Smooth alder	*Alnus serrulata*
Swamp loosestrife	*Decodon verticillatus*
Swamp rose	*Rosa palustris*
Sycamore	*Platanus occidentalis*
Virginia willow	*Itea virginica*
Water hemlock	*Cicuta maculata*

Table 4.10-05 Representative Plant Species Found on TVA Reservoir Flats

Common Name	Scientific Name
Amazon sprangletop	*Leptochloa panicoides*[1]
Blunt spike rush	*Eleocharis obtuse*
Bosc's mille graines	*Oldenlandia boscii*[1]
Clustered mille graines	*O. uniflora* [1]
Grassleaf mudplantain	*Heteranthera dubia*[1]
Grasslike fimbry	*Fimbristylis miliacea*[1,2]
Lowland rotala	*Rotala ramosior*
Slender fimbry	*Fimbrystylis fallalis*
Smallflower halfchaff sedge	*Hemicarpha micrantha*
Teal love grass	*Eragrostis hypnoides*
Vahl's fimbry	*F. vahlii*[1]
Valley redstem	*Ammania coccinea*
Variable flatsedge	*Cyperus difformis*[1,2]
White-edge flatsedge	*Cyperus albomarginatus*[1]
Yellowseed false pimpernel	*Lindernia dubia*

[1] In the Tennessee Valley, the distribution of this species is essentially restricted to the TVA reservoir flats.
[2] This species is not native to the Tennessee Valley.

Source: Webb et al. 1988.

Seeps, springs, and temporary ponds are often characterized by herbaceous wetland vegetation. Although specific locations have not been identified in the study area, four globally imperiled plant communities associated with these habitats potentially occur in the study area.

Future Trends

Existing and future trends in lowland communities in the Valley mirror the existing and future trends of wetland systems because the lowland communities depend on the functioning of wetland systems (refer to Section 4.8, Wetlands).

4.10.4 Upland Plant Communities

Existing Conditions

Most land within 0.25 mile of reservoir shorelines is dominated by hardwood forest communities. Reservoir levels sufficiently influence adjacent groundwater to affect some upland plant communities near reservoirs. Needle-leaved forests occupy relatively small areas within 0.25 mile of the reservoirs in the system, and a substantial amount of this forestland type has been converted to agricultural use.

Glades and barrens are upland habitats that have been, in some cases, flooded or encroached on by reservoirs. Two globally imperiled wetland plant communities associated with glades are known to occur in the study area, and a third could occur in the study area. Seepage areas associated with rock shelters or bluffs also support uncommon plant communities. Three globally imperiled wetland plant communities are known to occur in association with such habitats in portions of the study area. More detailed information on the upland plant communities can be found in Appendix D5, Terrestrial Ecology.

Upland depressions, including those associated with seeps, springs, and vernal pools, can be connected to the reservoir system via groundwater systems. None of the globally imperiled wetland plant communities reported from the seven Valley states are currently known to occur in these habitats in the study area, but seven globally imperiled plant communities have potential to occur in these habitats in the study area.

Future Trends

The existing trend for the region is toward degradation or loss of natural plant communities. This trend is expected to continue because of two principal factors: increase in human population and increase in invasive exotic species. Increased human population results in corresponding increases in development (for example, housing, schools, hospitals, roads, and utility corridors). This development results in an overall loss of natural vegetation or conversion of these habitats into lawns, roadsides, and fences rows. Development also often results in the introduction and spread of invasive exotic species and the degradation or loss of species diversity in existing natural communities (see Section.4.11, Invasive Plants and Animals).

4.10.5 Wildlife Communities

Existing Conditions

The diversity of plant communities throughout the Valley results in comparably diverse wildlife communities. Distribution of habitats, food availability, surrounding land use, and other limiting factors also influence the diversity and abundance of these wildlife communities in the study area. More detailed information on wildlife communities can be found in Appendix D5, Terrestrial Ecology. In most cases, the highest diversity of wildlife occurs at the interface of high-quality wildlife habitats and a waterbody in the reservoir system. Potential changes in bottomland hardwood forests, scrub/shrub wetlands, emergent wetlands, aquatic vegetation, flats, and other communities potentially affected by reservoir levels affect terrestrial wildlife populations.

Historically, pesticide use, wildlife management activities, human development, and creation of the reservoir system have influenced the distribution of animal populations throughout the Valley. In general, gulls, wading birds, waterfowl, raptors, game birds, mammals, reptiles, and amphibians are exhibiting stable or increasing numbers throughout the Valley. However, many individual species in these groups are decreasing in number—along with some members of other animal groups like shorebirds and Neotropical songbirds.

Several habitat types in the Valley, including riparian forests, exposed flats, vernal pools, wetlands, and river islands, are essential to wildlife for foraging, migration, and reproduction. Migrating and resident waterfowl, shorebirds, gulls, and wading birds use these habitats year round. Riparian forests, primarily bottomland hardwoods, have been ranked among the highest priority of areas that provide optimal habitat for wildlife such as Neotropical songbirds (Hunter et al. 1993). Shallow water with emergent vegetation, overhanging banks, exposed sandbars, and rotting wood along the shoreline provide vital nesting and basking habitat for non-game animals such as turtles and snakes. Semi-aquatic mammals, such as muskrat (*Ondatra zibethicus*), beaver (*Castor canadensis*), and river otter (*Lontra canadensis*), also use these habitats for foraging and shelter.

Shorebirds forage in moist drawdown zones along the reservoirs seasonally; concentrations are highest during fall migrations. Flats, isolated pools, and shallow water habitats are created by reservoir drawdowns. On many TVA reservoirs, these habitats are usually available in early August, and their availability often coincides with the peak of the fall migration. Flats are important to shorebirds as they forage in these areas to build fuel reserves necessary to migrate to their wintering grounds. The slowly receding waters result in large, open areas of shallow water and moist, exposed flats critical for foraging and resting. Kentucky and Douglas Reservoirs contain excellent examples of these habitats. Flats on Wheeler and Pickwick Reservoirs are also used by shorebirds but to a lesser extent as current operations on these reservoirs limit the availability of flats to the latter part of fall migration.

During fall and winter, a mixture of water depths, wetlands, riparian vegetation, aquatic macrophytes (aquatic plants that include aquatic vascular plants, a few mosses, and macroscopic algae [see Section 4.9, Aquatic Plants]), shallow flooded overbanks, and agricultural fields provide valuable habitat to large aggregations of waterfowl on TVA reservoirs. Vegetated flats provide foraging habitat for geese and ducks on several reservoirs (most notably Kentucky and Pickwick) during winter. Therefore, summer drawdowns—which allow flats to be exposed for vegetation development before the end of the growing season—benefit waterfowl. The largest aggregations of waterfowl and shorebirds are most notable on mainstem reservoirs such as Kentucky, Wheeler, Guntersville, Chickamauga, and Watts Bar, and tributary reservoirs such as Douglas Reservoir. These reservoirs are surrounded by a variety of state and federal wildlife refuges that actively support migrating waterfowl and shorebirds. Many of these wildlife refuges operate dewatering projects, which provide resources that are important to these migratory birds.

During winter, large concentrations of gulls roost and forage in the vicinity of several TVA hydropower dams. These aggregations are most notable at Kentucky, Pickwick, and Wilson Dams. Flats on reservoirs are also important roost sites for gulls and other shorebirds. Overall, use of the reservoirs by migratory birds varies throughout the year and largely depends on weather patterns, dynamics of bird populations, and water levels.

Southern Appalachian forests support some of the richest diversity of birds in North America (Simons et al. 1998). Drier upland habitats often contain a lower diversity of wildlife species than lowland moist habitats like those found in the riparian zone along the Tennessee River. Several animal species associated with upland habitats rely on lowlands for food, refuge, reproduction habitat, and migration routes. Features important to birds and other wildlife that occur in upland habitats include bluffs, caves, and other rock-dominated areas.

Future Trends

Future trends in wildlife populations are expected to mirror existing trends. Adaptable species should continue to thrive, while species that depend on habitats susceptible to development and degradation are likely to continue to decline.

4.11 Invasive Plants and Animals

4.11.1 Introduction

Resource Issues
▶ Population abundance and spread of invasive terrestrial and aquatic animals and terrestrial plants

Changes in the reservoir operations policy may affect population abundance and spread of invasive terrestrial and aquatic animals and terrestrial plants. Changes in land use can influence the abundance and spread of both invasive terrestrial animals and plants. Changes in water quality, elevation, and flow can influence the abundance and spread of invasive aquatic animal species. Invasive aquatic plants are covered in Sections 4.9 and 5.9, Aquatic Plants.

The study area for this topic included a zone of 1 mile from the reservoirs and tailwaters, because any impacts from the policy alternatives would be evident within this zone.

The invasive terrestrial and aquatic animals and terrestrial plants with the potential to occur in the Valley were determined based on discussions with TVA staff; the list of priority invasive species identified by TVA; and other federal and state invasive species lists—including state invasive plant lists from Exotic Pest Plant Councils for Tennessee, Kentucky, and North Carolina. Only terrestrial plant species within the Valley categorized as "severe threat" on any available state invasive plant lists were evaluated. The invasive aquatic animals considered in this document are being tracked as invasive nuisances in the Valley.

The present status of invasive aquatic animals was evaluated based on TVA reservoir and tailwater databases and on discussions with TVA resource staff. The invasive terrestrial animals considered in this evaluation included those species that posed a serious threat within the Valley. The present threat of invasive terrestrial animals was evaluated based on information from the National Invasive Species Council, because no comprehensive database was available on invasive species for the entire Tennessee River watershed.

Invasive Terrestrial Animals and Plants

Seven invasive terrestrial animal species that pose a serious threat to terrestrial communities in the TVA reservoir system would be potentially affected by the alternatives. They include:

- The Asian tiger mosquito (*Aedes albopictus*) is known as a potential vector (transmitter) of various diseases of humans and domestic animals.

- Nutria (*Myocastor coypus*), a large semi-aquatic rodent, constructs burrows that commonly damage dams and irrigation facilities, and weaken river and streambanks. Nutria can cause significant damage to crops and native vegetation.

- The European starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), rock dove (*Columba livia*), house finch (*Caropodacus mexicanus*), and Eurasian collared dove (*Streptopelia decaocto*) are birds with similar distributions that pose a similar severity of threat. These species all compete with native birds for food and nesting resources.

Of the 19 invasive terrestrial plants identified as priority species for TVA, the most problematic species are common privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), Japanese knotweed (*Polygonum cuspidatum*), and Nepal grass (*Microstegium vimineum*). These plants compete with native species, and their abundance has been linked to the decline of several native plant species. Areas that contain protected plants or uncommon community types are of particular concern.

Invasive Aquatic Animals

Seven invasive aquatic animal species pose a serious threat to aquatic communities in the TVA reservoir system: common carp (*Cyprinus carpio*), grass carp (*Ctenopharyndogon idella*), alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), rusty crayfish (*Orconectes rusticus*), Asiatic clam (*Corbicula fluminea*), and zebra mussel (*Dreissena polymorpha*). The Asiatic clam and zebra mussel are the most problematic of these species in the Tennessee River system, because these two species adhere to raw water intake systems at power plants and city water supplies.

4.11.2 Regulatory Programs and TVA Management Activities

Regulatory Programs

Executive Order 13112—Invasive Species requires federal agencies to (1) prevent the introduction of invasive species, (2) detect and respond rapidly to control populations of such species in a cost-effective and environmentally sound manner, (3) monitor invasive species populations accurately and reliably, and (4) provide for restoration of native species and habitat conditions in ecosystems that have been invaded. Consistent with this order, this EIS has considered the effects of the reservoir operations policy alternatives on invasive species.

TVA Management Activities

TVA conducts a variety of ongoing management activities to control invasive terrestrial plants and aquatic animals. Through its Natural Areas Management Program, the TVA has actively managed invasive terrestrial plants on lands known to contain rare plants or uncommon plant communities. Historically, invasive terrestrial plants were controlled mainly by hand removal, with limited herbicide application. Hand removal is still used, but herbicides are used to a greater extent now because more is known about this approach and more effective herbicides are available. Fire suppression occasionally is used, although recent forest fires have limited this option.

For invasive aquatic animals, TVA conducts an active program to monitor the populations of Asiatic clams and zebra mussels at power projects. When required, TVA uses chemical and warm-water treatments to control Asiatic clams and zebra mussels at generating facilities. TVA does not conduct management activities associated with the other invasive aquatic species.

4.11.3 Population Abundance and Spread of Invasive Terrestrial Animals and Plants

Existing Conditions

The early pattern of dispersal for Asian tiger mosquitoes subsequent to their arrival in the United States followed the interstate highway system, suggesting a relationship to human activity. Residential and urban areas commonly offer suitable habitat for this species. Artificial containers prevalent among dense human populations facilitate their spread.

Nutria has been reported in the Tennessee Valley from Pickwick Reservoir at the confluence of Bear Creek and the Tennessee River. The rodents inhabit marshes, reservoir edges, and sluggish streams—particularly in areas with emergent or succulent vegetation. They use natural and human-made waterways extensively for travel. Any drainage that holds water can facilitate their spread. Four of the five identified invasive bird species are abundant throughout the Tennessee Valley. They exploit a variety of habitats, but their populations are generally associated with human habitation.

Invasive terrestrial plant species are dispersed by a variety of means, including ingestion of fruits and seeds and transport by wildlife (common privet and Japanese honeysuckle), production of vegetative runners that form mats (Japanese honeysuckle), spreading by rhizomes (Japanese knotweed), and rooting at nodes along the stems and prolific seed production (Nepal grass). These plant species are abundant throughout the Tennessee Valley. Creating new openings and edges facilitates their spread.

Future Trends

Creating open habitats facilitates the spread of most of the invasive terrestrial animals considered in this analysis. For some species, movements and habitat preferences are tied to waterbodies and associated wetlands. Populations of priority invasive terrestrial animals are expected to increase with urban and industrial development. The invasive terrestrial plant species identified as a priority for TVA respond similarly to the creation of open habitat and changes in water level and duration, as well as forest fragmentation resulting from land development and habitat edges created from land conversion. Populations of all invasive terrestrial plant species are expected to increase throughout the TVA system as more edge is created and more forests become fragmented due to land development. Increasing global trade would also likely result in the introduction of more invasive species into the Valley.

4.11.4 Population Abundance and Spread of Invasive Aquatic Animals

Existing Conditions

Several invasive aquatic species, common carp, alewife, grass carp, zebra mussel, Asiatic clam, blueback herring, and rusty crayfish, have become management priorities for the TVA. These species have a wide distribution in the Tennessee River watershed. Common carp have been part of Tennessee River aquatic communities for over 100 years and are presently found in all waterbodies of the TVA reservoir system. Grass carp are reported primarily in the lower portions of the system. Following their introduction into Watauga and South Holston Reservoirs by Tennessee Wildlife Resources Agency (TWRA) in 1976, alewives have moved downstream into Boone, Fort Patrick Henry, and Cherokee Reservoirs as well as river segments in between. Rusty crayfish range expansion began about 30 years ago and is ongoing; this species is now well established in the Clinch, Holston, and Nolichucky River systems—including Norris Reservoir (Williams and Bivens 1996). Bait bucket releases of alewives by fishermen led to their establishment in Norris Reservoir in recent years. Fishermen also introduced the invasive blueback herring to the Tennessee River system's Nottely and Chatuge Reservoirs, where they have spread downriver into Hiwassee Reservoir and will likely inhabit Apalachia Reservoir in the near future. An isolated report of blueback herring from Melton Hill Reservoir is also attributed to fishermen releases of unused bait. Bait bucket introductions of alewife, blueback herring, and rusty crayfish account for their present dispersal in the Tennessee River system (Baxter pers. comm.).

Asiatic clams were discovered in the Ohio River in 1957 and have spread to virtually all the contiguous states. The clams occur throughout the TVA system except for cold tailwaters and certain deep tributary reservoirs with seasonally low DO. For Asiatic clams, humans are the primary agents of dispersal (Counts 1986). Zebra mussels were first documented in the TVA system in 1992, in Kentucky Reservoir, and are now found all along the mainstem navigation channel. Zebra mussels cannot disperse upstream on their own but do release larvae, which can float downstream for long distances before settling. This species can live in most aquatic habitats with firm substrates and can exist in extremely dense mats.

Future Trends

The continued spread or threat of alewife, blueback herring, Asiatic clam, and zebra mussel depends primarily on alterations to the aquatic environment. All four of these species are limited by water quality—alewives and blueback herring, primarily by temperature and low DO; the clam and mussel, primarily by low DO. Because Asiatic clams and zebra mussels attach by their bases, they are more susceptible to changes in water quality, water elevation, and flow. Zebra mussels have the ability to detach and move if changes in habitat parameters are not rapid. Under the present reservoir operations regime, their attainable population levels and potential effects remain to be seen. However, the common carp, grass carp, and rusty crayfish are all highly tolerant of poor water quality conditions and are expected to continue spreading throughout most of the Tennessee River system.

4.12 Vector Control

4.12.1 Introduction

Mosquitoes are referred to as vectors because they can transmit diseases between birds, mammals, and humans. There are 51 species of mosquitoes known in the Tennessee Valley.

> **Resource Issues**
>
> - Population abundance of permanent pool and floodwater species, which is related to the potential transmission of vector-borne diseases

All species of mosquitoes require standing water to complete their life cycle. The cycle from egg to adult typically takes from 7 to 12 days, depending on water temperature. With such a short reproductive cycle, a large number of generations can be produced over a single breeding season (March through October), leading to large and persistent populations of mosquitoes.

Mosquito breeding success is directly related to the extent and duration of shallow standing water, their breeding habitat. The degree to which a policy alternative would increase or decrease standing water throughout the Tennessee River watershed would directly affect the availability of breeding habitat, and indirectly affect the density and persistence of mosquito populations and the related potential transmission of disease.

Mosquitoes can be grouped ecologically, by breeding habitat, into three categories: permanent pool, floodwater (temporary pool), and container breeders ("containers" such as old tires, house gutters, and tree holes) (Breeland et al. 1961). Twelve species are considered to be major pests; most of these species are classified in the permanent pool and floodwater ecological categories. Since the container breeders are not likely to be largely affected by changes in reservoir operations, they are not included in the analyses of impacts associated with alternatives.

Based on the discussion above, the primary issue for vector control is population abundance of permanent pool and floodwater species, which is related to the potential transmission of vector-borne diseases. The Tennessee River watershed was the study area for this analysis.

Permanent Pool Species

The 17 mosquito species in the permanent pool category develop in standing water that is present for 3 weeks or longer along the margins of reservoirs, ponds, swamps, sewage lagoons, and other depressions and drainages. These species produce 10 or more generations per year. Factors conducive to the continued breeding of permanent pool populations include water level stability, lack of wave action, nutrient levels, and presence of cover (such as vegetation or floating debris) to protect larvae from wave action and predation. Water level conditions that are favorable to increases in aquatic plant acreage, such as the submersed plant Eurasian watermilfoil (see Section 5.9, Aquatic Plants), provide important breeding habitat and would likely result in increased reproductive success for a number of species, including *Anopheles* *quadrimaculatus* (the major malaria vector in the eastern United States) (Gartrell et al. 1981). Permanent pool species typically overwinter as adults, but two species overwinter as larvae and one as eggs.

Floodwater (Temporary Pool) Species

This group of 22 species includes some of the more aggressive pest species of mosquitoes. They develop in areas prone to intermittent flooding, such as floodplains and temporarily inundated areas. Eggs must go through a conditioning process (drying) before they hatch and can remain in this condition for up to 3 years or more and still be viable upon flooding. During hot summer months, a generation can develop as quickly as within 5 or 6 days. Rapid development is necessary for survival due to the temporary nature of the larval habitat. Development time is prolonged during spring and fall when temperatures are cooler. Adults emerge nearly simultaneously, seemingly producing a large population overnight. Floodwater mosquitoes overwinter in the egg stage.

Mosquito-Borne Diseases

Presently, four major viruses can be transmitted by mosquitoes bred in the Tennessee Valley: Eastern equine encephalitis, St. Louis encephalitis, LaCrosse encephalitis, and West Nile virus. These four viruses naturally infect birds and are incidentally passed to other vertebrates, such as horses and humans, by mosquitoes. Only certain species of mosquitoes have tested positive for the different viruses; however, not all species that have tested positive for a particular virus are competent vectors for that virus (Beaty and Marquardt 1996).

Malaria, a parasite of red blood cells, is not carried by birds. Since 1949, no cases of malaria of local origin have been reported, nor has there been an indigenous case traced to the TVA reservoirs (TVA 1974). But if an infected individual came to the Valley and was bitten by *Anopheles quadrimaculatus* (a permanent pool mosquito and a competent vector of malaria), malaria could be reintroduced to the Valley.

4.12.2 Regulatory Programs and TVA Management Activities

TVA actively manipulates reservoir levels on four reservoirs to limit mosquito breeding habitat. TVA monitors populations of all mosquito species by light trapping during the mosquito season. County and municipal governments are responsible for all other mosquito control activities, such as pesticide application and drainage improvement of non-TVA land.

Permanent Pool Species

To reduce populations of permanent pool mosquitoes, TVA manages the water level from late May to August on Chickamauga and Pickwick Reservoirs, and from late May to September on Guntersville and Wheeler Reservoirs. Each week, water levels are lowered 1 foot and are then returned to the normal summer pool levels. Weekly water level fluctuations of 1 foot during the mosquito season break the generation cycle because mosquito eggs and larvae are stranded on the banks, exposing them to drying and predators. This method of water fluctuation was developed early in TVA's history to reduce and control malaria in the Valley.

Other water management strategies that reduce populations of permanent pool mosquitoes include the following:

- Low winter reservoir water levels (January to mid-March), primarily in place for flood control, reduce the growth of submersed aquatic plants and provide drainage of low-lying areas.
- Higher reservoir water levels in early spring (mid-March to mid-April) retard emergent plant growth and leave driftwood and other floating material that is washed into the reservoir stranded on the shoreline when water recedes during the lower summer pool levels.
- Fluctuation and recession to winter reservoir water levels destroy eggs and larvae, reduce breeding area, and provide clean shorelines.

Floodwater Species

TVA shortens the amount of time for floodwater mosquitoes to develop by removing water from the floodplains and returning reservoirs to their normal level as soon as possible after a rain event, usually within 7 to 10 days. Removing water from the floodplain effectively reduces floodwater mosquito breeding habitat. Leaving water in the floodplains longer than 7 to 10 days can increase floodwater mosquito populations. If a reservoir could be maintained to never crest above maximum elevation levels, the problems of floodwater mosquitoes could be reduced, but not eliminated.

4.12.3 Population Abundance of Permanent Pool Species

Existing Conditions

Permanent pool mosquitoes occur on mainstem and tributary reservoirs with stable water levels, no wave action, and the presence of cover. On mainstem reservoirs, these conditions occur primarily from Chickamauga to Kentucky Reservoirs. Consequently, weekly 1-foot water level fluctuations to reduce mosquito populations are implemented at these reservoirs, excluding Wilson and Kentucky Reservoirs. Studies have confirmed that water level fluctuations will suppress permanent pool mosquito populations (Breeland et al. 1961, Gartrell et al. 1981). During wet years, higher populations of adult permanent pool mosquitoes will overwinter due to the extended high water levels. This could result in more females laying eggs in spring and population increases in early generations, which could increase the disease transmission potential because vector populations would be higher when migratory birds arrive—both in spring and fall. If water levels are high when fall migration begins (a time when virus-infected birds can move south), the potential exists to extend the mosquito-borne encephalitis season. Migration of birds through, or from, an area of high virus activity with coinciding high mosquito populations would increase mosquito–bird contact above typical levels, thus increasing the disease transmission potential.

Mosquitoes are not as widespread on tributary reservoirs as they are on mainstem reservoirs, and they tend to occur in pockets. The existing operation of drawdowns on tributary reservoirs in mid-July to August helps to reduce overwintering populations of mosquitoes.

Future Trends

No change in existing trends is anticipated without a change in existing operations.

4.12.4 Population Abundance of Floodwater Species

Existing Conditions

Floodwater mosquitoes develop in pools of water left on the floodplain after a breach of maximum water level elevation. This can occur on any of the mainstem or tributary reservoirs. In recent history, Kentucky Reservoir has experienced the largest concentration of floodwater mosquitoes. The existing early drawdown helps to reduce overwintering populations of floodwater mosquitoes and the associated risk of disease.

Future Trends

No change in existing trends is anticipated without a change in existing operations.

4.13 Threatened and Endangered Species

4.13.1 Introduction

Resource Issues

- Occurrence patterns of threatened and endangered species

Information presented in Section 4.7 (Aquatic Resources), Section 4.8 (Wetlands), and Section 4.10 (Terrestrial Ecology) indicates that a wide variety of aquatic and terrestrial animal and plant species occur all across the Tennessee River Valley. As discussed in those sections, the southern Appalachian Mountain region is a major center of diversity for many types of plants and animals. Much of the original biological diversity in this region was associated with the wide variety of forest, grassland, and stream habitats that occurred here prior to human habitation.

More than likely, Native Americans made some modifications to the land and water in the Tennessee River region that, over several centuries, probably modified the abundance and distribution of some animal and plant species. Once Europeans began to establish farms, towns, and cities in this region, they cleared most of the remaining forests, hunted various types of plants and animals, and started modifying the streams to reduce flooding and make it easier to move cargo by water. Virtually all of the land in this region was “developed” in one way or another by the 1920s. Development of the river system proceeded somewhat more slowly, with the completion of the mainstem Tennessee River reservoirs by about 1945 and the completion of tributary reservoirs by about 1980. All of the various human-induced changes in the landscape and streams in this region were intended to improve the lives of the people who lived here. At the same time, however, many of those changes also degraded the habitats for a majority of the non-human species that existed in the region.

Today, the Tennessee Valley actually includes a wider variety of terrestrial and aquatic habitats than were present before the Native Americans arrived. Remnants or recovering patches of natural habitats still occur in some places, along with managed fields and pastures, cities and industrial sites, reservoirs, and stream channels controlled by upstream dams. All of these habitats support populations of plants and animals; however, only some of those species were part of the original communities, and very few of the original species are thriving in the modified habitats. This section focuses on the surviving native species that are not thriving in the modified Tennessee Valley region—the species that are considered to be endangered, threatened, or of special concern in this region.

The present status of many protected species occurring in the Tennessee Valley region is closely tied to habitat conditions along the reservoirs and regulated stream reaches. Changes in the ways the dams are operated could result in a variety of effects on those species, depending on how the changes would affect the flowing water, shoreline, and other types of habitats used by the endangered, threatened, or special-concern species that occur there.

4.13.2 Regulatory and TVA Management Activities

The federal Endangered Species Act (ESA) directs the USFWS to establish national lists of animals and plants that meet identified criteria for endangered or threatened species status. Laws in each of the Valley states direct or encourage wildlife resource or conservation agencies to establish similar state lists of species that meet endangered, threatened, or various levels of special-concern criteria. In each case, the intent of placing species on the lists is to recognize their risk of extinction and to focus attention on ways to help those species survive and recover at least part of their former abundance. Some states also have established legal penalties for actions that would adversely affect species on their protected lists.

Under the ESA, federal agencies are required to consider the potential effects of their proposed actions on species federal-listed as endangered and threatened, as well as areas designated as critical habitats for those species. In addition, NEPA requires federal agencies to consider the potential effects of proposed actions on the human environment, including rare and protected species. TVA, along with each of the seven valley states, maintains copies of the lists of federal- and state-listed endangered, threatened, or otherwise protected species. TVA also keeps track of where those species have been encountered in the region. This occurrence information is routinely stored in a Natural Heritage database, where a common format and compatible storage systems facilitate sharing data among agencies. For the 201-county area included in the TVA Power Service Area, the TVA Natural Heritage database includes occurrence information on about 2,200 federal- and state-protected species.

The federal and state protection requirements, accompanied by considerable public interest in at least some rare species, have resulted in a wide variety of monitoring and management activities focused on endangered and other protected species. Recovery plans prepared for each species on the federal endangered or threatened species lists describe monitoring and management activities that would lead to the enhancement and eventual recovery of each animal or plant. Federal agencies, state agencies, and other interested groups have modified habitats to improve conditions for protected species, and have augmented or reintroduced protected species populations with individuals produced in the laboratory or relocated from other areas. TVA has conducted or participated in many enhancement and management activities focused on protected species, including distribution and monitoring surveys, establishment and protection of natural areas, habitat improvement projects, and restocking programs. In particular, TVA's RRI Program (described more fully in Section 4.4.2) has enhanced aquatic habitats in several regulated stream reaches to the point that native populations have increased and some protected aquatic species have been reintroduced.

4.13.3 Occurrence Patterns

Existing Conditions

The geographic area that could be affected by the ROS includes only specific parts of the TVA Power Service Area that are affected by operation of the various dams. As an initial step in recognizing which protected species should be evaluated for this programmatic study, TVA identified the 81 counties in which some type of ROS-related activity might have an effect, then used the Natural Heritage database to identify the protected species that occur (or once occurred) in those counties. The initial list was reviewed to identify protected species likely to still occur in areas that could be affected directly or indirectly by ROS-related activities. For most animal groups, this review typically included species that have been encountered alive within a 1-mile buffer around any affected waterbody during the last 30 years (since the early 1970s). With regard to plants, the potential for protected species to survive unnoticed for years suggested that all records from the 1-mile buffers should be included regardless of how old those records might be. With regard to wide-ranging protected birds and bats (such as the bald eagle and gray bat), the 1-mile outer boundary was not useful, but only records dating from the early 1970s were included because present distribution patterns of those species are fairly well known. The result of this review is a list of 526 endangered, threatened, or special concern species that are considered in this evaluation. The names and listing status of these species are presented in Appendix D6a.

Table 4.13-01 provides some basic statistics about the protected species known from the areas around the ROS waterbodies. Plants make up the majority of species on this list, about 59 percent of the total (311 of the 526 species), and the 66 fishes and 63 mollusks (each about 12 percent of the total) far outnumber the other animal groups. The 59 animals and plants protected as federal endangered, threatened, or identified candidate species comprise just over 11 percent of the total. With regard to state-level protection, the largest number of species on this list occur in Tennessee and Alabama (264 and 145 species, respectively), and the fewest occur in Virginia and Georgia (5 and 11 species, respectively). The state-level differences in the numbers of species on this list probably reflect more about how much or how little area in each state could be affected by ROS activities rather than the total number of species that are protected there.

Examining 1-mile buffers around the waterbodies serves as a conservative way to identify any federal- or state-protected species that might be affected directly or indirectly by ROS-related activities. Many of the species reported from the 1-mile buffers around the waterbodies, however, are not known to occur in the water or on the land immediately adjacent to the reservoirs or regulated stream reaches. TVA biologists also reviewed the site-specific information about these records in the Natural Heritage database to determine whether each species had been found in the waterbodies or within much more narrow (200-foot-wide) buffers around them. Species and the individual waterbodies where those direct contacts have been recorded are indicated by asterisks in Appendix D6a.

Table 4.13-01 Summary Protection Statistics about the Endangered, Threatened, and Special-Concern Species Known from within 1 Mile or (in parentheses) within 200 Feet around the Waterbodies Included in the ROS

Jurisdiction	Numbers of Species within Major Taxonomic Groups								1-Mile Buffers	200-Foot Buffers
	Plants	Mollusks	Arthropods	Fish	Amphibians	Reptiles	Birds	Mammals		
Federal	10 (3)	30 (21)	0 (0)	11 (6)	0 (0)	0 (0)	6 (5)	2 (2)	59	37
Alabama	61 (11)	46 (43)	13 (1)	8 (7)	4 (1)	4 (0)	4 (2)	5 (3)	145	68
Georgia	3 (1)	0 (0)	0 (0)	6 (2)	1 (1)	0 (0)	1 (1)	0 (0)	11	5
Kentucky	28 (7)	12 (12)	0 (0)	8 (3)	5 (1)	6 (2)	10 (3)	3 (2)	72	30
Mississippi	81 (13)	2 (2)	0 (0)	14 (3)	8 (1)	4 (1)	3 (1)	3 (2)	115	23
North Carolina	2 (1)	9 (6)	1 (0)	6 (2)	5 (1)	0 (0)	1 (0)	4 (2)	28	12
Tennessee	171 (45)	27 (21)	1 (0)	34 (18)	3 (1)	4 (1)	12 (4)	12 (4)	264	94
Virginia	0 (0)	3 (2)	0 (0)	1 (0)	0 (0)	1 (0)	0 (0)	0 (0)	5	2
Total species in 1-mile buffers	311	63	15	66	18	14	23	16	526	
Total species in 200-foot buffers	72	53	1	29	2	3	8	4		172
Percent of 1-mile totals in 200-foot buffers	23.2	84.1	6.7	43.9	11.1	21.4	34.7	25.0		32.7

Note: Entries in the columns are not additive because many species are protected in more than one jurisdiction.

Source: TVA Natural Heritage database.

Protection status information about the 172 species known from within the 200-foot buffers along the waterbodies also is presented (in parentheses) in Table 4.13-01. Within these narrow buffers, plants still make up a majority of the protected species (72 of the 172 species, almost 42 percent of the total), and mollusks and fish (53 and 29 species, 31 and 17 percent of the total, respectively) still far outnumber the other animal groups. The 37 federal endangered, threatened, or identified candidate species known from the immediate vicinity of the waterbodies constitute 22 percent of the total, twice their representation within the full 1-mile buffers. With regard to state-level protection, the largest number of species within the narrow buffers again occur in Tennessee and Alabama (94 and 68 species, respectively), and the fewest still occur in Virginia and Georgia (2 and 5 species, respectively). Once more, these state-by-state numbers probably reflect more about how much or how little area within each state would be affected by ROS activities rather than anything about the total number of species that are protected in each state. As indicated in the last row of Table 4.13-01, the overall effect of focusing on the 200-foot buffers instead of the 1-mile buffer widths appears to be increased emphasis on mollusks and fish, and decreased emphasis on plants, arthropods, and other groups or species not as closely associated with stream habitats.

The summary information about each federal- or state-protected species presented in Appendix D6a includes two additional entries, both of which relate to the habitats in which each species occurs. One of the columns in that extended table indicates the type(s) of habitats in which each species is typically found. TVA biologists developed those entries from a variety of literature sources and from personal observations of these species in the wild. The 13 broad habitat types, representing a wide range of very wet to very dry conditions, were included specifically because each was important to one or more protected species included in this evaluation.

Table 4.13-02 presents a summary of this habitat characterization information, both for the area within the 1-mile buffers and (in parentheses) for the 200-foot buffers around the waterbodies. As indicated in this table, moist woodlands is the habitat within the 1-mile buffer in which the most species typically occur (131 of the 526 species, or about 25 percent of the total). Other important habitats for protected species within the 1-mile buffers are small rivers and large creeks (98 species, 19 percent); ponds and riparian areas along creeks (93 species, almost 18 percent); caves, boulders, and cliff faces (81 species, 15 percent); and big rivers (75 species, 14 percent). When only the 200-foot buffers are considered, big rivers (62 of the 172 species) and small rivers and large creeks (61 species) become the most typical habitats (both about 36 percent), followed by ponds and riparian areas (35 species, 20 percent), non-forested wetlands (27 species, 16 percent), and moist woodlands (20 species, 12 percent). (All of these numbers add up to more than 100 percent of the totals because some species typically occur in more than one habitat type.)

Table 4.13-02 Summary Statistics about the Typical Habitats of the Endangered, Threatened, and Special-Concern Species that Exist within 1 Mile or (in parentheses) 200 Feet around the Waterbodies Included in the ROS

Habitat Types	Numbers of Species within Major Taxonomic Groups								1-Mile Buffers	200-Ft Buffers
	Plants	Mollusks	Arthropods	Fish	Amphibians	Reptiles	Birds	Mammals		
Big rivers	7 (6)	38 (38)	0 (0)	13 (9)	1 (1)	4 (2)	11 (5)	1 (1)	75	62
Small rivers and large creeks	0 (0)	47 (40)	1 (0)	45 (18)	1 (1)	4 (2)	0 (0)	0 (0)	98	61
Small creeks	0 (0)	12 (5)	2 (0)	33 (8)	5 (1)	1 (0)	0 (0)	0 (0)	53	14
Underground aquifers	0 (0)	0 (0)	5 (1)	2 (2)	1 (0)	0 (0)	0 (0)	0 (0)	8	3
Ponds and riparian areas along creeks	56 (26)	0 (0)	0 (0)	0 (0)	14 (2)	4 (1)	11 (4)	8 (2)	93	35
Gravel bars or boulders in large creeks or rivers	8 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (2)	0 (0)	10	6
Nonforested seeps, wetlands, or wet meadows	56 (25)	0 (0)	0 (0)	0 (0)	1 (0)	2 (0)	8 (2)	2 (0)	69	27
Forested seeps or wetlands	38 (12)	0 (0)	0 (0)	0 (0)	10 (1)	1 (1)	1 (1)	3 (0)	53	15
Moist woodlands	113 (16)	1 (0)	0 (0)	0 (0)	3 (0)	1 (0)	2 (1)	11 (3)	131	20
Xeric hardwood or coniferous forests, or mountain woods	42 (2)	0 (0)	0 (0)	0 (0)	0 (0)	5 (0)	3 (0)	2 (1)	52	3
Prairies, fields, roadsides, fencerows, or early successional woodlands	40 (1)	0 (0)	0 (0)	0 (0)	1 (0)	3 (0)	1 (1)	2 (0)	47	2
Limestone, sandstone, or granite outcrops (including cedar glades)	32 (2)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	33	2

Table 4.13-02 Summary Statistics about the Typical Habitats of the Endangered, Threatened, and Special-Concern Species that Exist within 1 Mile or (in parentheses) 200 Feet around the Waterbodies Included in the ROS (continued)

Habitat Types	Numbers of Species within Major Taxonomic Groups								1-Mile Buffers	200-Ft Buffers
	Plants	Mollusks	Arthropods	Fish	Amphibians	Reptiles	Birds	Mammals		
Caves, sinkholes, rock houses, boulders, bluffs, and cliff faces	56 (10)	0 (0)	8 (0)	0 (0)	6 (0)	0 (0)	3 (0)	8 (4)	81	14
Total species in 1-mile buffers	311	63	15	66	18	14	23	16	526	
Total species in 200-foot buffers	72	53	1	29	2	3	8	4		172

Note: Entries in the columns are not additive because some species occur in more than one habitat type.

Source: TVA Natural Heritage database.

Information presented in Section 4.1 indicates that TVA aquatic biologists developed a system to identify all of the river reaches that could be affected by ROS activities and to associate similar impounded and tailwater habitat types. This waterbody classification identifies eight types of waterbodies, ranging from pooled mainstem reaches to warm tributary tailwaters. The eight categories reflect several important differences among the waterbodies, including physiographic relationships, whether the reaches are pooled or flowing, and predominant thermal characteristics.

The last column in the Appendix D6a table indicates the waterbodies in which each of these species occurs where it is protected (some species are protected in one state but not in others). The waterbody reference numbers used in this column are the same numbers identified in Section 4.1.2, Reservoir and Waterbody Classifications. Table 4.13-03 presents a summary of the occurrence information for the five taxonomic groups of protected species associated with the waterbodies (mollusks, fish, amphibians, reptiles, and birds), sorted by waterbody categories. Plants, arthropods, and mammals are excluded from this table because most species in those taxonomic groups are not distributed based on stream-related habitat characteristics—the characteristics used to establish the waterbody categories.

Within the 1-mile buffers, most of these protected species occur in or around pooled mainstem reaches (86 species, almost 47 percent of the total), followed by warm tributary tailwaters (77 species, 42 percent), flowing mainstem reaches (66 species, 36 percent), and cool-to-warm tributary tailwaters (34 species, 18 percent). Within the 200-foot buffers, the same four categories are most important; however, the largest number of protected species occur in or along warm tributary tailwaters (51 of 94 species, 54 percent of the total), followed by flowing mainstem reaches (48 species, 51 percent), pooled mainstem reaches (33 species, 35 percent), and cool-to-warm tributary tailwaters (21 species, 22 percent). The major reason for the shift in importance among these waterbody categories is the substantial number of species within four groups (most amphibians, reptiles, and birds and about half of the fishes) that occur within the 1-mile buffers but do not occur in or immediately adjacent to the waterbodies. This shift suggests that many protected species in these four groups occur in habitats that can be found near the reservoirs or regulated stream reaches, while the other species occur in habitats that may not be closely associated with the waterbody categories.

Considered together, the information presented in Tables 4.13-02 and 4.13-03 leads to two general conclusions about the occurrence of protected species as it relates to the evaluation of the ROS alternatives. Most protected species known from within or immediately adjacent to the waterbodies where ROS activities could take place typically occur in aquatic habitats along the least modified stream habitats (warm tributary tailwaters, flowing mainstem reaches, some pooled mainstem reaches, and cool-to-warm tributary tailwaters). Very few protected species occur in or adjacent to any tributary reservoir, in cold/cool tributary tailwaters, or in the drier terrestrial habitats that exist within 200 feet of any waterbody. These observations indicate that warm tributary tailwaters, flowing mainstem reaches, and some pooled mainstem reaches and cool-to-warm tributary tailwaters are the waterbody categories where any direct effects of the ROS alternatives on protected species would be most likely to occur.

The information presented in Tables 4.13-02 and 4.13-03 also suggests that at least a few protected species could occur in just about any type of habitat within 1 mile around almost any reservoir or tailwater included in this evaluation. This observation indicates that all protected species known from the 1-mile buffers should be considered with regard to any indirect or cumulative effects associated with the policy alternatives.

Future Trends

If existing management activities and their present results are suitable indicators, future trends related to the protection of endangered, threatened, and rare species in the Tennessee Valley will include a few successes, more failures, and many unknowns. Some well known and widely appreciated species on the federal lists (such as the bald eagle and snail darter) appear to be responding to the recovery measures that have been conducted, so much so that they may not require federal ESA protection in the future. The vast majority of protected species in the region, however, are likely to remain extremely rare and virtually unknown to the general public. Efforts to enhance or recover those protected species may be more difficult than they are now, both because the species may not be viewed as being particularly important and because as the human population and human use of land and water resources in the region continue to increase, more natural habitats will be degraded and some protected species that exist only in those areas may be lost.

Table 4.13-03 Summary Statistics about the Known Occurrences of Endangered, Threatened, and Special-Concern Species within 1 Mile or (in parentheses) 200 Feet around the Waterbodies Included in the ROS Arranged by Waterbody Category

Waterbody Category	Numbers of Species within Major Taxonomic Groups					1-Mile Buffers		200-Foot Buffers	
	Mollusks	Fish	Amphibians	Reptiles	Birds	Number	Percent	Number	Percent
Flowing mainstem reaches	36 (36)	14 (8)	4 (1)	4 (0)	8 (3)	66	35.9	48	51.1
Pooled mainstem reaches	18 (15)	29 (8)	10 (2)	12 (3)	17 (5)	86	46.7	33	35.1
Blue Ridge-type reservoirs	6 (1)	13 (1)	2 (1)	0 (0)	1 (0)	22	12.0	3	3.2
Ridge and Valley-type reservoirs	4 (0)	5 (0)	1 (1)	1 (0)	3 (1)	14	7.6	2	2.1
Interior Plateau-type reservoirs	3 (0)	7 (2)	2 (0)	0 (0)	3 (1)	15	8.1	3	3.2
Cool/cold tributary tailwaters	5 (5)	4 (1)	1 (0)	1 (0)	1 (0)	12	6.5	6	6.4
Cool-to-warm tributary tailwaters	11 (10)	19 (9)	3 (1)	0 (0)	1 (1)	34	18.5	21	22.3
Warm tributary tailwaters	32 (30)	29 (18)	8 (1)	6 (1)	2 (1)	77	41.8	51	54.2
Total species in 1-mile buffers	63	66	18	14	23	184			
Total species in 200-foot buffers	53	29	2	3	8			95	
Percent of 1-mile totals in 200-foot buffers	84.1	43.9	11.1	21.4	28.6			51.6	

Note: Entries in the columns are not additive because some species occur in more than one category.

Source: TVA Natural Heritage database.

4.14 Managed Areas and Ecologically Significant Sites

4.14.1 Introduction

Resource Issues
▶ Integrity of managed areas and ecologically significant sites

Managed areas and ecologically significant sites are lands set aside for a particular management objective or lands that are known to contain sensitive biological, cultural, or scenic resources. TVA identified 428 managed areas and 98 ecologically significant sites within 1 mile of full pool levels of TVA reservoirs, using the TVA regional Natural Heritage Project comprehensive database. Managed areas and ecologically significant sites are typically established and managed to achieve one or more of the following objectives:

- **Species/Habitat Protection—**places with endangered or threatened plants or animals, unique natural habitats, or habitats for valued fish or wildlife populations. Examples include national and state wildlife refuges, mussel sanctuaries, TVA habitat protection areas, Audubon refuges, and identified but unprotected ecologically significant sites.
- **Recreation—**parks, picnic areas, camping areas, trails, greenways, and other sites managed for outdoor recreation or open space, such as national parks, national recreation trails, scout camps, and county and municipal parks.
- **Resource Production/Harvest—**lands managed for production of forest products, hunting or fishing, such as national forests, state game lands, and fish hatcheries.
- **Scientific/Educational Resources—**lands protected for scientific research and education, including biosphere reserves, research natural areas, environmental education areas, and research parks.
- **Cultural Resources—**lands with human-made resources of interest, including military reservations, state historic areas, and state archeological areas.
- **Visual/Aesthetic Resources—**areas with exceptional scenic qualities or views, such as national and state scenic trails, wildlife observation areas, and wild and scenic rivers.

Most managed areas and ecologically significant sites have multiple management objectives. If management objectives cannot be met, the integrity of the area may be lost or compromised. Twenty-three percent of the 526 areas identified are located on or adjacent to TVA reservoirs and could be affected by changes in reservoir operations (Table 4.14-01). For example, extending summer pool levels into the fall migration season could adversely affect wildlife refuges with flats critical to migratory birds. This change could also affect rare plant protection sites on reservoir shorelines. Seasonal changes in water depth could affect (adversely or beneficially) habitat for rare aquatic plants and animals. Higher winter water levels could increase the risk of spring flooding on impounded croplands managed for wildlife.

Altered discharge rates could directly affect endangered mussel sanctuaries, rare snail habitat, riparian roost trees, or rare plant sites along tailwaters or major rivers. These sites comprise 13 percent of managed areas and ecologically significant sites. Sites in upland or headwater positions in the landscape, comprising 64 percent of all managed areas and ecologically significant sites, are unlikely to be directly affected by changes in reservoir operations. However, all three categories of managed areas and ecologically significant sites could be indirectly affected by increases in shoreline development, recreational use, erosion, and water quality decline potentially associated with changes in reservoir operations.

4.14.2 Regulatory Programs and TVA Management Activities

The managed areas and ecologically significant sites addressed in this section have been established by various agencies for numerous and often overlapping objectives. Federal agencies, such as TVA, manage small wild areas and habitat protection areas (HPAs) (such as the Riley Creek Islands HPA) according to agency policy. Federal lands, such as Tennessee and Wheeler National Wildlife Refuges (NWRs), the Appalachian National Scenic Trail, and several national forests, are managed with public funds by various agencies within the Department of the Interior and Department of Agriculture, in accordance with applicable laws and regulations.

State laws and regulations permit state agencies, commissions, departments, and divisions to establish and manage a variety of public sanctuaries, parks and forests, and wildlife management areas (WMAs)—such as Kentucky Reservoir State WMA. City and county governments, through their parks and recreation divisions or their equivalent, serve to provide passive recreational opportunities for the public through management of municipal parks, watersheds, and picnic areas. Various private entities, including the National Audubon Society and The Nature Conservancy, often use private donations to purchase and maintain lands for protection of sensitive resources and passive recreational activities.

4.14.3 Integrity of Reservoir- and Tailwater-Dependent Managed Areas

Protecting resources and management objectives within their boundaries maintains the integrity of managed areas. To identify the range of management objectives and protected resources associated with managed areas and ecologically significant sites, seven reservoir, tailwater, or upland areas were examined to identify the variety of management objectives, managed area types, and landscape positions that may potentially be affected by changes in reservoir operations. Many of the resources and activities for which managed areas and ecologically significant sites are managed, including aquatic resources, wetlands, terrestrial ecology, endangered and threatened species, cultural resources, and recreation, are addressed in other sections of this EIS.

Table 4.14-01 Number of Managed Areas and Ecologically Significant Sites by Reservoir

Reservoir	Mainstem (A) or Tributary (B)	Managed Areas	Ecologically Significant Sites	Total Natural Areas	Pooled Reservoir Areas	Tailwater and Mainstem Riverine Habitats	Upland and Headwater Areas
Apalachia	B	3	0	3	0	0	3
Barkley	N/A	20	5	25	10	0	15
Barkley tailwater	N/A	1	2	3	0	1	2
Bear Creek	B	0	1	1	0	0	1
Blue Ridge	B	2	0	2	0	0	2
Boone	B	7	2	9	0	5	4
Cedar Creek	B	0	1	1	0	0	1
Chatuge	B	8	0	8	2	0	6
Cherokee	B	10	0	10	3	7	0
Chickamauga	A	36	2	38	9	8	21
Douglas	B	4	0	4	4	0	0
Fontana	B	5	3	8	3	0	5
Fort Loudoun	A-B[1]	16	3	19	4	7	8
Fort Patrick Henry	B	1	0	1	1	0	0
Great Falls	N/A	2	0	2	0	0	2
Guntersville	A	32	1	33	9	2	22
Hiwassee	B	4	0	4	0	0	4
Kentucky	A	66	19	85	17	13	55
Kentucky tailwater	A	4	1	5	0	3	2
Little Bear Creek	B	1	2	3	1	0	2
Melton Hill	A-B[1]	49	5	54	12	1	41
Nickajack	A	20	13	33	5	7	21
Normandy	B	5	1	6	2	0	4
Norris	B	25	7	32	11	0	21
Nottely	B	1	0	1	0	0	1
Ocoee #1	B	3	2	5	0	1	4

Table 4.14-01 Number of Managed Areas and Ecologically Significant Sites by Reservoir (continued)

Reservoir	Mainstem (A) or Tributary (B)	Managed Areas	Ecologically Significant Sites	Total Natural Areas	Pooled Reservoir Areas	Tailwater and Mainstem Riverine Habitats	Upland and Headwater Areas
Ocoee #2	B	3	0	3	0	0	3
Ocoee #3	B	4	1	5	0	0	5
Pickwick	A	12	13	25	2	7	16
South Holston	B	3	0	3	0	0	3
Tellico	A	9	2	11	4	1	6
Tims Ford	B	4	0	4	1	0	3
Upper Bear Creek	B	8	3	11	4	0	7
Watauga	B	6	3	9	1	0	8
Watts Bar	A	27	2	29	12	0	17
Wheeler	A	21	3	24	3	3	18
Wilbur	B	4	1	5	1	0	4
Wilson	B	2	0	2	0	1	1
Total		**428**	**98**	**526**	**121**	**67**	**338**

Notes:

Areas with multiple designations are represented once, although overlapping/nestled areas are each counted. The Managed Areas category supercedes the Ecologically Significant Sites category. National Forest Purchase Units were not counted individually but as part of the National Forest.

[1] Fort Loudoun Reservoir includes Tennessee River Mile (RM) 602.3 to 641.0 (mainstem) and Tennessee RM 641.0 to 652.2, French Broad RM 0.0 to 32.3, and Holston RM 0.0 to 52.3 (tributary). Melton Hill Reservoir includes Clinch RM 23.1 to 66.3 (mainstem) and Clinch RM 66.3 to 79.8 (tributary).

Source: TVA Natural Heritage database.

Approximately 60 percent of 53 selected areas identify protection of state- or federal-listed species as a management objective. Approximately 40 percent are managed for water-dependent birds (including waterfowl, gulls, shorebirds, herons, eagles, and ospreys), and 26 percent specifically list non-consumptive recreation (hiking, bird-watching, and camping) as popular activities. Almost all managed areas and ecologically significant sites protect habitat, whether or not the objective is stated. Approximately 13 percent of recreational boating, fishing, swimming, camping, picnics, hiking, and hunting user days in the TVA system originates on public lands (see Section 5.24, Recreation), many of which are managed areas; approximately 83 percent of these recreational user days depend on water.

Managed areas and ecologically significant sites on reservoir or tailwater shorelines are affected by existing reservoir operations, and could be affected by changes in operations. In general, the integrity of managed areas is not compromised by existing operational practices, although shoreline erosion is an issue at a few sites. TVA reservoir Land Management Plans and other activities involve consideration of and coordination with the various managing entities of managed areas and ecologically significant sites.

Existing Conditions

Reservoir-Dependent Sites

Approximately 121 managed areas and ecologically significant sites are located on or adjacent to TVA reservoirs and contain resources or uses directly dependent on reservoir water levels and potentially sensitive to secondary impacts (Table 4.14-01). These areas comprise from 12 to 69 percent of the shoreline of selected reservoirs (Table 4.14-02). The Kentucky Reservoir State WMA (3,270 acres) includes flats, islands, lowlands, and narrow shoreline strips along the Kentucky Reservoir managed for waterfowl and hunting. Both Tennessee and Wheeler NWRs were established as wintering areas for waterfowl and migratory birds. Both areas are popular for hunting, fishing, hiking, and wildlife observation. The 15-acre Riley Creek Island TVA HPA is managed for waterfowl, herons, and wetlands. The 19-acre Maclellan Island Audubon Society Wildlife Refuge harbors a colony of great blue herons (*Ardea herodias*). The Watauga Reservoir Protection Planning Committee Rare Plant Site includes populations of the state-listed species showy lady's-slipper (*Cypripedium reginae*), northern white cedar (*Thuja occidentalis*), white camass (*Zygadenus elegans* ssp. *glaucus*), and shining ladies' tresses (*Spiranthes lucida*).

Tailwater-Dependent Sites

Approximately 67 managed areas and ecologically significant sites are located along flowing mainstem rivers or tailwaters. These sites are typically small, but often critical for protection of endangered or threatened species. Included are most of the representative state mussel sanctuaries and restricted mussel harvest areas. Managed areas and ecologically significant sites with shorelines or riverine islands containing nest or roost trees, fringe wetlands, or endangered riparian plants would also be included if protection of these resources is a management objective.

Table 4.14-02 Shoreline Miles of Managed Areas and Ecologically Significant Sites for Seven Representative Reservoirs in the TVA System

Reservoir	Shoreline Miles on Reservoir	Approximate Miles of Shoreline Designated as Managed Area or Ecologically Significant Site[1]	Percent of Reservoir Shoreline Comprised of Managed Area or Ecologically Significant Site
Chatuge	128	44	34%
Kentucky	2,064	663	32%
Nickajack	179	123	69%
Normandy	75	43	57%
Watts Bar	722	92	13%
Watuaga/Wilbur	110	61	55%
Wheeler	1,027	120	12%

[1] In the event of overlapping areas, miles for each designation were included in the total. In most cases, the amount of overlap was small.

Upland and Headwater Areas

Approximately 338 managed areas and ecologically significant sites are located within 1 mile of full pool levels but are not dependent on reservoir water levels or river flow for maintaining their resources. These sites account for the greatest number and largest acreage of managed areas. Examples include the Appalachian National Scenic Trail, small (less than 20-acre) upland bluff HPAs, large (35,000-acre plus) state WMAs with a focus on upland game, and the Eller Seepage Bog Preserve located on a headwater stream.

Upland/headwater resources are not generally directly affected by reservoir operations. Resources worthy of management or protection continue to be identified through TVA's land planning process.

Future Trends

The general trend for the period 2003 to 2030 is likely to be a gradual increase in the number and size of managed areas and ecologically significant sites and a gradual increase in visitor use. With increasing development in the Tennessee Valley, the importance of protecting managed areas and ecologically significant sites will increase.

4.15 Land Use

4.15.1 Introduction

Resource Issues

- Rate of residential shoreline development and land use along reservoirs

Management of reservoir levels and releases affects land use at the shoreline; therefore, the analysis of land use impacts focused on shoreline development in the immediate vicinity of TVA shorelines. A total of 6,700 shoreline miles surround the nine mainstem reservoirs, and 4,308 shoreline miles surround the 26 tributary reservoirs included in the ROS. The land use analysis concentrated on residential development, the most prevalent developed land use around the reservoirs. The Shoreline Management Initiative (SMI) identified three times as many miles of residentially developed shoreline as all other developed uses combined (TVA 1998). Developed recreation (i.e., public facilities and commercial marinas) was a distant second. The residential land use category is expected to experience the majority of the growth during the ROS period of study. The SMI, which was developed to address growing concerns about the effects of increasing residential development over an ensuing 25-year period, also reflects this projection. The SMI projected that up to 38 percent,[1] or 4,192 miles of reservoir shoreline systemwide, was likely to be developed for residential uses, with each reservoir having its own development pattern and length of shoreline available for residential access.

The primary region of influence on land use extends 0.25 mile from the full-pool elevation around a particular reservoir. TVA is directly involved in implementing policies for shoreline development at the immediate waterfront shoreline. The 0.25-mile zone encompasses a typical waterfront residential subdivision. A secondary zone of influence extends outward 0.75 mile from the primary zone. Development within the primary and secondary zones often must also conform to certain federal, state, and local (county and municipal) development and environmental regulations.

Shoreline residential development is ongoing and will continue at some rate until complete buildout (the point at which the available shoreline property has been consumed by residential development). The SMI anticipated that buildout would occur by 2023. Through reservoir-specific, land management planning efforts and TVA management practices, TVA has defined the amount and location of shoreline property available for residential development. The primary effect of alternative reservoir operation policies on land use would be the rate of shoreline residential development (i.e., buildout would be likely to occur sooner or later than projected by the SMI).

Identified changes to TVA's operations policy would not materially change operation of any run-of-river reservoir and certain reservoirs with no available shoreline for residential development. Therefore, two mainstem reservoirs (Wilson and Nickajack) and 11 tributary reservoirs (Melton

[1] Actual buildout is expected to be less than 38 percent because of environmental safeguards and maintain and gain exchanges, as required by the SMI.

Hill; Fort Patrick Henry; Wilbur; Apalachia; Ocoee #1, #2, and #3; Upper Bear Creek; Bear Creek; Little Bear Creek; and Cedar Creek) were not considered in the land use analysis.

4.15.2 Regulatory Programs and TVA Management Activities

Shoreline development along TVA reservoirs is managed in accordance with the Shoreline Management Policy (SMP); TVA Land Management Plans (LMPs) for individual reservoirs; and applicable federal, state, county, and municipal regulations. In addition to its reservoir land management planning, TVA manages reservoir shoreline development through the Section 26a permit, which regulates the construction of shoreline structures. TVA does not otherwise regulate private property, except as specifically provided for in individual property flowage easements or in deeds where TVA sold property but retained rights to protect flood control interests and manage certain construction activities. Flowage easements vary widely among reservoirs and provide TVA with varying levels of control over construction on and use of flowage easement shorelands.

Section 26a

Section 26a of the TVA Act requires that TVA approve the construction, operation, and maintenance of any obstruction affecting navigation, flood control, or public lands—across, along, or in the Tennessee River or its tributaries—even when TVA has no land rights involved. TVA is charged with administering and ensuring compliance with Section 26a regulations and reviews more than 2,000 permit applications each year.

Since the early 1970s, a number of environmental laws have been enacted that indirectly affect implementation of Section 26a, including NEPA, the Archaeological and Historic Preservation Act (AHPA), and the ESA. These statutes require TVA to evaluate the environmental impacts of proposed actions; for major projects, preparation of an EIS may be required for Section 26a approval. This process leads to approval, denial, or revision of proposed project plans in order to avoid adverse environmental impacts. Once approved, permit recipients are required to follow the construction procedures and environmental protection measures specified. Coupled with these and other environmental requirements, Section 26a ensures that development along the Tennessee River and its tributaries receives adequate planning and review. The SMI indicated that 85 percent or more of all Section 26a permit approvals were for structures directly associated with shoreline residential property, such as private docks, piers, and boathouses.

Shoreline Management Initiative

In the 1990s, TVA recognized the growing public concern for potential effects on reservoir shoreline resources due to increasing shoreline residential development. In response, TVA developed and implemented the SMI (also see Section 1.8) to better protect shoreline and aquatic resources while allowing adjacent residents reasonable access to the water. Access rights to the water determine the geographical pattern for residential development around specific reservoirs. In areas designated by the SMI as closed to new residential access, the SMI does not allow private water use facilities without a “maintain and gain exchange.” This exchange requires the developer to propose to relinquish water access rights elsewhere on TVA reservoirs, and TVA must then determine that net public and environmental benefits would result from the change. Specific standards for facility size and vegetation management were established in the SMI. The SMI also established a shoreline classification system wherein shoreline environmental constraints would be identified and appropriate management strategies implemented.

Land Management Plans

Through the Section 26a permitting process, TVA has some control over the types and extent of shoreline development. TVA also manages shoreline development through its land management planning process. The SMI defined the policy that sets the parameters and process for future residential access to the waters of TVA-managed reservoirs. Eleven Watershed Teams are responsible for the implementation of shoreline management, through both Section 26a and the SMP that was created by the SMI. In addition to other responsibilities, these teams oversee and coordinate the land use planning and management of one or more TVA reservoirs within a defined watershed.

Land Management Plans are a responsibility of each Watershed Team. In 1979, TVA initiated a comprehensive planning process to define allocations for its multipurpose reservoir lands. Established LMPS are being revised to be consistent with the SMP. Watershed Teams are responsible for preparing or revising reservoir-specific LMPs. Each revised or new LMP includes an Environmental Assessment or EIS, and involves extensive interagency and public review. Land Management Plans define allowable development for recreational, commercial, residential access, and industrial uses along TVA shorelines.

Other Regulations

Certain federal, state, county, and municipal regulations control the development of private property both inside and outside the 0.25-mile primary zone of influence. The state, county, and municipal regulations vary widely in their applicability and effectiveness in mitigating shoreline development impacts.

4.15.3 Shoreline Residential Development

Existing Conditions

LANDSAT imagery provided the most recent (ca. 1992) record of land use for the TVA reservoir system. A simplified, standard USGS land use classification was applied to the primary zone of influence for all reservoirs. Simplification of the classification system was accomplished by merging certain open space cover types that would be likely to undergo similar impacts from development (Table 4.15-01).

Table 4.15-01 The USGS Land-Use Classification System

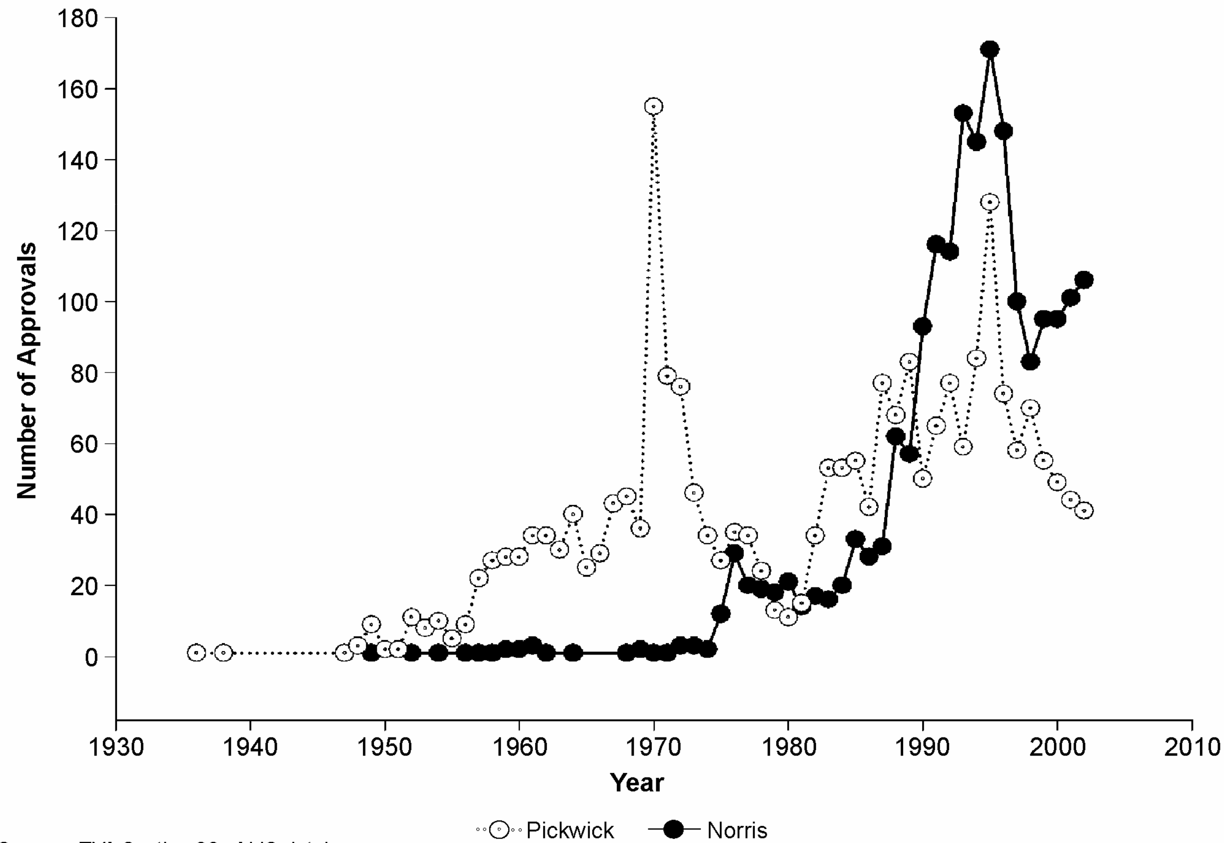
• Open water
• Low-intensity residential
• High-intensity residential
• Commercial/industrial/transportation
• Bare rock/sand/clay
• Forest
• Pasture/hay
• Cropland (row crops)
• Urban/recreational grasses (e.g., close-mown parkland open space, playing fields, large-lot lawns)
• Wetlands

The number of acres available for shoreline residential development and the respective percentage of cover type (predominantly forested) were calculated for each reservoir, as shown in Table 4.15-02. For the reservoirs included in the land use analysis, Table 4.15-02 includes the shoreline type; total shoreline miles; total shoreline miles available for residential development; miles and percent of total shoreline miles that are developed; miles, percent of available shorelines, and acres of undeveloped shoreline; residentially developable open space by cover type; and the projected 1990s development rate.

Section 26a permit approvals involve approximately 60 different types of activities for which TVA exercises jurisdiction. Within that group, 16 of the items clearly reflect private residential activity. Items identified include a variety of boat slips, boathouses, and dock/piers, as well as activities without structures, such as landscaping/minor clearing and vegetation management plans. Two reservoirs, Norris and Pickwick, have electronically retrievable Section 26a permit data back to 1936 and 1949, respectively. These data were available for analysis to determine whether there was a discernible change in permit activity coincident with a change in the reservoir operations policy (Figure 4.15-01).

The Lake Improvement Plan forecasts the 1990s development of private shorelands around TVA reservoirs in terms of low, medium, and high growth rates. Those projections, which were confirmed for the SMI, are identified in Table 4.15-02. TVA land management specialists reviewed certain reservoir forecasts and verified their continued accuracy.

Shoreline residential development is projected to reach full buildout at some future time, irrespective of any changes TVA makes in its reservoir operations policy. The SMI estimated that full residential buildout would be achieved in approximately 25 years. The ROS examines the potential for changes in the rate of shoreline residential development brought about by proposed reservoir operation alternatives and the resulting impacts.



Source: TVA Section 26a ALIS database.

Figure 4.15-01 Section 26a Permit Approvals of Structures Related to Shoreline Recreation at Norris and Pickwick Reservoirs

Reservoir Characteristics

The reservoirs considered in this study have widely varying amounts of developable shoreline, making it difficult to make broad generalizations about them. Some reservoirs have a certain attractiveness that others do not—such as proximity to urban centers and a well-developed transportation infrastructure—and those reservoirs are likely to reach buildout sooner. Some reservoir characteristics that are regarded as positive factors in the growth of shoreline residential development would be good infrastructure, good recreation, and good shoreline access. Conversely, some reservoir characteristics that are regarded as negative factors or detractors to residential development would be remoteness, lack of developed infrastructure, and poor shoreline access.

The residential development of shorelines also influences the development of "backlands," those parcels adjacent to shoreline parcels, within the 0.75-mile band that surrounds the 0.25-mile shoreline band. In time, increased shoreline development would stimulate expansion of the support service industries nearby (i.e., gasoline stations, supermarkets, restaurants, and motels).

Table 4.15-02 Shoreline Development for Reservoirs Considered in the Land Use Analysis

Reservoir	Type[1]	Total Shoreline (miles)[2]	Shoreline Available for Residential Development		Developed Shoreline				Undeveloped Residential Shoreline			Developable Shoreline by Cover Type			Projected Development Rate
					Residential		Other								
			Miles	% of Total	Miles	% of Total	Miles	% of Total	Miles	% of Available	Acres	Forest (%)	Pasture (%)	Crop (%)	
Mainstem Reservoirs															
Kentucky	MS	2,064.3	936.9	45.4	120.5	5.8	47	2.3	816.4	87.1	130,624	81	3	5	Medium
Pickwick	MS	490.6	118.3	24.1	63.7	13.0	27.8	5.7	54.6	46.2	8,736	82	6	6	High (low last 3 years)
Wheeler	MS	1,027.2	165.4	16.1	59.7	5.8	28.2	2.7	105.7	63.9	16,912	58	17	18	Medium
Guntersville	MS	889.1	113.3	12.7	87.3	9.8	83.2	9.4	26.0	22.9	4,160	71	8	7	Medium
Chickamauga	MS	783.7	248.7	31.7	88.7	11.3	21.6	2.8	160.0	64.3	25,600	71	10	4	Medium
Watts Bar	MS	721.7	340.4	47.2	141.8	19.6	17.4	2.4	198.6	58.3	31,776	83	9	2	Medium
Fort Loudoun	MS	378.2	317.2	83.9	184.8	48.9	13.8	3.6	132.4	41.7	21,184	68	20	4	High
Subtotal		6,354.8	2,240.2	35.3	746.5	11.7	239.0	3.8	1,493.7	66.7	238,992	–	–	–	
Tributary Reservoirs															
Norris	TS	809.2	360.8	44.6	91.0	11.2	16.0	2.0	269.8	74.8	43,168	93	4	1	Medium
Douglas	TS	512.5	454.9	88.8	78.1	15.2	8.3	1.6	376.8	82.8	60,288	74	14	5	Medium
South Holston	TS	181.9	48.2	26.5	18.1	10.0	6.9	3.8	30.1	62.4	4,816	82	12	3	Medium
Boone	TS	126.6	102.6	81.0	64.3	50.8	2.8	2.2	38.3	37.3	6,128	63	22	6	Medium
Cherokee	TS	394.5	172.3	43.7	59.9	15.2	38.1	9.7	112.4	65.2	17,984	72	18	6	Medium
Watauga	TS	104.9	50.2	47.9	19.4	18.5	2.9	2.8	30.8	61.4	4,928	91	5	1	Medium
Fontana	TS	237.8	19.3	8.1	2.6	1.1	45.0	18.9	16.7	86.5	2,672	97	0	0	Low

Table 4.15-02 Shoreline Development for Reservoirs Considered in the Land Use Analysis (continued)

Reservoir	Type[1]	Total Shoreline (miles)[2]	Shoreline Available for Residential Development		Developed Shoreline				Undeveloped Residential Shoreline			Developable Shoreline by Cover Type			Projected Development Rate
					Residential		Other								
			Miles	% of Total	Miles	% of Total	Miles	% of Total	Miles	% of Available	Acres	Forest (%)	Pasture (%)	Crop (%)	
Tributary Reservoirs (continued)															
Tellico	TS	357.0	110.4	30.9	19.7	5.5	5.8	1.6	90.7	82.2	14,512	84	11	4	High
Chatuge	TS	128.0	79.6	62.2	52.1	40.7	2.3	1.8	27.5	34.5	4,400	79	16	2	High
Nottely	TS	102.1	58.8	57.6	25.9	25.4	2.6	2.5	32.9	56.0	5,264	88	8	1	High
Hiwassee	TS	164.8	20.3	12.3	12.0	7.3	0.8	0.5	8.3	40.9	1,328	94	1	1	Medium
Blue Ridge	TS	68.1	26.0	38.2	15.5	22.8	1.8	2.6	10.5	40.4	1,680	97	1	0	Medium
Tims Ford	TS	308.7	47.7	15.5	43.2	14.0	15.3	5.0	4.5	9.4	720	61	16	13	High
Normandy	TS	75.1	11.2	14.9	0.0	0.0	4.6	6.1	11.2	100.0	1,792	89	8	2	Low
Great Falls[2]	TS	120.0	–	–	–	–	–	–	–	–	–	–	–	–	–
Subtotal		3,571.2	1,562.3	43.7	501.8	14.1	153.2	4.3	1,060.5	67.9	169,680	–	–	–	–

[1] MS = Mainstem storage; TS = Tributary storage.

[2] Great Falls does not come under the Shoreline Management Policy.

Source: TVA file data.

The proposed changes in reservoir operations policy could potentially alter the relative attractiveness of certain reservoirs by changing the recreational and aesthetic appeal to the real estate buying public. This study will attempt to explain the relative impact the ROS alternatives could have on current shoreline residential development.

Factors Affecting the Rate of Shoreline Residential Development

The rate of shoreline residential development within the 0.25-mile shoreline band during the estimated period to full buildout (2023) is affected to a large degree by a number of external factors, such as the general state of the economy, growth in the TVA region, attractiveness of mortgage rates, proximity to urban areas, transportation infrastructure and accessibility, and real estate marketing efforts. As mentioned on page 4.15-5, factors like well-developed infrastructure, good shoreline access, and commercial recreational opportunities play a key role in the pattern of residential development.

Proximity to urban areas has also been identified as a contributor to residential development at certain reservoirs. The discussion of population in the SMI recognized that growth has not been uniform throughout the TVA region and that urbanization trends have affected certain counties more than others. The Southern Forest Resource Assessment (SFRA) (USDA 2002) concluded that one of the forces strongly influencing land use changes is “urbanization, driven by population and general economic growth.” Two of the areas identified in the SFRA as experiencing urbanization are Nashville and Knoxville, Tennessee.

Real estate investment has held or increased its value during the most recent recession. Over the past 3 years, the value of real estate investment trusts (REITS) has risen synchronously with the fall in value of the S&P 500 index (Morningstar 2003). The rise of investor interest in real estate, despite the current economic recession, correlates with a general decline in both fixed- and variable-rate mortgages over the same period (HSH Associates 2003). The market for second homes in the United States is showing a lot of activity (Fogarty 2002) and although it is not a primary driver in TVA reservoir residential development (only 20 percent, according to the SMI [TVA 1998]), it is a contributor.

The relationship between proximity to the reservoirs, their operating characteristics, and higher property values is documented in the literature. Studies indicate that there is a measurable difference in home values between shoreline and non-shoreline properties (see Section 5.25.2).

Future Trends

During the 1980s, the population of the TVA region increased by 5.7 percent—adding more than 42,000 people annually—to a level of 7,937,330 residents by 1990. The regional population increase was lower than across the United States as a whole, which increased 9.8 percent over the same time period. Between 1990 and 2000, the population of the TVA region increased at a rate greater than the United States—averaging over 120,000 residents annually—to a level of

9,153,412 residents. This represents an increase in the regional population of 15.3 percent, compared to the 13.1 percent population growth of the United States over the same time period.

In both decades, Nashville had the largest population growth across TVA sub-regions. The sub-regions of Chattanooga and Knoxville also contributed to the increased growth rate in the 1990s.

The projected increase in population of the TVA region follows the trend of the last decade, whereby it will exceed that of the United States. Over the 27-year period, the population of the TVA region is forecast to rise to 12,476,306—representing an increase of 30.0 percent—compared to the projected increase in the national population of 28.2 percent over the same time period. The projected population booms in Nashville and Knoxville are expected to be the major contributors to this population increase.

The SMI indicated that both public use of reservoirs and shoreline residential development has continued to increase. Section 26a permits for residential types of structures and modifications reflect shoreline residential development, and the SMI analysis of Section 26a permits revealed an increase of approximately 6 percent per year.

While changes to the existing reservoir operations policy may affect the attractiveness of certain reservoirs during certain times of the year, TVA's stewardship role and its reservoir operations policy are not the primary determining factors for the rate of shoreline residential development over time.

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4.16 Shoreline Erosion

4.16.1 Introduction

Resource Issues
▶ Rate of erosion of reservoir and tailwater shorelines

Soil erosion, whether from upstream land use practices or from the cutting away of stream and reservoir shorelines, can cause adverse environmental impacts. Sediments from eroded soils can alter water chemistry and aquatic habitats, restrict navigation, and reduce water storage capability. Erosive forces can cause stream and reservoir banks to recede, resulting in loss of land and vegetation that provides important canopy cover for habitat. Sediments and nutrients, particularly nitrogen and phosphorus, from eroded soils are the cause of water quality impairment of more miles of rivers and streams in the United States than any other pollutants (USEPA 1992).

Natural erosion is a process driven by raindrop impact forces, streamflow shearing forces, and wave energy that dislodges and moves sediments from highlands through waterways to the oceans. Human activities have and will continue to accelerate the natural process. A portion of the erosion and sedimentation affecting the waterways in the TVA system is a result of land use activities in the backlands that are within the watershed but outside the control of TVA, such as soil disturbances associated with construction, agriculture, and forestry. Some erosion and associated sedimentation also occurs in the tailwater streambanks and the reservoir shorelines due to the presence and operation of TVA facilities for power generation, navigation, flood control, and wave action associated with recreational boating. These latter causes of erosion are the subject of this section. Sediment contamination of TVA waterways, produced either through reservoir operations or from activities on land within the watershed, is discussed in Section 4.4, Water Quality.

The primary issue for this resource area is the potential changes (increase) in the rate of erosion of reservoir and tailwater shorelines. To help focus the definition of the affected environment, the erosion analysis used seven representative reservoirs and tailwaters of the TVA system (Table 4.16-01). Considerations used to select the reservoirs and tailwaters included representation of the various physiographic regions in the TVA study area, representation of both mainstem and tributary reservoirs, and the amount of available data.

4.16.2 Regulatory Programs and TVA Management Activities

Regulatory Programs

Section 26a of the TVA Act provides TVA with permit authority for structures along the shoreline. This regulation allows TVA to require applicants to incorporate erosion control measures into the design and construction of docks and other alterations fronting waterfront property.

Table 4.16-01 Representative Reservoirs Used in the Erosion Analysis

Reservoir	Physiographic Region	Reservoir Type
Chatuge	Blue Ridge	Tributary storage
Douglas	Valley and Ridge	Tributary storage
Fort Loudoun	Valley and Ridge	Mainstem storage
Nickajack	Cumberland Plateau	Mainstem run-of-river
Tims Ford	Highland Rim	Tributary storage
Normandy	Highland Rim	Tributary storage
Pickwick	Coastal Plain	Mainstem storage

TVA Management Activities

Hydro Modernization Projects. TVA is rehabilitating and modernizing the hydro turbine units at various dams. HMOD projects seek to improve operating efficiency and provide additional peak generating capacity while maintaining safe and reliable peak power generation. Because the modernization of the units may potentially increase peak flows and change flow, TVA investigates the potential effects on erosion in the tailwater. The investigations are incorporated into EAs under NEPA where appropriate. TVA has prepared EAs for its existing HMOD projects and will continue to prepare these assessments as additional units are considered for hydro modernization.

Shoreline Treatment Program. TVA has been conducting a widespread, intensive effort to treat critical erosion sites. Shorelines for the entire TVA reservoir system have been surveyed to identify and prioritize those that are in need of stabilization. Treatment techniques are focused on bioengineering (use of live and dead vegetation for reinforcement and protection of soil) where appropriate, which provide increased benefits to aquatic habitat, water quality, and aesthetics. More intensive treatment techniques, such as riprap, a combination of riprap and bioengineering, gabion walls, or live crib walls are used if needed. TVA typically applies stabilization treatments to approximately 20 critically eroded sites each year (TVA 1998). TVA can treat shorelines only on TVA-owned and managed lands; however, TVA encourages private landowners to implement treatments and provides educational materials and technical support.

4.16.3 Reservoir Shoreline Erosion Conditions

Existing Conditions

TVA has conducted an extensive analysis of the shoreline conditions of each reservoir in its system to prioritize erosion sites for possible future treatment. TVA maintains the Automated Land Information System (ALIS) Shoreline Conditions Database (TVA 2002), a geographic information system (GIS) for storing and graphically displaying shoreline conditions. The ALIS data cover virtually all of the shorelines in the TVA reservoir system. Because of the direct impact on land and property, erosion of shoreline above summer pool has been a greater concern; therefore the data describe the shoreline conditions only at summer pool elevations. No systematic data were available about the shoreline status at winter pool elevations or at intermediate elevations between summer pool and winter pool.

Two rating systems have been used to characterize the shoreline. The Muncy system, used on some TVA reservoirs, was developed to identify and prioritize areas for shoreline stabilization; this system focuses entirely on shoreline erosion conditions, vegetation cover, and land use. The Shoreline Aquatic Habitat Index (SAHI) is used to rate aquatic habitat conditions. While it includes ratings of shoreline erosion and vegetation, the focus of the index is on aquatic habitat structure and conditions in areas that are under water at full pool. The erosion condition metric (good, fair, or poor) from the available system was compiled (see Table 4.16-02 and Figure 4.16-01) to show the extent of erosion on TVA reservoirs. The differences in purpose and frame of reference between the two rating systems must be taken into account when interpreting Table 4.16-02 and Figure 4.16-01.

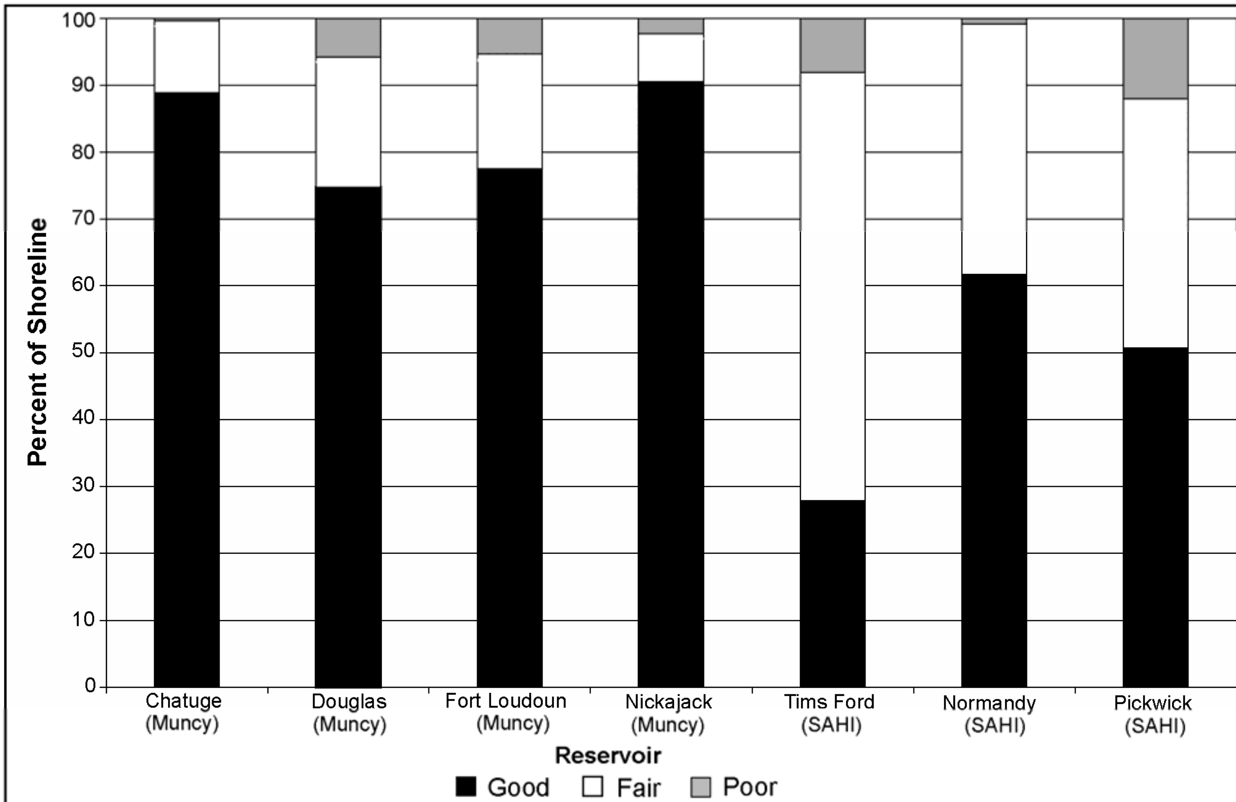
Erosion conditions of the shorelines for the seven representative reservoirs varied, but much of the difference is because of the rating systems used. Among the reservoirs rated using the Muncy system, most (75 to 91 percent) of the shoreline was characterized as being in good shape; a smaller portion (7.2 to 20 percent) was rated fair, and relatively little was rated as poor (0.41 to 5.8 percent). These small percentages represent substantial shoreline length in some cases (up to 26.8 miles of poor shoreline on Douglas). The reservoirs rated using the SAHI were approximately equally good and fair (28 to 62 percent good and 37 to 64 percent fair). Again, the smallest portion was rated poor (0.89 to 12 percent), representing up to 51 miles on Pickwick Reservoir.

Future Trends

Without a change in reservoir operations, erosion in the reservoirs is anticipated to continue through the 2030 study period. Factors such as the 16-percent projected increase in recreational boating (see Section 4.24, Recreation) and the associated boat waves would likely accelerate the erosion of shorelines. The application of treatments and best management practices (BMPs) by TVA and other shoreline landowners would partially reduce erosion effects.

Table 4.16-02 Reservoir Shoreline Erosion Conditions from TVA Automated Land Information System (ALIS) Data

Erosion Conditions	Reservoir						
	Chatuge	Douglas	Fort Loudoun	Nickajack	Tims Ford	Normandy	Pickwick
Rating method	Muncy	Muncy	Muncy	Muncy	SAHI	SAHI	SAHI
Total shoreline miles	128.2	512.7	336.0	137.4	259.0	75.2	491.3
Shoreline miles unrated	0	48.3	0	0	0	0	73.1
Miles erosion rating poor	0.52	347.1	18	3.13	21.13	0.667	50.67
Percent erosion rating poor	0.41	74.7	5.36	2.28	8.16	0.89	12.1
Miles erosion rating fair	13.85	90.53	57.6	9.89	165.8	28.2	155.7
Percent erosion rating fair	10.8	19.5	17.1	7.20	64.0	37.5	37.2
Miles erosion rating good	113.8	26.76	260.4	124.4	72.1	46.3	211.8
Percent erosion rating good	88.8	5.76	77.5	90.5	27.8	61.6	50.6



Notes:
Two rating systems were used to characterize the shoreline: the Muncy system (Muncy) and the Shoreline Aquatic Habitat Index (SAHI).
Because no ratings are available for 48 miles at Douglas, 3.7 miles at Normandy, and 73.1 miles at Pickwick, less than 100 percent of the shoreline has been rated.
Source: TVA data 2003.

Figure 4.16-01 Reservoir Shoreline Erosion Rankings (Percent)

4.16.4 Tailwater Shoreline Erosion Conditions

Existing Conditions

Tailwaters include the waterbodies immediately downstream of dams. Tailwaters can be subdivided into tributary and mainstem tailwaters. Tributary tailwaters are riverine waterbodies, whereas mainstem tailwaters typically are the upstream section of the next downstream reservoir. Data for the conditions of the representative tailwaters were obtained from the erosion potential surveys conducted for HMOD reports and from a field survey program conducted in November 2002. The tailwater surveys generally considered:

- Bank stability at the toe and high-flow areas and evidence of existing erosion;
- Slope and height of the stream bank;
- Canopy cover—the percentage of tree or shrub cover along the bank; and,
- Riparian zone—the width of area adjacent to the bank containing woody vegetation.

Qualitative assessments were made of these characteristics for segments of the river that exhibited consistent properties (for those tailwaters studied for HMOD analysis) or at specific discrete locations along the tailwater (for those tailwaters surveyed by Normandeau Associates in November 2002). The data then were generalized to classify the condition of the entire tailwater. Table 4.16-03 summarizes the results of the surveys.

Table 4.16-03 Tailwater Shoreline Erosion Conditions

Tailwater	Bank Stability	Slope and Height of Bank	Canopy Cover	Riparian Zone
Mainstem Tailwaters				
Fort Loudoun	TBD	TBD	TBD	TBD
Nickajack	Fair to good	Varies from 1.5:1 to vertical, high	Good	Good
Pickwick	Poor	Typically 1:1 and high	Poor to fair	Poor to fair
Tributary Tailwaters				
Tims Ford	Poor to good	Typically 1:1 and low	Fair	Fair
Normandy	Fair to good	Typically 1:1 and low	Fair	Fair
Chatuge	Fair to good	Steep and high	Good	Good
Douglas	Fair to good	Steep and low	Good	Fair

Future Trends

Without a change in reservoir operations, erosion in the tailwaters is anticipated to continue through the 2030 study period. Although recreational use is not thought to be a primary driver in erosion of tributary tailwaters (see Section 5.16), increased recreational boat traffic would likely accelerate the erosion of shorelines. The application of treatments and BMPs by TVA and other shoreline landowners would partially reduce erosion effects.

4.17 Prime Farmland

4.17.1 Introduction

Resource Issues
▸ Farmland conversion

This section addresses soil resources with high agricultural value that are classified as prime farmland. Farmland conversion is the key issue for this resource, with soil erosion as a secondary impact, and was used to determine potential impacts associated with a change in the reservoir operations policy. Farmland conversion occurs by shifting the use of land to non-farm uses, with irretrievable losses occurring when the land is developed. Farmland is considered prime or unique as determined by the appropriate state or local unit of government. Prime farmland is defined as:

> Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion. Prime farmland includes land that possesses the above characteristics but is being used currently to produce livestock and timber. (7 USC 4201 et seq.)

Farmland conversion and soil erosion are expected to occur as a result of both direct and indirect actions as a result of TVA operations. Indirect impacts would result from land use activities occurring in the backlands (lands extending out 0.25 mile from the shoreline and generally in private ownership) that would either influence farmland conversion or increase soil erosion. A direct impact on prime farmland and soils would result from erosion along the shoreline. It is anticipated that the loss of prime farmland as a result of shoreline erosion is small compared to the loss as a result of farmland conversion. Floods also affect farmland; however, the impact of flooding was considered to be a temporary economic impact as it pertains to loss of use and crop loss.

The study area for prime farmlands is the zone around the reservoirs extending 0.25 mile from the shoreline, since this zone is considered to be the area influenced by the reservoir operations policy (TVA 1998). Because the data associated with the 0.25-mile zone are limited, data for counties that border TVA reservoirs were used to interpolate the amount or percentage of prime farmland in the study area. In addition, seven representative reservoirs in the water control system were selected to show current use of prime farmland and how prime farmland has and is currently being converted to other land uses.

4.17.2 Regulatory Programs and TVA Management Activities

Regulatory Programs

As a federal agency, TVA is mandated by the Farmland Protection and Policy Act (FPPA) (7 CFR 658.1 et seq.) to complete a prime farmland review prior to initiating a program. Congress passed the Agriculture and Food Act of 1981 (Public Law 97–98), which contains the FPPA—Subtitle I of Title XV, Section 1539–1549. The FPPA does not authorize the federal government to regulate the use of private or nonfederal land, or in any way to affect the property rights of landowners.

Parcels allocated by TVA for development prior to the passage of the FPPA would be excluded, and the remaining parcels with 10 or more acres of soils classified as prime farmland would be required to complete the FPPA process prior to development. The FPPA excludes land that is "already in" or committed to urban development or water storage from its definition of farmland land:

- Farmland already in urban development includes all lands with a density of 30 structures per 40-acre area.
- Farmland already in urban development also includes lands identified as "urbanized area" on the Census Bureau Map, or as urban areas mapped with a "tint overprint" on the USGS topographical maps, or as "urban built-up" on the USDA Important Farmland Maps (7 CFR 658.2).

Section 26a of the TVA Act established standards to minimize soil erosion by requiring soil stabilization measures and vegetation management, which reduce the erosion potential from development activities. These activities are required for all development projects on lands under TVA's jurisdiction.

TVA Management Activities

As a federal agency, TVA uses the criteria of the FPPA to (1) identify and take into account adverse effects on preservation of prime farmland that may occur due to TVA activities; (2) consider alternative actions, as appropriate, that could lessen the adverse effects; and (3) ensure that TVA programs, to the extent practicable, are compatible with units of state and local government, and other private programs and policies to protect farmland.

This programmatic EIS provides an overview of the prime farmland resource in the TVA region and evaluates potential effects on prime farmland that could result from reservoir operations policy alternatives. More detailed assessments using FPPA criteria will be conducted as LMPs for specific reservoirs are written and updated, and as future specific land-disturbing projects are proposed. Subsequent assessments will complete Form AD 1006, Farmland Conversion Impact Rating, when appropriate (with assistance from the Natural Resources Conservation Service [NRCS]). These assessments will include summarizing total acres of prime farmland to be converted directly and indirectly by a proposed action, and assigning a total score for the rating process.

TVA initiated a comprehensive reservoir lands planning process in 1979. Since that time, LMPs have been completed and approved by the Board for seven mainstem reservoirs. The SMI projected a maximum buildout of 38 percent of the shoreline into residential use by 2023. The land planning process identifies and evaluates the most suitable use of lands under TVA's control and custody, and then allocates the land into clearly defined zones. TVA considers leases for agricultural land as short-term uses with renewable leases, which are compatible with TVA land use zones, and it is assumed that the same zones will protect prime farmland based on allowable uses.

4.17.3 Farmland Conversion

Existing Conditions

Within the counties surrounding TVA reservoirs, approximately 34 percent of the total land area is considered farmland, of which 21 percent (or 62 percent of the farmland) is considered prime farmland (Table 4.17-01). In the study area, the percentage of prime farmland surrounding a reservoir ranges from approximately 3 to 71 percent, based on data from representative reservoirs (Table 4.17-02). Over 50 percent of the prime farmland is in forestland for all six reservoirs (Table 4.17-02). On average, less than 10 percent of prime farmland on these reservoirs is in non-farm use.

The acreage of farmland in the counties surrounding TVA reservoirs has declined 2.9 percent from 1987 to 1997. The highest declines occurred in the tributary reservoirs where there is the lowest total prime farmland acreage presently (Table 4.17-03).

Soil erosion potential is influenced by vegetative cover. Forestland is considered to have the least potential to erode compared to cropland and grassland while bare ground has the highest potential. The majority of the soils bordering the representative reservoirs have a moderate potential for soil erosion based on an erodibility factor (k) of 0.2 to 0.3 (Brady 1990).

Table 4.17-01 Acreage of Prime Farmland in the Tennessee River Watershed

Land Area in Counties Surrounding Reservoirs[1]	1987 Farmland[2]		1997 Farmland[2]		1997 Prime Farmland[3]		Farmland Conversion Rate from 1987 to 1997[2]
Acres	Acres	% Total Land Area	Acres	% Total Land Area	Acres	% Total Land Area	Percent
18,296,866	6,343,153	35	6,165,591	34	3,849,358	21	-2.9

[1] Acreage of counties bordering the TVA reservoirs in this EIS.
[2] Source: Oregon State University Libraries, Corvallis, Oregon. GovStats. (http://govinfo.kerr.orst.edu/php/agri/index.php).
[3] Data provided by the Natural Resources Conservation Service county offices.

Table 4.17-02 Land Use of Prime Farmland within 0.25 Mile of Representative Reservoirs

Reservoir	Reservoir Category [1]	Total Land Within 0.25 Mile (acres) [2]	Prime Farmland		Prime Farmland Land Use			
			Acres [3]	Percent	Forestland (%) [4]	Pasture/ Hay [4] (%)	Row Crops [4] (%)	Non-Farm [4] (%)
Chatuge	TS	11,047	None					
Cherokee	TS	32,088	4,059	13	69	20	4	7
Fort Loudoun	MS	27,914	4,454	16	54	38	6	3
Kentucky	MS	81,779	30,163	37	67	8	8	16
Nickajack	MR	9,085	369	4	57	20	12	11
Normandy	TS	9,831	319	3	75	16	4	5
Tims Ford	TS	24,491	17,443	71	55	18	16	11

[1] TS = Tributary storage; MS = Mainstem storage; MR = Mainstem run-of-river.

[2] Landsat TM imagery (circa 1992).

[3] STATSGO (Natural Resources Conservation Service 1994a-d).

[4] Non-farm includes commercial, industrial, transportation, quarries, strip mines and gravel pits. Data generated by overlaying STATSGO data layer with Landsat TM imagery to which the U.S. Geological Survey land use classification was applied.

Table 4.17-03 Acreage of Farmland by Reservoir Grouping

Reservoir	Reservoir Category[1]	Total Prime Farmland in County [2](acres)	Total Land in County[2] (acres)	Prime Farmland in County (%)	Farmland Conversion Rate[3](%)
Chickamauga	MS	254,688	1,183,360	21.5	-5.2
Fort Loudoun	MS	123,638	843,794	14.7	-7.1
Melton Hill	TR	120,143	938,523	12.8	-6.2
Nickajack	MR	157,503	827,870	19.0	-6.14
Tellico	TS	116,670	936,594	12.5	-7.1
Watts Bar	MS	125,964	731,163	17.2	-6.6
Apalachia	TR	NA[4]	NA		
Blue Ridge	TR	8,345	461,000	1.8	-29.0
Boone	TS	49,500	484,890	10.2	-4.5
Chatuge	TS	10,859	482,886	2.2	-22.0
Cherokee	TS	73,456	961,000	7.6	-12.8
Douglas	TS	98,494	840,860	11.7	-13.0
Fontana[5]	TS	3,114	193,018	1.6	-7.0
Fort Patrick Henry	TR	49,500	484,890	10.2	-7.5
Hiwassee	TS	NA	NA		
Norris	TS	43,492	1,162,068	3.7	-4.0
Nottely	TS	8,345	461,000	1.8	-4.5
Ocoee #1, #2, and #3	TS and TR	19,715	282,900	7.0	-15.9
South Holston	TS	27,153	624,100	4.4	-13.0
Wautaga	TS	23,130	413,360	5.6	-13.0
Wilbur	TR	14,142	222,000	6.4	3.4
Guntersville	MS	391,730	1,595,720	24.5	3.3
Kentucky	MS	1,000,013	3,836,740	26.1	2.2
Pickwick	MS	507,882	1,514,520	33.5	-4.5
Wheeler	MS	1,168,253	2,610,690	44.7	3.6
Wilson	MR	482,196	1,318,570	36.6	6.8
Upper Bear, Bear	TR and TS	54,405	475,870	11.4	-2.0
Normandy	TS	206,922	582,200	35.5	1.6
Tims Ford	TS	138,120	442,100	31.2	-14.22

1 TS = Tributary storage; TR = Tributary run-of-river; MS = Mainstem storage; MR = Mainstem run-of-river.
2 Natural Resources Conservation Service county soil data.
3 Census of Agriculture, 1987 to 1997. Percent change of total farmland acres from 1987 to 1997.
4 NA = Data not available.
5 Farmland data were available only for Graham County, North Carolina. No data were collected on Great Falls Reservoir.

Future Trends

As data were not available on conversion of prime farmland, trends in farmland conversion were based on total cropland data by county from the Census of Agriculture. The Census defines cropland as "land from which crops were harvested or hay was cut; land in orchards, citrus groves, vineyards, nurseries, and greenhouses; cropland used only for pasture or grazing; land in cover crops, legumes, and soil-improvement grasses; land on which all crops failed; land in cultivated summer fallow; and idle cropland."

The Census of Agriculture indicated that from 1987 to 1997 over 50 percent of the counties in the TVA region experienced conversion of farmland to non-farm use, with 20 counties experiencing a conversion of 10 percent or higher (Figure 4.17-01). The Census of Agriculture indicated that 22 counties experienced an increase in farmland, the majority occurring in Alabama (Highland Rim) and along the northern portion of the Kentucky Reservoir (Coastal Plain and Highland Rim). These numbers reflect a strong farm economy in those regions. Overall, the TVA region experienced a 2.9-percent (or a 177,562-acre) decline in farmland (Table 4.17-01).

The decline in farmland in the majority of counties bordering the TVA region is expected to continue based on anticipated land use pressures from development and recreation (as outlined in Section 4.15 [Land Use] and in Section 4.24 [Recreation]). The highest rate of conversion is expected to continue to occur in the eastern portion of the region, based on past trends or population growth around urban centers.

The conversion of prime farmland was projected to 2030 based on the assumption of a fixed rate of conversion, using the average farmland conversion rate for counties bordering the representative reservoirs during the decade from 1987 to 1997 (Table 4.17-04). Further assumptions were made that farmland conversion would occur at a faster rate than forestland conversion, as the characteristics of farmland are considered ideal for development, and all the conversion would affect prime farmland. Based on these assumptions, farmland conversion would be less than the SMI maximum projected buildout of 38 percent by 2023. Kentucky and Normandy Reservoirs would actually experience an increase in prime farmland if current conversion rates continue (Table 4.17-04).

The loss of prime farmland bordering the representative reservoirs would vary between 5 and 37 percent of the total prime farmland within 0.25 mile of each reservoir (Table 4.17-04). The majority of conversions would occur in areas away from the influence of a reservoir operations policy.

Soil erosion would be directly influenced by changes in land use. Soil erosion would continue as land would be converted from forestland, although the degree of erosion would be lessened through practices such as those required by Section 26a. Activities in the backlands that are not under TVA jurisdiction would come under the jurisdiction of county regulations, which may not specify minimum erosion control standards.

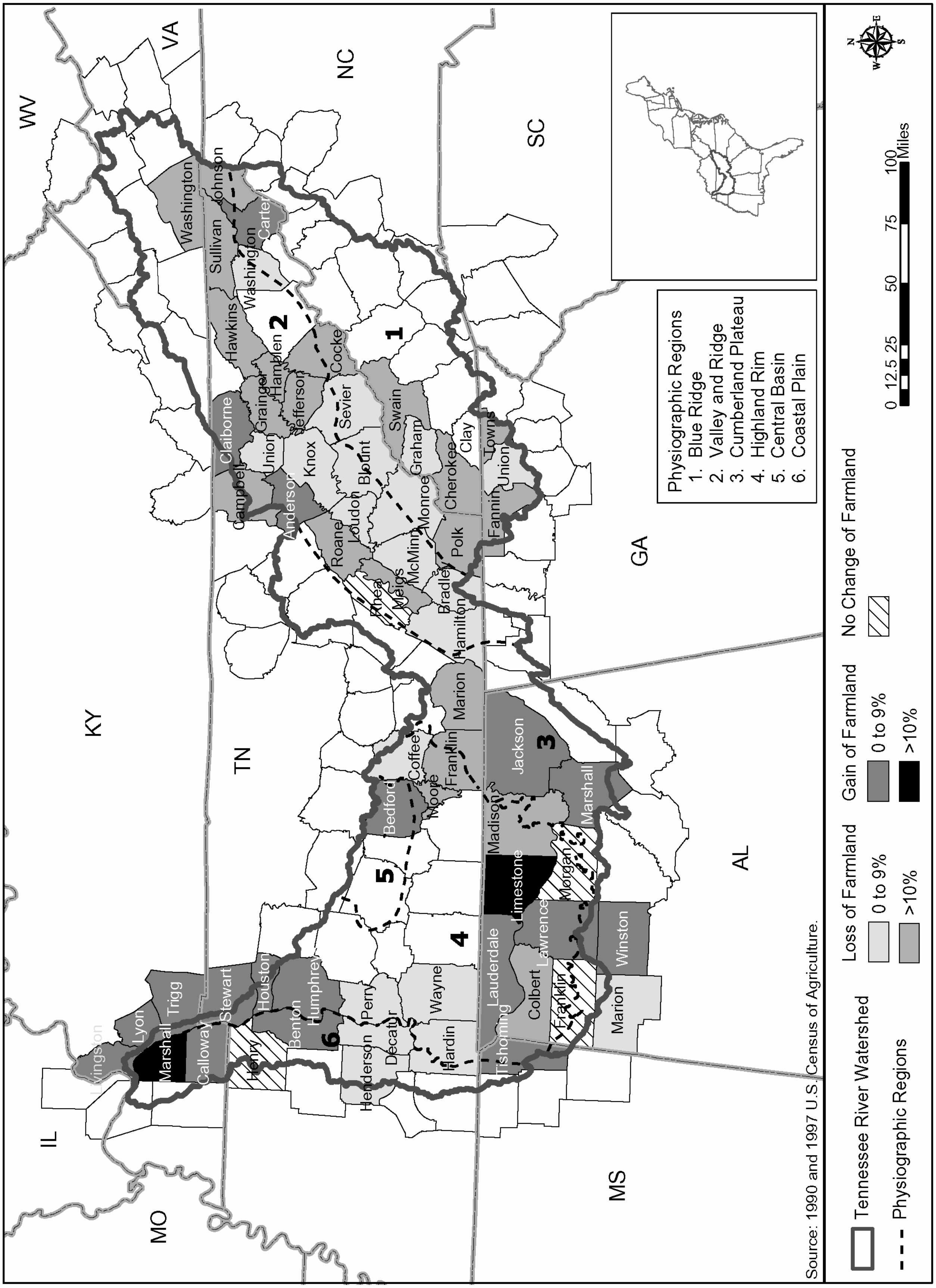


Figure 4.17-01 Farmland Conversion within Counties in the Tennessee River Watershed (1987 to 1997)

Table 4.17-04 Projection of Prime Farmland Conversion within 0.25 Mile of Representative Reservoirs

Reservoir	Total Prime Farmland in Cropland[1] (acres)	Farmland Conversion Rate[2] (%)	Projected Prime Farmland Conversion (acres)				
			2010	2020	2030	Total Converted	SMI Buildout Cap[3]
Chatuge	–[4]	–[4]		–[3]	–[3]		
Cherokee	982	-12.8	-125	-109	-95	-330	373
Fort Loudoun	1,926	-7	-136	-127	-118	-380	732
Kentucky	5,032	+2.2	110	113	115	+338	1,912
Nickajack	119	-6.1	-7	-7	-6	-21	45
Normandy	65	+1.6	+1	+1	+1	+3	25
Tims Ford	5,891	-14.2	-838	-719	-616	-2,173	2,239

1 Sum of pasture/hay and row crops from Landsat TM imagery (circa 1992) (NRCS 1994a-d).

2 Rate based on change in total county acreage from 1987 to 1997 Oregon State University Libraries, Corvallis Oregon. GovStats. Available at http://govinfo.kerr.orst.edu/php/commerce/state/show.php.

3 Shoreline Management Initiative (SMI) maximum buildout of 38 percent.

4 Chatuge Reservoir has no cropland within 0.5 mile of its border.

4.18 Cultural Resources

4.18.1 Introduction

Resource Issues

- Integrity of historic structures and archaeological sites eligible or potentially eligible for listing in the National Register of Historic Places

For this study, cultural resources are defined as historic properties that are archaeological sites or historic structures. Archaeological sites date from approximately 12,000 BC through the historic period, which can be as recent as AD 1950. A historic structure has been standing for 50 years or more. These two types of historic properties are addressed separately in this section because their information in the TVA database is organized separately and because the resources could be affected differently by project operations. The cultural chronology of the TVA reservoir lands is typically divided into five broad periods: Paleoindian (10000-8000 BC), Archaic (8000-1000 BC), Woodland (1000 BC-AD 900), Mississippian (AD 900-1600), and Historic (AD 1600 to present). Some regions include the Gulf Formational (1200-600 BC) as an additional chronological period. A culture history summary is contained in Appendix D7.

For both types of historic properties, the area of potential effect (APE) includes all areas that could be both directly affected by changes in reservoir operations (direct effects) and areas where a change could occur indirectly as a result of change in reservoir operations (indirect effects). The factors that could affect the integrity of cultural resources as a result of changes in reservoir operations include:

- **Shoreline Erosion.** Archaeological sites and historic structures could be affected around the summer pool shoreline, in the winter pool drawdown, and along tailwater streambanks, as discussed in Sections 4.16 and 5.16, Shoreline Erosion.
- **Exposure by Elevation Fluctuations.** Archaeological deposits could be saturated and/or dried out from exposure by elevation fluctuations. Exposure of archaeological sites and historic structures by elevation fluctuations could promote vandalism, looting, and disturbance from recreational activity.
- **Land Development.** Shoreline and back-lying land development could affect archaeological sites and historic structures, as discussed in Sections 4.15 and 5.15, Land Use. Development up to 2 km from the summer pool elevation was considered in this section.
- **Visual Impacts.** Archaeological sites and historic structures could be affected by changes to the view shed as discussed in Sections 4.19 and 5.19, Visual Resources.

4.18.2 Regulatory Programs and TVA Management Activities

Part of TVA's responsibility as a lead agency in preparing an EIS that complies with the NEPA is to address requirements of the National Historic Preservation Act (NHPA) of 1966 and the Archaeological Resource Protection Act (ARPA) of 1979. Section 106 of the NHPA requires that historic properties be taken into consideration during the planning process. Historic properties are defined archaeological sites or historic structures that are eligible or potentially eligible for listing in the National Register of Historic Places (NRHP). The NRHP is the official list of historic properties throughout the nation that are worthy of preservation because of their cultural significance and research potential in American history, architecture, and archaeology. Section 110 of the NHPA pertains to historic properties owned by federal agencies and provides responsibility to federal agencies for the identification, evaluation, and protection of these resources. The primary objective and concern regarding historic properties for the TVA ROS is to identify NRHP-eligible archaeological sites and historic structures that lie within areas affected by project operations.

Impacts on historic properties are considered in the ROS because changes in reservoir operations have the potential to affect the integrity of a property, which could compromise its eligibility for listing in the NRHP. In compliance with Sections 106 and 110 of the NHPA, consideration includes identification, evaluation, and protection of resources.

4.18.3 Archaeological Sites

Existing Conditions

Archaeological investigations in the ROS study area have a long and prominent history, dating back to 19th-century Smithsonian explorations. Although the six physiographic regions vary in size and the archaeological investigations at reservoirs within each region have varied, the summary numbers are useful. A total of 7,726 archaeological sites have been recorded within the APE defined for the ROS (Table 4.18-01). Of these, 2,002 (26 percent) are considered either eligible or potentially eligible for listing in the NRHP.

The number of archaeological sites represented in Table 4.18-01 indicates substantial differences in the number of sites among the reservoirs. This reflects a wide variation in the availability of information about these sites. Some areas have been surveyed more than other areas, and NRHP eligibility has not been assessed for many sites. More comprehensive surveys and site assessments would likely result in a more equal distribution of archaeological sites and NHRP-eligible sites at each reservoir. Consequently, the variation in the distribution in the existing data was not a major consideration in the impact analysis.

Table 4.18-01 Numbers of Archaeological Sites in the Area of Potential Effects

Project and Locations	Recorded Archaeological Sites	NRHP-Eligible or Potentially Eligible Archaeological Sites	NRHP-Listed Archaeological Sites
Mainstem Projects			
Kentucky, KY/TN	330	74	0
Pickwick, AL/MS/TN	516	166	1
Wilson, AL	0	0	0
Wheeler, AL	892	219	0
Guntersville, AL/TN	600	0	0
Nickajack, TN	40	22	0
Chickamauga, TN	397	73	0
Watts Bar, TN	707	400	0
Fort Loudoun, TN	185	15	0
Total mainstem	**3667**	**969**	**1**
Tributary Projects			
Norris, TN	280	71	0
Melton Hill, TN	178	84	0
Douglas, TN	132	7	0
South Holston, TN/VA	70	0	0
Boone, TN	51	3	0
Fort Patrick Henry, TN	65	0	0
Cherokee, TN	460	355	0
Watauga, TN	105	0	0
Wilbur, TN	Unknown	0	0
Fontana, NC	21	0	0
Tellico, TN	735	218	0
Chatuge, NC/GA	227	9	0
Nottely, GA	185	17	0
Hiwassee, NC	258	158	0
Apalachia, NC	16	2	0
Blue Ridge, GA	143	49	0
Ocoee #1, TN	20	10	0
Ocoee #2, TN	Unknown	0	0
Ocoee #3, TN	Unknown	0	0
Tims Ford, TN	163	5	0
Normandy, TN	183	0	0
Great Falls, TN	Unknown	0	0
Upper Bear Creek, AL	237	21	0
Bear Creek, AL	231	22	0
Little Bear Creek, AL	238	0	0
Cedar Creek, AL	61	2	0
Total tributary	**4,059**	**1,033**	**0**
Total projects	**7,726**	**2,002**	**1**

NRHP = National Register of Historic Places.

Although the entire TVA shoreline has not been surveyed, substantial archaeological information exists about the project study area. This information was used to develop a predictive model concerning the potential for the occurrence of archaeological sites in uninventoried locations. Known archaeological sites that were used in the predictive model analysis are located between the minimum winter pool elevation and 2 km of the maximum summer pool shoreline (Tables 4.18-02 and 4.18-03).

Of the 3,246 archaeological sites between the maximum summer pool (June 1) elevation and the minimum winter pool (January 1) elevation, the majority of the sites (1,955) have an identified prehistoric component, 605 have a historic component, 568 are multicomponent, and 121 have an unidentified prehistoric cultural affiliation. Approximately 37 percent of the sites located between the summer and winter elevations have been recommended as eligible or potentially eligible for inclusion in the NRHP.

Of the 7,726 archaeological sites within the APE, the majority of the sites (4,758) have an identified prehistoric component, 1,365 archaeological sites are historic, 1,005 are multicomponent, and 560 have an unidentified prehistoric cultural affiliation. Approximately 25 percent of the sites located within the APE have been recommended as eligible or potentially eligible for inclusion in the NRHP.

The probability model determined that slightly over 20 percent of the study area was classified as having a high to moderate potential for the occurrence of archaeological sites.

Future Trends

Continued operations under the existing reservoir operations policy (or the Base Case) would adversely affect archaeological sites. Direct effects of reservoir operations on archaeological sites are erosion and exposure by elevation fluctuations. Erosion occurs along the summer pool shoreline, in the winter pool drawdown, and along the tailwater streambanks.

Summer elevations erode archaeological sites along the shoreline and have the potential to disturb vulnerable cultural remains along the shoreline and above the summer pool elevation through recreational activities and human intrusions from camping, boating, and hiking. Winter pool elevations expose sites in the drawdown to erosion and archaeological deposits to saturation and drying. Sites in the drawdown are also indirectly affected by vandalism and looting.

Other indirect impacts on archaeological sites include development of shoreline- and back-lying land. Development often occurs as an indirect result of TVA operations (recreation and industrial development), impacts on archaeological sites are indirect because TVA does not undertake these actions specifically.

Table 4.18-02 Cultural Affiliation of Archaeological Sites Located between Summer and Winter Pool Elevations

Reservoir	Total Sites	Prehistoric	Historic	Multi-Component	Unknown Affiliation	NRHP-Eligible Sites
Apalachia	4	3	0	1	0	2
Boone	9	1	5	3	0	1
Fort Patrick Henry	0	0	0	0	0	0
Hiwassee	253	143	42	65	3	82
Norris	167	71	55	40	1	40
Ocoee	20	10	3	7	0	10
South Holston	12	3	3	6	0	0
Watauga	5	5	0	0	0	0
Watts Bar	375	166	164	45	0	289
Cherokee	388	78	145	148	20	318
Douglas	93	30	19	37	7	1
Chickamauga	250	215	14	12	9	42
Bear Creek	3	2	1	0	0	1
Cedar Creek	38	38	0	0	0	1
Little Bear Creek	112	88	4	20	0	0
Upper Bear Creek	0	0	0	0	0	0
Blue Ridge	58	38	5	15	0	24
Chatuge	193	94	37	59	3	6
Fontana	3	1	1	1	0	0
Nottely	126	89	3	34	0	5
Kentucky	131	94	15	20	2	10
Pickwick	235	230	2	3	0	90
Guntersville	115	37	0	4	74	0
Wheeler	383	364	7	10	2	113
Wilson	0	0	0	0	0	0
Fort Loudoun	23	9	13	1	0	15
Tellico	208	107	66	35	0	145
Melton Hill	13	10	1	2	0	5
Nickajack	0	0	0	0	0	0
Normandy	21	21	0	0	0	0
Tims Ford	8	8	0	0	0	0
Total	**3,246**	**1,955**	**605**	**568**	**121**	**1,193**

Note: NRHP = National Register of Historic Places.

Table 4.18-03 Cultural Affiliation of Archaeological Sites in the Area of Potential Effect

Reservoir	Total Sites	Prehistoric	Historic	Multi-Component	Unknown Affiliation	Potentially Eligible/NRHP-Eligible Sites
Apalachia	16	9	5	2	0	2
Boone	51	17	23	11	0	3
Fort Patrick Henry	65	20	5	21	19	0
Hiwassee	258	116	43	98	1	158
Norris	280	65	125	50	40	71
Ocoee	20	10	3	7	0	10
South Holston	70	49	11	12	2	0
Watauga	105	72	2	13	18	0
Watts Bar	707	378	260	69	0	400
Cherokee	460	110	181	163	6	355
Douglas	132	69	28	35	0	7
Chickamauga	397	302	67	28	0	73
Bear Creek	231	194	31	6	22	22
Cedar Creek	61	59	1	1	0	2
Little Bear Creek	238	191	14	33	0	0
Upper Bear Creek	237	212	10	5	0	21
Blue Ridge	143	80	27	25	11	49
Chatuge	227	105	66	46	10	9
Fontana	21	3	11	7	0	0
Nottely	185	77	13	40	1	17
Kentucky	330	181	54	40	55	74
Pickwick	516	446	36	12	22	166
Guntersville	600	205	87	59	249	0
Wheeler	892	711	24	53	104	219
Wilson	0	0	0	0	0	0
Fort Loudoun	185	80	83	22	0	15
Tellico	735	532	99	104	0	218
Melton Hill	178	125	29	24	0	84
Nickajack	40	28	9	3	0	22
Normandy	183	177	1	5	0	0
Tims Ford	163	135	17	11	0	5
Total	**7,726**	**4,758**	**1,365**	**1,005**	**560**	**2,002**

Note: NRHP = National Register of Historic Places.

4.18.4 Historic Structures

Existing Conditions

A total of 5,322 historic structures have been recorded within the APE (Table 4.18-04). Of these, 233 are considered either eligible or potentially eligible for listing in the NRHP, 85 are listed in the NRHP, and nine NRHP historic districts have been recorded—one each at Little Bear, Normandy, Pickwick, Tims Ford, and Wheeler Reservoirs; and four at Wilson Reservoir. In addition, Wilson Dam is listed as a National Historic Landmark, the only such designated TVA property, as well as the only such property within the TVA study area.

The majority of the historic structure data came from individual county surveys on file at State Historic Preservation Offices and from past TVA surveys, primarily associated with TVA lands planning. Many of these surveys are incomplete or out of date. Recent comprehensive work at South Holston, Douglas, Chatuge, Normandy, and Tims Ford Reservoirs and partial coverage at Boone, Fort Patrick Henry, and Norris Reservoirs supplemented these surveys.

The number of historic structures represented in Table 4.18-04 indicates substantial differences in the number of structures among the reservoirs. This reflects a wide variation in the availability of information about these structures. Some areas have been surveyed more than other areas, and NRHP eligibility has not been assessed for many structures. More comprehensive surveys and structure assessments would likely result in a more equal distribution of structures and NHRP-eligible structures at each reservoir. Consequently, the variation in the distribution in the existing data was not a major consideration in the impact analysis.

Future Trends

The formation of reservoirs on the Tennessee River mainstem and its tributaries uprooted historic cultural settlement patterns and permanently changed the cultural geography of those regions. Sufficient time has passed, and these reservoirs are now historically significant and potentially eligible for listing in the NRHP, as are their dams and hydropower plants. Inundation reduced the available farmlands in reservoir valleys, with many of the remaining fragmented farms being sold off and their farm buildings abandoned. From the time of the formation of the TVA reservoirs, it was policy to develop and encourage state parks, recreational facilities, and family summer communities. TVA promoted the enhancement and use of its new reservoirs for the benefit of all the public.

Continued operations under the existing reservoir operations policy (the Base Case) would adversely affect historic structures. A direct effect of reservoir operations on historic structures is erosion. Erosion occurs at historic structures located below the summer pool elevation. These include TVA dams, pre-TVA hydro-development structures, and extant pre-inundation structures.

Table 4.18-04 Numbers of Historic Structures in the Area of Potential Effects

Project and Location	Recorded Historic Structures	NRHP-Eligible or Potentially Eligible Historic Structures	NRHP-Listed Historic Structures/Districts
Mainstem Projects			
Kentucky, KY/TN	438	1	12
Pickwick, AL/MS/TN	151	2	1
Wilson, AL	21	1	4
Wheeler, AL	546	1	7
Guntersville, AL/TN	1,223	64	6
Nickajack, TN	50	1	0
Chickamauga, TN	138	1	10
Watts Bar, TN	91	1	10
Fort Loudoun, TN	139	1	2
Total mainstem	**2,797**	**73**	**52**
Tributary Projects			
Norris, TN	421	22	0
Melton Hill, TN	19	1	5
Douglas, TN	413	47	4
South Holston, TN/VA	184	17	1
Boone, TN	89	4	5
Fort Patrick Henry, TN	73	1	0
Cherokee, TN	362	12	8
Watauga, TN	67	1	0
Wilbur, TN	0	1	0
Fontana, NC	28	1	3
Tellico, TN	269	6	3
Chatuge, NC	25	4	2
Nottely, GA	23	5	2
Hiwassee, NC	25	1	2
Apalachia, NC	1	1	0
Blue Ridge, GA	38	1	0
Ocoee #1, TN	1	2	0
Ocoee #2, TN	0	1	0
Ocoee #3, TN	1	1	0
Tims Ford, TN	158	3	1
Normandy, TN	93	1	4
Great Falls, TN	111	1	0
Upper Bear Creek, AL	63	2	0
Bear Creek, AL	2	2	1
Little Bear Creek, AL	14	1	1
Cedar Creek, AL	45	21	0
Total tributary	**2,525**	**160**	**42**
Total projects	**5,322**	**233**	**94**

Notes: Due to incomplete or out of date surveys, these numbers do not necessarily reflect the actual number of sites at each reservoir.
NRHP = National Register of Historic Places.

Indirect effects of reservoir operations include development and visual impacts. Large industrial complexes associated with barge facilities have displaced farms, as well as other historic features, along the reservoirs. Residential lake front and lake view development has also become popular, and marina development has accelerated. These new large-scale developments adversely affected the remaining historic buildings and their landscapes.

Another indirect effect is the development of back-lying land. The remaining farmsteads in view of the reservoirs are being replaced with development tracts; the historic buildings that are retained (if any buildings are retained, typically only the house is) lose their historic context. This accelerating residential development is changing extensive areas of open farmland or woodland surrounding the reservoirs. The practice of building a new individual house on a single tract has been replaced by large-tract development that takes up entire farms. The already diminished number of remaining historic buildings and historic landscapes are being lost rapidly.

Development can affect the scenic integrity of adjacent historic resources. The transformation of historic rural and agricultural landscapes into dense and usually upscale housing developments is the most widespread adverse impact on historic structures and their landscapes.

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4.19 Visual Resources

4.19.1 Introduction

Scenic resources are an important component in the management of TVA reservoirs and associated shoreline environments. The factors affecting the visual resources issues that are associated with a change in reservoir operations are:

Resource Issues

- Scenic attractiveness
- Scenic integrity
- Landscape visibility

- The barren zone or "bath tub ring" that occurs immediately around the shoreline as reservoir levels are drawn down.
- Exposure of reservoir bottoms and flats at lower pool levels.
- Shoreline development and land use patterns that are a component of the existing reservoir landscape character.

The first two factors are direct effects of lower pool levels while the third factor, for this study, is associated with indirect effects. As identified in Section 5.15, Land Use, proposed changes in reservoir operations could accelerate shoreline residential development around tributary reservoirs by enhancing their recreational and aesthetic appeal. An increase in development ultimately could lead to a reduction in the scenic quality of shoreline environments. All three identified factors are influenced by the timing and duration at which the reservoirs are at or near their full summer pool levels.

Evaluating the visual effects of pool level fluctuations was based on detailed reviews and analyses of nine representative reservoirs, which are identified in Table 4.19-01. These reservoirs were selected to represent the variety in landscape character associated with the different physiographic regions of the project area. The attributes of landform and vegetation combined with the land use patterns occurring in these regions define the landscape character of the different reservoir and tailwater environments.

The greatest differences in landscape character and scenic quality occur between the tributary reservoirs located in the steeper hills and mountainous terrain of eastern Tennessee, North Carolina, and northern Georgia and the mainstem reservoirs located in the flatter terrain of central and western Tennessee, northern Alabama, and western Kentucky.

The selection of specific reservoirs for study was also based on representation of mainstem and tributary reservoirs, different extremes in pool level fluctuation and the resulting range of conditions affecting scenic quality. Variations in recreational and other land uses that could influence users' perceptions of the landscape's visual importance were also considered. Field observations were made at different pool elevations and from a range of viewing locations that included a variety of recreational, residential, and highway settings.

Table 4.19-01 Primary Visual Attributes of Representative Reservoirs

Reservoir	Physiographic Region	Pool Level Fluctuation (feet)[1]	Present Land Uses
Tributary Reservoirs			
Boone	Valley and Ridge	26.0	Recreation, residential, forest/ conservation
Cherokee	Valley and Ridge	44.0	Recreation, residential
Fontana	Blue Ridge	78.0	Recreation, forest/conservation
Tims Ford	Highland Rim	18.0	Recreation, residential, urban, forest/ conservation
Watauga	Blue Ridge	26.0	Recreation, forest/conservation
Mainstem Reservoirs			
Chickamauga	Valley and Ridge	7.5	Recreation, residential, urban
Guntersville	Cumberland Plateau	2.0	Recreation, residential, urban, industrial, forest/conservation
Kentucky	Highland Rim Coastal Plain	5.0	Recreation, residential, urban, industrial, forest/conservation
Wheeler	Highland Rim	6.0	Recreation, residential, urban, industrial, forest/conservation

[1] Values represent the approximate differences in targeted elevations between summer and winter pool levels under the existing operations policy.

Run-of-river projects were also considered when selecting representative reservoirs. The minimal fluctuation in water levels that characterizes these projects does not result in noticeable visual effects. All nine reservoirs in Table 4.19-01 are classified as storage projects. In this group, however, fluctuation levels for Guntersville are comparable to those found in run-of-river projects. These fluctuations are minimal when compared to the greater changes in pool levels that are associated with other storage projects.

4.19.2 Regulatory Programs and TVA Management Activities

Regulatory Programs

The SMI (TVA 1998) established an integrated management approach that conserves, protects, and enhances shoreline resources, including visual resources. The upgraded standards and specific guidelines adopted under this plan promote the use of best management practices for construction of docks, management of vegetation, stabilization of shoreline erosion, and other shoreline alterations. The SMI also promotes the voluntary establishment of conservation easements to protect scenic landscapes.

TVA Management Activities

TVA classifies the quality and value of scenery using criteria adapted from a Scenery Management System (SMS) developed by the U.S. Forest Service (USFS) (USDA 1995). TVA has integrated this modified evaluation method into its current planning and environmental review processes. Most TVA reservoir LMPs written or updated since the SMI reflect the SMS process in the descriptions of the existing conditions for visual resources. Visual attributes identified through the SMS process are further used during lands planning to allocate lands or parcels with distinct visual characteristics as Sensitive Resource Management and Natural Resource Conservation Zones. This evaluation method was also used for the ROS EIS.

4.19.3 Descriptions of Scenic Value

TVA's scenic value criteria that were used to describe and assess the visual resources within the scope of this project address three key areas of scenic importance: scenic attractiveness, landscape visibility, and scenic integrity. Table 4.19-02 summarizes the current scenic conditions for each of the representative reservoirs according to these parameters, as described in the following sections.

Scenic Attractiveness

Scenic attractiveness is a measure of scenic quality and its importance based on the perception of natural beauty that is expressed in the features of a landscape. An important attribute of scenic attractiveness for the project area is the distinct shoreline that is present for each reservoir, as these are clearly visible zones where the water features make their mark on the land (Burton et al. 1974). The highest level of scenic attractiveness is present when the shorelines exhibit a positive and natural-appearing relationship within the landscape. This includes both the shoreline edge and the adjacent visible land along the reservoir shore.

Research has indicated that lines or edges in a landscape composition, such as those created by shorelines, tend to be focus points when one first observes a specific view (Burton 1984). The more contrasting the shoreline, the higher is its probability of being a primary focus point. This factor is important to viewing the shorelines of both tributary and mainstem reservoirs, but the more dramatic drawdown levels of the tributary reservoirs tend to make the shoreline contrast more distinctive for these waterbodies.

KEY AREAS OF SCENIC IMPORTANCE

Scenic Attractiveness—a measure of scenic quality and its importance is based on the perception of natural beauty that is expressed in the features of a landscape.

Landscape Visibility—a combination of several factors that include the context of those viewing the landscape and the concern they have toward the scenic value of the land.

Scenic Integrity—the measure of disturbance to a landscape and the degree to which the landscape deviates from the character and quality that are desired and valued for its scenic attractiveness.

Table 4.19-02 Existing Scenic Conditions for Representative Reservoirs

Reservoir	Scenic Attractiveness	Landscape Visibility	Existing Scenic Integrity
Tributary Reservoirs			
Boone	• Moderate to high • Substantial forested, natural-appearing shoreline surrounded by hills	• High concern level • High opportunity for viewing • Recreational use • Substantial residential development	• Typical drawdown is 26 feet • Compared to other reservoirs, high water level is held longer (mid-May to early September) • Low water levels create ring effect and expose flats • High amount of shoreline residential development and related facilities
Cherokee	• Moderate to high • Flat to gently rolling terrain • Wooded hillsides and rural countryside; island and bluffs present	• Moderate to high concern level • High opportunity for viewing • High amount of recreational use, with many public access areas, county and municipal parks, resorts, state parks, and a wildlife management area • Residential development present • High elevation viewpoint present (Panther Creek Vista)	• Typical drawdown is 44 feet • Substantial drawdown creates highly contrasting ring effect and large area of flats • High water elevation is of short duration • Ring effect is evident most seasons of year • Moderate shoreline development
Fontana	• High • Remote and isolated • Steep forested slopes in mountainous terrain • Mostly natural-appearing shoreline	• Moderate to high concern level • Limited opportunity for viewing but presence of several higher elevation view points • Moderate recreational use (wilderness hikers and campers) • Crossing of Appalachian Trail at dam • Reservoir bordered by Great Smoky Mountains National Park	• Typical drawdown is 78 feet • Exhibits highly visible and contrasting ring effect • High water level is maintained from end of May through early July • Little shoreline development

Table 4.19-02 Existing Scenic Conditions for Representative Reservoirs (continued)

Reservoir	Scenic Attractiveness	Landscape Visibility	Existing Scenic Integrity
Tributary Reservoirs (continued)			
Tims Ford	• Moderate to high • Rural area with attractive reservoir • Flat to gently rolling terrain with high amount of natural-appearing vegetated shoreline	• Moderate to high concern level • Moderate opportunity for viewing • Moderate recreational use (especially canoeing and kayaking) • Residential development present • Two communities on tailwaters	• Typical drawdown is 18 feet • Exhibits contrasting ring effect and some bottom or flats exposure • Maximum pool levels are maintained from mid-May through mid-October • Moderate shoreline development
Watauga	• High • Mostly forested, natural-appearing shoreline surrounded by steep, mountainous terrain • Identified as one of the most scenic reservoirs in the Tennessee River watershed	• Moderate to high concern level • Moderate opportunity for viewing • Recreational use • Crossing of Appalachian Trail at dam • Surrounded by Cherokee National Forest	• Typical drawdown is 26 feet • Exhibits highly contrasting ring effect • High water elevation is of short duration • Ring effect is evident most seasons of the year • Little shoreline development
Mainstem Reservoirs			
Chickamauga	• Moderate • Some rock outcrop, bluff formations, and wetlands but no unique features	• Moderate • High opportunity for viewing • High recreational use • Residential development present	• Typical headwater drawdown is from 5.5 to 7.5 feet • Some exposed bottom is evident at low water elevations, including the Patten Island–Harrison Bay area (with high scenic value) • Pool elevation is held at higher water levels from mid-April through first of October • Mixed land uses, including industrial and urban

Table 4.19-02 Existing Scenic Conditions for Representative Reservoirs (continued)

Reservoir	Scenic Attractiveness	Landscape Visibility	Existing Scenic Integrity
Mainstem Reservoirs (continued)			
Guntersville	• Moderate to high • Attractive islands, rock bluffs, secluded coves, wetlands, agricultural lands, and wooded ridges • Substantial amount of undisturbed shoreline and natural-appearing landscape	• Moderate to high concern levels • High opportunity for viewing • High recreational use • Residential development; some on ridgeline, with opportunity for high elevation views	• Typical headwater drawdown: the reservoir is virtually stable at 1 to 2 feet • 1-foot fluctuation occurs from April 1 through November 1 • Noticeable development; several communities and urban areas located adjacent to reservoir
Kentucky	• Moderate to high • Narrow southern half that is more characteristic of a river (Large extent of undeveloped, natural-appearing vegetated shoreline) • Wide expanse of water in northern half, with higher level of development present but large extent of natural-appearing shoreline remaining	• Moderate to high • Low to moderate opportunity for viewing in southern half • Moderate to high opportunity for viewing in northern half • State parks, commercial recreational developments, Land Between the Lakes National Recreation Area in northern half	• Typical headwater drawdown is 5 feet • High water level is maintained from late April through end of June • Flood conditions occasionally occur • Moderate shoreline development evident around northern half • Industry is present

Table 4.19-02 Existing Scenic Conditions for Representative Reservoirs (continued)

Reservoir	Scenic Attractiveness	Landscape Visibility	Existing Scenic Integrity
Mainstem Reservoirs (continued)			
Wheeler	• Low to moderate • Primarily level to slightly rolling terrain • Riverine character in upper third of reservoir, with little erosion, numerous high rock bluffs, and natural-appearing shoreline • More lake-like setting in mid portion; Wheeler National Wildlife Refuge on north shore • Less developed in remaining portion, with more natural-appearing shoreline; highly eroded main channel • Areas of scenic interest provided by embayments	• Low to moderate concern level • High opportunity for viewing • Does not support residential densities of other TVA reservoirs • Lower boating and recreational use than other reservoirs	• Typical headwater drawdown is from 4 to 6 feet • High water elevation is maintained from mid-April through August 1 • Numerous areas of flats are evident at maximum drawdown levels • City of Decatur is a highly visible urban area along the shoreline • Industry is present • Overhead utility lines are highly visible

Sources: TVA 1985, 1988, 1999a, 1999b, 2001a, 2001b, and 2001c; TVA Resource Group 1995; TVA Resource Development Group 1989.

Landscape Visibility

Landscape visibility is a combination of several factors that include the context of those viewing the landscape and the concern they have toward the scenic value of the land. Other factors include duration of view; number of viewers; viewing distance; and discernible details that can be influenced by light/shadow, atmospheric conditions, and air quality.

The highest user concern levels related to scenic values are associated with recreational uses and residential areas. Users in these categories have expressed that longer durations of pool levels at the higher elevations would be more desirable for the maintenance of scenic values of the reservoirs. Landscapes related to recreational and residential uses are most often viewed within the foreground zone, where detail is highly evident. In general, there was also greater opportunity to make observations from high-elevation viewpoints with respect to tributary reservoirs, because of the steeper terrain surrounding these features.

The primary period for scenic viewing of and from the reservoirs occurs in late spring through late fall. The fall foliage season, starting in mid- to late-October is an important time for viewing landscapes associated with the Tennessee River Valley and its tributaries. During this period, most tributary reservoirs are under unrestricted drawdown, and lower pool levels are a part of existing scenic views.

The lowest pool levels are observed from late fall to early winter; pools reach their lowest elevation points in late December. During this period, the deciduous vegetation has dropped its leaves and the visibility of reservoir shorelines is higher than at other times of the year. In addition, recreational and seasonal home use is at its lowest point.

Scenic Integrity

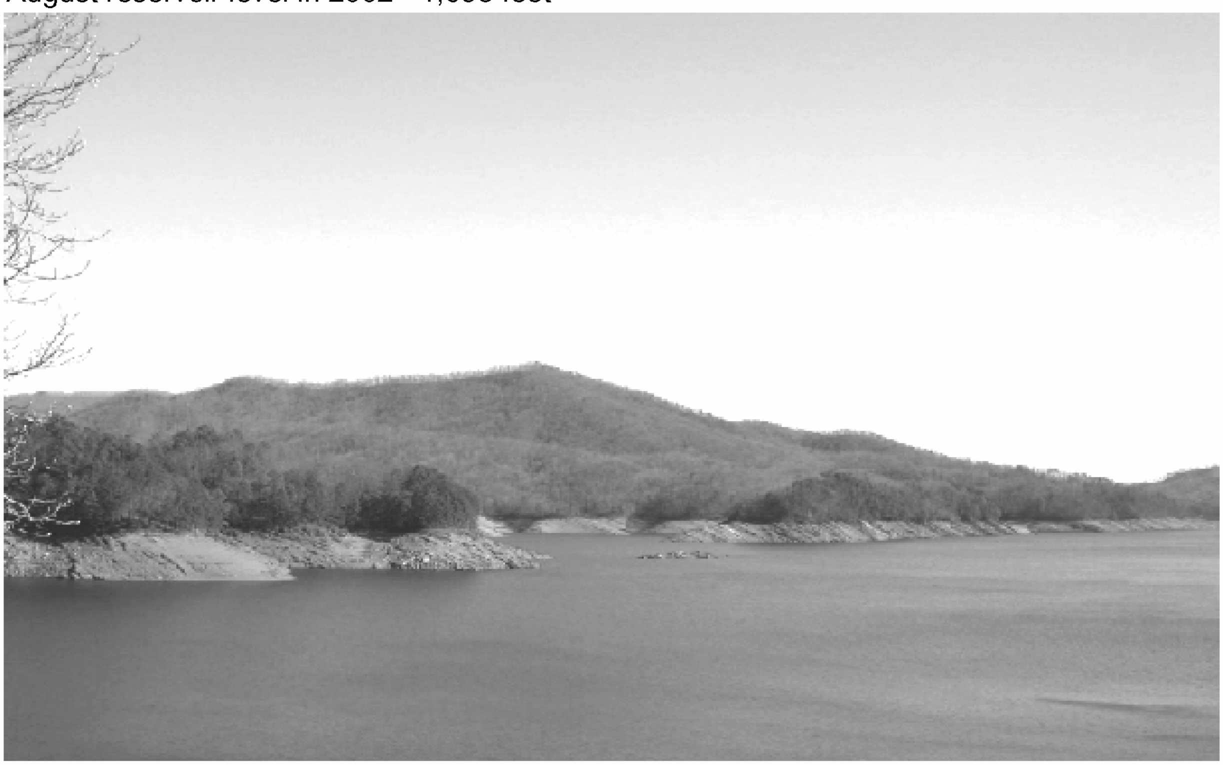
Scenic integrity is the measure of disturbance of a landscape and the degree to which the landscape deviates from the character and quality that are desired and valued for its scenic attractiveness. Scenic integrity is influenced by both the type and degree of shoreline development and pool elevations. Water fluctuations vary widely within the TVA system and produce different visual effects; some result in high visual contrast in the landscape. Attributes that affect scenic integrity are discussed in the following sections that describe the affected environment for each visual resource issue.

4.19.4 Barren Drawdown Zone or Shoreline Ring

Existing Conditions

Fluctuation of pool levels, in combination with the steeper slopes of the tributary reservoirs, exposes what is referred to as the bathtub ring or barren drawdown zone around the shoreline (Figure 4.19-01). Soil coloration also affects the visual impact of the exposed shoreline; the light brown to orange colors contrast with those of the water and shoreline vegetation.

August reservoir level in 2002 - 1,698 feet



January reservoir level in 2003 - 1,642 feet (56 feet lower than August level)

Source: Thomas Kokx Associates 2003.

Figure 4.19-01 The "Ring Effect" from Lower Water Levels - Observed from Fontana Reservoir at an Overlook Site near the Dam

This ring may be evident at any time throughout the year. The degree of contrast created is in proportion to the drop in water level and amount of shoreline exposed. Contrast becomes maximized in reservoirs such as Fontana that experience the largest difference in pool elevations. In some cases, especially when the effects are extreme, the contrast may be observed in a different context and viewed as a point of interest. This occurs when a large amount of highly contrasting shoreline takes on a layered sculpture appearance.

The ring effect also occurs, but usually is not as dramatic, in the flatter terrain associated with the mainstem reservoirs such as Chickamauga and Wheeler. These reservoirs have occasional steeper slopes or rock bluffs. On rock bluffs, the ring effect may be more evident as discoloration of the rock.

Although the ring effect distracts from the natural appearance of the shoreline, a threshold between 3 and 6 feet of normal full pool level for tributary reservoirs seems to be an acceptable part of the landscape associated with reservoir operations. Beyond this range and, depending on other reservoir attributes, the integrity of the shoreline starts to diminish and continues to decline as the water levels drop further. The ring effect is less of an issue with mainstem reservoirs. It was noted during field observations that the presence of erosion contributes to reduced visual integrity, especially when erosion occurs in combination with the ring effect.

Future Trends

No trends are in place to change the existing occurrences of the ring effect.

4.19.5 Exposure of Reservoir Bottoms and Flats

Existing Conditions

Lower winter pool levels often result in the exposure of reservoir bottoms and flats. This visual change in reservoir character is created in shallower portions of the reservoir and becomes most evident in the tailwater and embayment areas (Figure 4.19-02). Tailwater areas often revert to characteristics common of the original river environment, including wide, barren shorelines, and may create discoloration of rock bluffs along the river channel (Figure 4.19-03). Exposure of reservoir bottom areas is common to both tributary and mainstem reservoirs but occurs more frequently in the mainstem reservoirs.

The visual effect for mainstem reservoirs from lower winter pool levels can range from the occurrence of sandbars and small islands to extensive flat areas that are dry with exposed ground. Many of these large, exposed flat areas are associated with wildlife management areas or other natural areas that exhibit wetland characteristics. Consequently, their appearance tends to blend in an acceptable degree with the surrounding landscape. In other cases, the flats are a notable part of residential viewsheds, where the change in landscape character is not as acceptable and was interpreted as creating a lower level of scenic integrity.

August reservoir level in 2002 - 1,382 feet

January reservoir level in 2003 - 1,361 feet (21 feet lower than August level)

Source: Thomas Kokx Associates 2003.

Figure 4.19-02 The Effects of Lower Pool Levels on Exposing Reservoir Bottom and Flats--Boone Reservoir Observed from a Rural Road Adjacent to a Residential Area

The upper and lower photos illustrate a summer and winter elevation difference of 21 feet.

Source: Thomas Kokx Associates 2003.

Figure 4.19-03 The Effects of Lower Pool Levels - Upper Boone Reservoir Observed from Highway 11E near Bluff City

Each reservoir exhibits its own combination and degree of visual effects with respect to its operating plan. In comparison to the major pool elevation differences for Fontana Reservoir, Guntersville Reservoir exhibits little difference in pool level fluctuation—resulting in minimal effects on scenic integrity. Its existing character and level of scenic attractiveness is maintained throughout the year. The same can be said for reservoirs classified as run-of-river projects. Cherokee Reservoir and reservoirs with similar landscape characteristics display a combination of effects related to both shoreline rings and exposed reservoir bottoms. These combinations create lower levels of scenic integrity.

It was noted during field observations that exposed shorelines or reservoir bottoms alone do not create the lowest level of scenic integrity, but rather exposure of other visible elements from lower water levels. Woody debris, trash, riprap, underwater structures such as rubber tires used for fish habitat, and floating structures sitting on the bottom add unattractive visual contrast to the area viewed (Figure 4.19-04).

It is also important to note that, for some of the mainstem reservoirs, flood conditions create shoreline conditions that do not appear natural. For example, vegetated areas, normally above water, are covered; shoreline structures float higher than their moorings; and parking lots or other recreational facilities are submerged in water.

Future Trends

Introduction of new floating structures associated with residential development, construction of additional fish habitat structures, and other new shoreline structures allowed under current guidelines would create new visible and potentially distracting elements in the viewed landscape that, in combination with exposed reservoir bottoms and flats, would further decrease visual integrity over time.

4.19.6 Shoreline Development

Existing Conditions

Various combinations of development and land use patterns that are present in the viewed landscapes contribute to the overall visual character of the project area. These can range from the more urban and industrial developments often associated with the mainstem reservoirs to residential developments that are common to both mainstem and tributary reservoirs. Urban and industrial developments, such as those found around Decatur, Alabama on Wheeler Reservoir, generally create a lower level of scenic integrity. Residential areas and water-related facilities that include docks, boathouses, stairways, and shoreline protection structures are becoming more common in the project area. The presence of these facilities in the landscape reduces scenic integrity.

Boat docks sitting on exposed reservoir bottom at a marina on Boone Reservoir

Exposed fish habitat structures viewed from a rural road on Boone Reservoir

Source: Thomas Kokx Associates 2003.

Figure 4.19-04 Effects of Floating Structures Sitting on Exposed Reservoir Bottom and Other Exposed Structures, Resulting in Lowered Scenic Integrity

Future Trends

The SMI (TVA 1998) noted that continued conversion of natural-appearing shorelines to residential or other uses is a factor contributing to lower scenic integrity levels. The initiative provided guidelines related to shoreline vegetation management, dock and other water use facilities, shoreline stabilization, and land based structures that help to reduce the visual impacts of continued residential development on the shoreline environment. These guidelines recognize the importance of shoreline aesthetics and the benefits of maintaining a more natural-appearing shoreline. A substantial amount of reservoir land still retains a naturally attractive character and an undisturbed appearance. These qualities contribute to the current desirability and demand for home sites, even with the visual changes of seasonal water fluctuation. Present trends of residential development are anticipated to continue in the future regardless of changes in the present operational practices.

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4.20 Dam Safety

4.20.1 Introduction

The factors associated with dam safety relative to the proposed changes in system operations include:

Resource Issues
▶ Reservoir-triggered seismicity ▶ Dam stability ▶ Leakage from dams

- Effects on reservoir-triggered seismicity (RTS) due to changes in filling or drawdown rates, or higher than normal reservoir levels;
- Effects on dam stability of changes in seismicity, higher reservoir levels, filling or drawdown rates; and,
- Leakage from dams in response to higher reservoir levels in areas of carbonate rocks with karst development.

Potential impacts on these key elements of dam safety are all indirect effects of the policy alternatives.

4.20.2 Regulatory Programs and TVA Management Activities

The Federal Guidelines for Dam Safety require that dams with a direct federal interest, which includes all dams in the TVA's system, must be designed, inspected, and maintained throughout their operating life to verify and protect the structural integrity of the dam and appurtenant structures to ensure protection of human life and property.

The requirements for design floods for dams that are the responsibility of federal agencies are contained in the following documents:

- Federal Guidelines for Dam Safety, Federal Emergency Management Agency Publication FEMA 93, November 1998.
- Federal Guidelines for Dam Safety: Selecting and Accommodating Inflow Design Floods for Dams, Federal Emergency Management Agency Publication FEMA 94, October 1998.

4.20.3 Seismology

Existing Conditions

Reservoir-triggered seismicity is the initiation of earthquakes by the impoundment or operation of a reservoir. Reservoir-triggered earthquakes can be identified by a change in the pattern of earthquake activity in the immediate vicinity of a reservoir that usually begins during or shortly after (days to a few years) initial filling of the reservoir. Rapid reservoir elevation changes can also trigger earthquakes.

The mechanisms that control RTS—primarily increased pore pressures in fractured rock surrounding or beneath the reservoir and increased load due to water volume—are generally agreed upon. The relative importance of these mechanisms on a site-specific basis and whether individual reservoirs exhibit RTS are not as clear.

While at least four reservoirs in the Southeastern United States exhibit RTS, the evidence for RTS at TVA reservoirs is weak at best. Many of the TVA reservoirs are located within the Southern Appalachian Seismic Zone, a zone that was active before the introduction of TVA reservoirs and continues to be active today (Reinbold and Johnston 1987). Earthquakes typically associated with RTS are more shallow than most southern Appalachian earthquakes. There have been a few instances of small, shallow earthquakes near TVA reservoirs (e.g., the February 1990 sequence of earthquakes near Tellico Reservoir); there have also been similar sequences of shallow earthquakes in the Southern Appalachians well removed from reservoirs (e.g., Bristol, Virginia in February 1988 and Greeneville, Tennessee in March 1995).

If TVA reservoirs do exhibit RTS, it appears to be rare and would be difficult to confirm. To determine whether RTS is occurring or has occurred at any TVA reservoir, detailed seismic activity records would be required in the vicinity of all reservoirs for a few years before and for several years after the initial filling of the reservoirs. This type of seismic documentation is not available. The question of RTS at TVA reservoirs cannot be answered with confidence. If RTS does occur, however, it is not obvious based on earthquake data collected over the past 20 years (Chapman and Mathena 2001).

Future Trends

No trends have been identified relative to RTS; therefore, future trends are expected to be the same as existing conditions.

4.20.4 Reservoir Levels

Existing Conditions

Water levels at TVA reservoirs fluctuate under normal operations (see Section 2.2). In addition to the normal operating levels, the reservoirs are designed to withstand forces associated with a flood condition. All TVA dams classified as either high or significant hazard potential are capable of passing the applicable inflow design flood (IDF) as required by the federal guidelines with the exception of Chickamauga. Dams classified as high hazard potential are those dams where failure or improper operation probably would cause loss of human life. Dams classified as significant hazard potential dams are those dams where failure or improper operation would result in no probable loss of human life but could cause economic loss, environmental damage, disruption of lifeline facilities, or could affect other concerns. Dams that are classified as significant hazard potential are often located in predominantly rural or agricultural areas but could be located in areas with higher population and significant infrastructure. The hydrologic design for Chickamauga is under review to determine the applicable IDF and needed modifications, if any.

Future Trends

Reservoirs levels are variable year to year but fall within the flood guides for each reservoir. Levels would not be allowed to fluctuate such that dam safety was compromised.

4.20.5 Reservoir Drawdown Rates

Existing Conditions

Water pressure from a reservoir causes water to gradually infiltrate the surrounding reservoir rimrock, soil embankments, or foundations. Over time, internal pressures, called pore pressures, are created within the surrounding area. These pressures increase until the surrounding area reaches equilibrium. If the reservoir is rapidly drawn down after pore pressures are established, they may create unstable conditions in the surrounding rim that can cause slides or sloughing of the rim material.

The structures that surround reservoirs that are subject to fill and drawdown cycles are designed to withstand the expected fluctuations of external water pressures and internal pore pressures. The design is based on an upper limit on the allowable rate of drawdown. Table 4.20-01 lists the maximum allowable drawdown rates necessary to ensure the stability of the dams within the scope of the EIS.

Future Trends

Under the existing operations policy, future drawdown rates would continue to be maintained within present limits.

4.20.6 Leakage

Existing Conditions

Some leakage, or unintended flow, is expected to occur at all dams either through structural joints, earthen embankments, reservoir rims, or foundation materials. Any leakage is evaluated during periodic dam inspections and a determination is made as to whether the volume, rate of change, and sediment content (if any) of the leak poses structural concerns. When necessary, the leakage is periodically measured and recorded so that trends can be defined. Changes in these trends can indicate that a more detailed evaluation of the seepage is warranted.

Table 4.20-01 Drawdown Limits for Tributary Reservoirs

Project[1]	Description	Drawdown Limits[2]
Apalachia	Concrete	3 feet per day not to exceed 12 feet per week
Blue Ridge	Hydraulic fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
Chatuge	Impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
Cherokee	Concrete and impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
Douglas	Concrete and impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
Fontana	Concrete	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per day not to exceed 12 feet per week
Great Falls	Concrete	2 feet per day not to exceed 12 feet per week
Hiwassee	Concrete	2 feet per day not to exceed 7 feet per week
Norris	Concrete and earth fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
Nottely	Impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
South Holston	Impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
Watauga	Impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week

1 For those reservoirs not shown, the drawdown rate would follow the rate shown for Blue Ridge.
2 Restrictions are based on dam safety and slope stability considerations.
Source: TVA files - Dam Safety Group 2003.

Table 4.20-02 details TVA reservoirs within the scope of the EIS that have been monitored for leakage. This table also indicates whether the amount of leakage would increase as the reservoir headwater elevation increases and, where known, describes the cause of the leakage. The data are reviewed periodically to assess the leakage and ensure the continued safety of the structures. Periodically, an Instrumentation Project Performance Report is issued, which reviews the history of the project, evaluates the appropriateness of the instrumentation and frequency of observation, identifies conditions that might threaten dam safety, and evaluates the structural and geotechnical performance of the dam.

Table 4.20-02 Leakage Monitored at Non-Power and Power Projects

Project	Leakage Increases with Increasing Headwater	Bedrock	Leakage Mechanism
Non-Power Projects			
Bear Creek	Yes	Limestone and shale	Karst
Cedar Creek	No, seasonal	Sandstone	Unknown
Little Bear Creek	No, seasonal	Limestone and shale	Karst
Normandy	Yes	Limestone	Karst
Tellico	No, seasonal	Limestone and shale	Karst
Upper Bear Creek	No, seasonal	Sandstone, shale and conglomerate	Unknown
Power Projects			
Blue Ridge	Yes	Schist and metagraywacke	Spring along abutment/ embankment interface
Chatuge	Yes	Biotite Gneiss	Unknown
Douglas (Dandridge Dike)	Yes	Unknown	Foundation of dike
Fort Patrick Henry	Inconclusive	Limestone, dolomite, shale	Unknown
Great Falls	Yes	Limestone and chert	Karst
Guntersville	No	Limestone	Karst
Melton Hill	Yes	Dolomite	Karst
Norris	Yes	Dolomite	Karst
Nottely	Yes	Schist, metagraywacke, metaconglomerate	Unknown
Tims Ford	Yes	Limestone and shale	Karst
Wheeler	Yes	Limestone	Karst
Wilson	No, seasonal	Limestone	Karst

Source: TVA files - Dam Safety Group 2003.

Future Trends

The trends exhibited by the leakage observed at TVA dams are shown in Table 4.20-02. These trends are expected to continue through 2030 due to the continued operation of TVA reservoirs under the existing reservoir operations policy.

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4.21 Navigation

4.21.1 Introduction

Resource Issues
▶ Cargo transport
▶ Channel depth

The Tennessee River and its tributaries provide navigation from Knoxville downstream to Paducah (where the system is linked to the Ohio River); these waterways are key components of the nation's inland waterway system. The river also provides access to the Tennessee–Tombigbee Waterway and connects the Tennessee–Tombigbee Waterway to the Ohio River system. The Tennessee River system shown in Figure 4.21-01 is the study area for the discussion of navigation.

The Tennessee River navigation system provides for a year-round channel with a minimum depth of 11 feet between Knoxville and Paducah and on several tributaries. The 11-foot channel provides the 9-foot navigation depth mandated by the TVA Act plus a 2-foot margin of safety. This depth accommodates the tug and barge fleet developed for use on the system. The Tennessee–Tombigbee Waterway has a minimum channel depth of 10 feet. The upper Ohio River (above Smithland Dam) has a minimum channel depth of 10 feet. The lower Ohio River has a minimum depth of 12 to 13 feet when the wicket gates are in an upright position at Locks and Dams 52 and 53.

Future planned improvements to the system include the replacement of Locks and Dams 52 and 53 with the Olmsted Lock and Dam, a replacement lock at Chickamauga Dam, and a lock addition at Kentucky Lock. The expected completion date for the Olmsted Lock and Dam is 2010. The improvement will provide 12.5 feet of channel depth at the tailwater of the Kentucky Dam. The Kentucky Lock addition estimated completion date is 2014. The improvement will include a 110- by 1,200-foot lock with a lower sill elevation of 285 feet. A 110- by 600-foot chamber at Chickamauga Dam has been authorized for construction, and preliminary design work has begun.

Changes in the reservoir operations policy may increase or decrease the timing and depth of navigation channels in TVA reservoirs and thus enhance or impede navigation along the Tennessee River system as follows:

- Existing cargo movements on the Tennessee River may be increased or decreased; and,
- Highway and rail cargo volumes may change as river cargo volumes change.

In 2000, barge traffic on the Tennessee River and its navigable tributaries totaled 49.7 million tons and ranked fourth among 17 national waterways. Commodities moved by barge are typically high-bulk, non-time-sensitive materials such as aggregates, chemicals, coal, coke, grains, iron and steel, ores and minerals, and petroleum fuels.

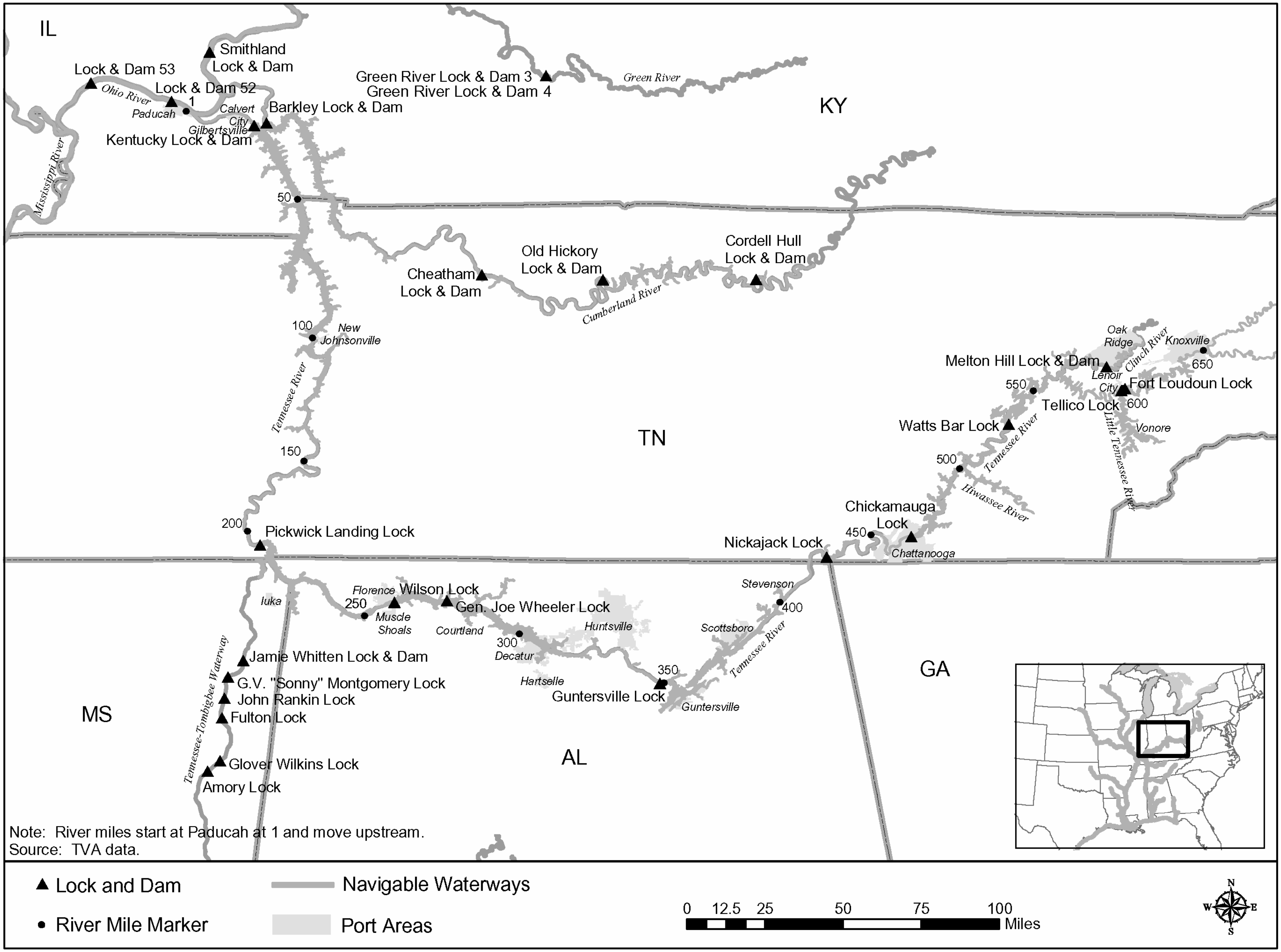

Figure 4.21-01 Inland Navigation System for the Tennessee River and Connecting River Systems

Existing key constraints to navigation on the system include the tailwater depths at the Pickwick and Kentucky Dams and their relation to the Barkley Reservoir, shallow access channels to various terminals, and restrictions on the upper Tennessee River in the Fort Loudoun Reservoir.

Shipper savings are costs that shippers avoid by moving cargo via barge versus rail or highway. Shipper savings are realized when navigation channels are deepened, or when available depth is sustained at consistent levels. The savings result when barges can be loaded with greater tonnages but can move on the system with roughly the same cost—that is, towboat operating costs will rise only marginally when pushing a somewhat deeper draft barge. Savings realized by reduced transportation costs will, to some extent, be passed on to the shipper, increasing the competitiveness of barge transportation.

The existing 11-foot navigation depth limits barge drafts to approximately 9 feet at low water conditions. When waterway depth increases sporadically—for example, due to floods or reservoir operations—no change in shipping economics is likely based on two factors. First, the overall barge fleet is generally designed for the year-round condition—in this case, a depth of 9 feet. Second, when increased channel depth is available only sporadically, there is not enough time for planning and initiating the use of greater barge loads. If greater navigation depth is consistently available, however, the barge fleet can be designed to handle greater loads, or the existing fleet can carry more capacity.

Use of larger barges would be possible for internal or local traffic on the Tennessee River. Use of larger barges for the connecting traffic would require that connecting waterways also be able to provide additional depth on a predictable basis.

4.21.2 Regulatory Programs and TVA Management Activities

The TVA Act requires TVA to operate the dams and reservoirs on the Tennessee River and its tributaries to provide a 9-foot navigation channel from Knoxville to Paducah. The responsibilities of maintaining safe navigation on the Tennessee River are divided among three federal agencies. TVA has custody of and control over the physical structures in the water and releases water to provide sufficient depth for navigation. TVA also has responsibility for navigation aids in the secondary channels. The USACE operates the locks and is responsible for periodic dredging to maintain channel depth. The U.S. Coast Guard installs and maintains the navigation aids in the main channels.

4.21.3 Cargo Movements on the Tennessee River

Existing Conditions

Cargo moving on the river navigation system can be reviewed by origin and destination as well as by type of cargo. Table 4.21-01 breaks out origin and destination data among entering (entering or destined for river ports); leaving (leaving river ports); through (using the river for access to another water, such as the Tennessee–Tombigbee Waterway); and local (the cargo originates and terminates at river ports) traffic for 1991 and 2000.

Table 4.21-01 Tennessee River Tonnages by Traffic Category

Traffic Category	2000 (tons)	1991 (tons)
Entering	17,961,619	12,723,461
Leaving	12,760,178	8,841,817
Through	11,110,763	9,260,397
Local	7,830,919	11,337,997
Total	**49,663,479**	**42,163,672**

Source: USACE 2000.

Local traffic could benefit the most from an increased depth or an increased depth for more months per year because the tugs and barges used could be designed or loaded to take full advantage of such improvements. All other traffic is constrained by the depths available and the equipment used on the connecting waterways: the Ohio River, Mississippi River, Tennessee-Tombigbee Waterway, and potentially others.

Table 4.21-02 shows total system tonnages by commodity group for 1991 and 2000, and includes a forecast of tonnage for 2030. This table confirms that the river traffic is dominated by dry bulk cargoes.

Table 4.21-02 Tennessee River Tonnages by Commodity Group

Commodity	1991 (tons)	Percent of Total	2000 (tons)	Percent of Total	2030 Forecast (tons)	Percent of Total
Coal and coke	20,773,434	49.27	18,881,050	38.02	14,451,698	25.56
Aggregates	8,520,175	20.21	11,196,098	22.54	17,025,592	30.11
All other	2,962,966	7.03	4,502,692	9.07	3,127,475	5.53
Iron and steel	1,163,249	2.76	3,630,829	7.31	6,038,859	10.68
Grains	3,558,992	8.44	3,588,008	7.22	5,267,935	9.32
Chemicals	2,458,868	5.83	2,935,479	5.91	5,076,332	8.98
Ores and minerals	1,182,924	2.81	2,915,782	5.87	3,474,664	6.15
Petroleum fuels	1,543,064	3.66	2,013,547	4.05	2,073,810	3.67
Total	**42,163,672**	**100**	**49,663,479**	**100**	**56,536,633**	**100**

Sources: USACE Waterway Commerce Statistics Center 2000, 1991.

Movements of cargo that directly benefit the region are counted as Regional Economic Development (RED)[1] benefits. Cargoes that pass through the river navigation system are not counted. RED commodity movements for 2000 are provided in Table 4.21-03. These cargo tonnages provide the basis for future projections and the analysis of shipper savings in the ROS and this EIS.

Table 4.21-03 Regional Economic Development Tennessee River Tonnages by Commodity Group

Commodity	2000 (tons)	Percent of Total
Coal and coke	12,949,615	33.79
Aggregates	9,970,553	26.02
All other	3,035,090	7.92
Iron and steel	2,852,132	7.44
Grains	3,305,014	8.62
Chemicals	2,591,761	6.76
Ores and minerals	2,034,838	5.31
Petroleum fuels	1,585,204	4.14
Total tons	**38,324,207**	**100**

Source: TVA, Navigation and Hydraulic Engineering Department 2003.

Future Trends

Several methodologies are available to project future cargo movements on the river navigation system. The first approach is to examine the historical growth of the system. Table 4.21-02 shows the 1991 and 2000 tonnages by commodity type and the forecasted 2030 tonnages. The growth from 42.16 to 49.66 million tons over a 9-year period represents an annual growth rate of 2 percent. Note that the growth was somewhat uniform over all commodities, with only coal and coke showing a decline in tonnage and grains essentially showing no growth over the period.

In addition, river traffic forecasts for the period from 2004 through 2030 were developed at the Wharton School of Business Administration for the Institute of Water Resources of the USACE. The forecasts were based on an average growth rate for the period 2004 through 2020 and a low growth rate for the period 2021 through 2030.

Future commodity movements on the Tennessee River system depend on many interacting factors, including socioeconomic changes, public policy, and technological developments. The

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1 Economic analysis of federally funded regional projects requires only that economic effects accruing to the region be counted. These are called Regional Economic Development (RED) benefits.

river navigation system is important to energy production. Should technological developments lead to a sharp decline in coal consumption, coke and coal shipments would decline. The system also plays an important role in agricultural production, which is expected to maintain steady growth.

Of the cargo transport options, the lowest environmental and safety impacts are associated with waterborne transportation. In Europe, strong initiatives have developed to switch cargo to waterways in order to relieve roadway congestion. In the United States, some effort is being made to shift cargo from highways to waterways, especially on the East Coast. Substantial shifts from rail or highway to waterway transport require infrastructure investment and incentives that may require a change in public policy. If such support materializes in the United States, the Tennessee River could experience an increase in barge movement of commodities.

4.22 Flood Control

4.22.1 Introduction

Resource Issues
▸ Magnitude of flood flows
▸ Potential flood damage
▸ Flood recovery

For the purpose of this EIS, flood control is addressed in terms of flood risk. Flood risk is defined in terms of peak flows, the expected frequency of occurrence of those peak flows, and the resulting potential flood damage. Under the existing reservoir operations policy, the reservoir system reduces flood risk in the Tennessee Valley by reducing peak flood flows and thus, flood levels. This flood reduction is provided by reserving a volume of storage—called the flood storage allocation—in each storage reservoir and making it available during rainfall events. The amount of storage currently allocated to flood control varies from reservoir-to-reservoir and from month-to-month as described in Section 2.2, Water Control System. During high river flow periods, discharge from the storage projects is either reduced or stopped entirely, and the inflows are stored, filling a portion—or all—of the allocated flood storage volume. After the downstream peak river flows have reached their highest level and begun to recede, the water is released in accordance with the flood recovery policy (Section 2.3.2, Operations for Flood Control) to make the flood storage available for the next storm event.

The effect of an alternative reservoir operations policy on flood risk depends on whether the alternative modifies the amount of flood storage allocation and the store and release policy to the extent that peak river flows are altered downstream. Further, to understand whether changes in peak flows due to an alternative are meaningful, changes in flood elevations and flood damage potential associated with the altered flows must also be evaluated. In addition to these direct effects, changes in the flood recovery policy considered in this EIS to improve fish spawning habitat would affect flood risk. Thus, the key issues related to flood risk that were evaluated in this EIS are:

- How the expected magnitude of flood flows are affected by changes in flood storage allocation, and flood storage and recovery policies; and,

- The potential flood damage that is associated with changes in peak flows and flood elevations.

The discussion of effects of the proposed alternative reservoir operating policies focuses on the changes in flood risk and potential damage in the Tennessee Valley through 2030. This section addresses potential flooding impacts and the role of FEMA. No siting activities are proposed in floodplains, and the Preferred Alternative minimizes floodplain effects to the extent practicable consistent with Executive Order 11988.

4.22.2 Regulatory Programs and TVA Management Activities

TVA's responsibility to provide flood control and thus reduce flood risk in the Tennessee Valley is outlined in Section 9a of the TVA Act. Authority for the regulation of flow from the Tennessee River by the USACE during flood periods on the lower Ohio and Mississippi Rivers is outlined in Section 7 of the Flood Control Act of 1944. In addition, TVA cooperates with local governments and the FEMA to encourage sound floodplain management.

- **TVA Act—**Section 9a of the TVA Act provides the legal context for the policies that guide the operation of TVA's dams and reservoirs today. Section 9a requires that the reservoir system be operated primarily to promote navigation and flood control and—to the extent consistent with these purposes—for power production.

- **U. S. Army Corps of Engineers—**Consistent with the Flood Control Act of 1944, the USACE may direct TVA flow releases from Kentucky Reservoir to reduce flood crests on the lower Ohio and Mississippi Rivers. A declaration of a flood control operation is made at the discretion of the USACE when the stage at the Cairo, Illinois gage reaches 35 feet and is predicted to go above 40 feet. The flood control operation ends when the stage at Cairo falls to 40 feet and further recession is predicted.

- **Federal Emergency Management Agency—**FEMA administers the National Flood Insurance Program (NFIP). In exchange for federally backed flood insurance for their homeowners, renters, and business owners, communities adopt and enforce floodplain management ordinances to reduce future flood damage (www.fema.gov). TVA works closely with FEMA and local governments responsible for administration of NFIP requirements to guide sound floodplain development below TVA projects, provide assistance with identification of areas within the Tennessee Valley that are prone to flooding, provide information on flood risks, and advise communities on appropriate steps needed to ensure consistency with the NFIP.

4.22.3 Peak Flows and Frequency

Existing Conditions

It was necessary to define a consistent methodology for this EIS in order to describe the existing flood risk condition. Flood risk is typically described in terms of the magnitude of peak flows and the expected frequency of occurrence of those peak flows. Frequency of occurrence is typically described either using exceedance probabilities or recurrence intervals. Thus, a peak flow of a given magnitude can be said to have a certain probability of being equaled or exceeded (the exceedance probability) in a given season (usually an annual period). That same peak flow can also be described as being equaled or exceeded, on average, every so often (the recurrence interval). A 100-year flood has a 1-percent chance of being equaled or exceeded in any given year, and its recurrence interval is said to be 100 years. How often a given flow can be expected to occur at a location is determined by performing a flow frequency analysis. This analysis is typically based upon historical basin runoff recorded at gaged locations and can be performed to determine annual or seasonal flow frequency. For watersheds with storage reservoirs, the analysis must take into account the effect of both natural runoff characteristics and reservoir regulation.

TVA has a record of historical discharges since reservoir operations began in 1936. In addition, stream gage and site-specific flood event data are available back into the mid- to late-1800s. The observed discharges account for the effect of local inflow and reservoir storage. However, since 1936 the reservoir system has undergone many changes—most notably the construction of new reservoirs. As new reservoirs were constructed, the reservoir system operating policy necessarily evolved to integrate them into the system. The historical discharges reflect these system and operating policy changes over time and do not always represent expected discharges under the existing operating policy.

To evaluate potential changes in flood risk (given the complexity of the frequency analysis for the Tennessee River), TVA selected a methodology using historical inflows as regulated by the existing reservoir system and operating policy. The TVA analysis included: (1) a 99-year continuous RiverWare model simulation using 6-hour inflows at 55 locations for the entire reservoir system; (2) the use of design storms based on actual observed events with inflow volumes increased to produce storm inflow volumes in the 100- to 500-year range; and (3) the evaluation of the impact of changes, if any, on the Maximum Probable Flood (MPF) and the Probable Maximum Flood (PMF).

To assess the adequacy of TVA's methodology, TVA convened a panel of flood risk experts to review and comment on the TVA approach. The panel concurred with TVA's approach to perform the continuous simulation using the RiverWare model and to use simulation results to assign flow frequencies out to the 100-year recurrence interval. For the hypothetical design storms, the panel agreed that the existing condition would be adequately described by a discrete simulation of each storm using the RiverWare model.

To determine discharges that would result from the historical runoff as regulated by the existing reservoir system and operating policy, TVA computed historical natural watershed runoff for the 99-year period from 1903 to 2001 for each sub-basin within the Tennessee Valley based upon historical flow records. This 99-year dataset of inflow data was then input into a RiverWare model that mimicked the existing system and operating policies. From this model, the discharge at 35 dams and flows at 13 flood damage centers were computed for each 6-hour time step in the 99-year simulation.

To establish the recurrence interval for various flows, the frequencies were estimated by using a standard approach in hydrologic analysis. The annual peak discharges from the model for each of the 99 years were sorted in descending order and assigned a frequency of one chance in 100 to the highest flow, two chances in 100 to the second-highest flow, and so on. To illustrate this process, the discharge data for Chickamauga Dam are plotted in Figure 4.22-01.

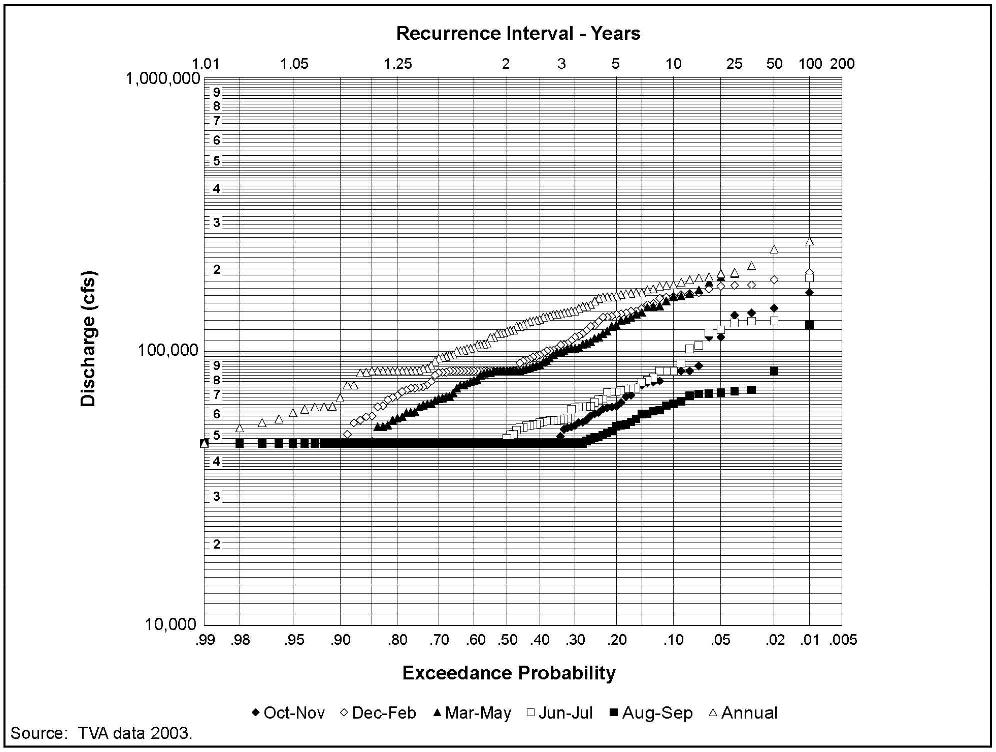


Figure 4.22-01 Simulated Peak Discharge Frequency for Chickamauga Dam (1903 to 2001)

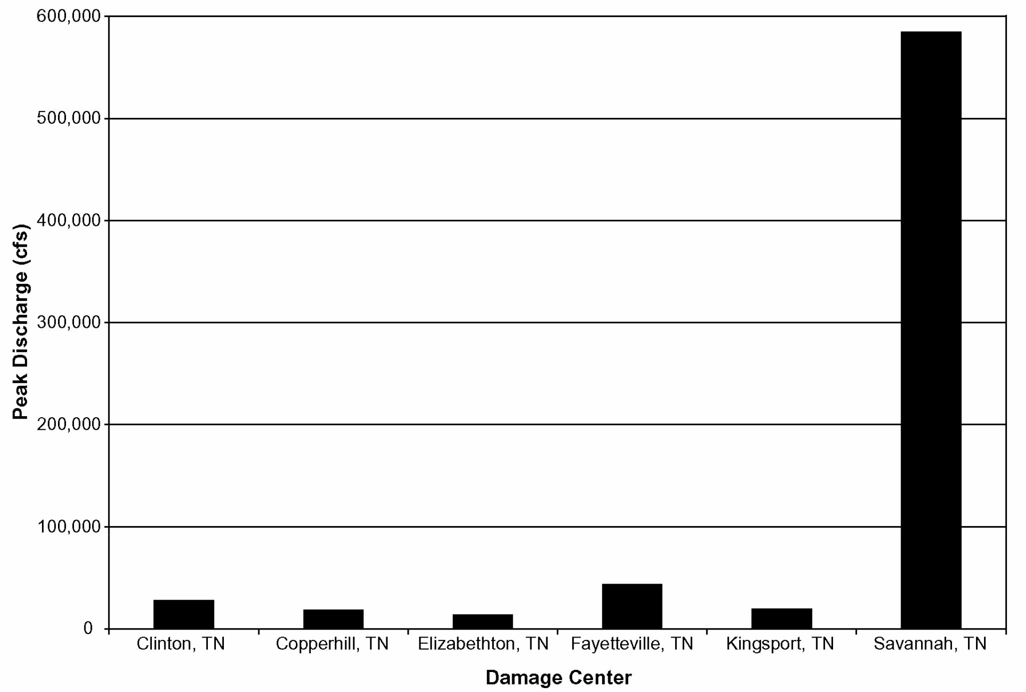
Figure 4.22-01 graphically represents the relationship between peak discharges below Chickamauga Dam and the probability that those discharges will be equaled or exceeded. Under the existing reservoir operations policy, a discharge from Chickamauga Dam of 250,000 cfs or larger would be expected to be equaled or exceeded only once in approximately 100 years on average. Similar plots were developed in this way to estimate the peak flows and frequencies for the 99-year historical inflows for all 48 locations (Table 4.22-01). The peak flows from the 99-year continuous simulation at six selected flood damage centers under the existing reservoir system and operations policy are presented in Figure 4.22-02.

For the design storms, TVA selected a group of historical storms from the 99-year data set to represent each of five periods, or seasons, during the annual cycle. The inflows for each storm were increased by a factor of 1.5 and 2.0 to reflect a reasonable range of postulated larger storms. While a specific recurrence interval was not assigned to the design storms, use of the 99-year inflow record to develop volume frequency curves provides information on the magnitude of the multiplier to be applied. This approach ensured that the inflow volumes associated with the design storms were at least up to the 500-year range.

The scaled-up inflows were evaluated using a RiverWare model similar to the one used for the 99-year data set. The peak discharge for each storm was then plotted versus the day and month of the historical storm peak as shown in Figure 4.22-03 for Chickamauga Dam. The highest discharge resulting from the 69 selected design storms is also presented in Figure 4.22-04 for each of seven flood damage centers.

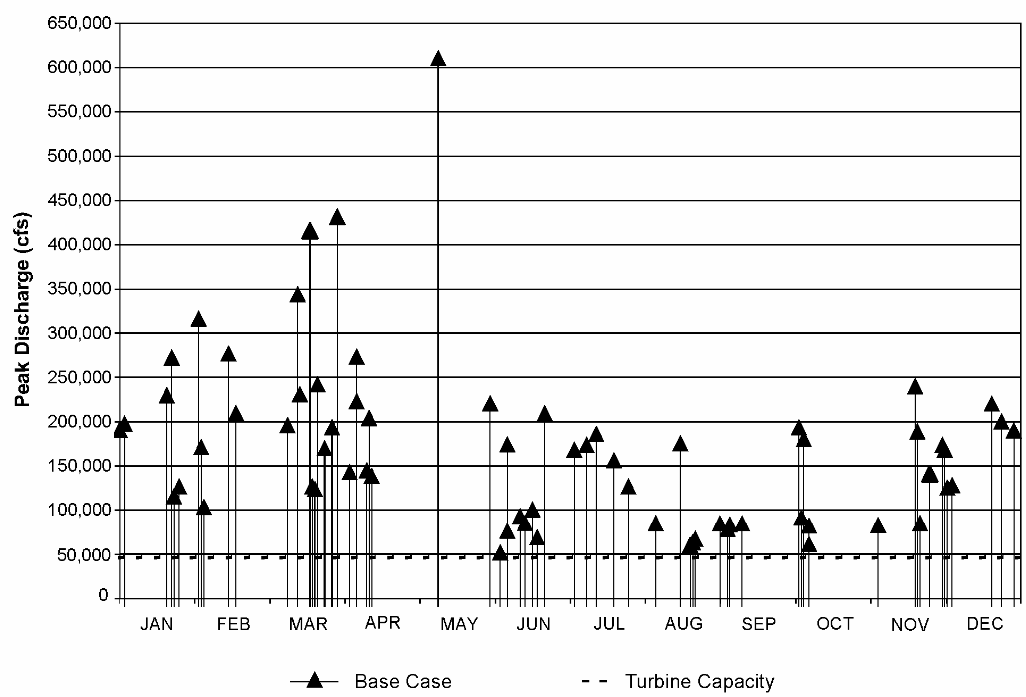
Table 4.22-01 Critical Locations for Evaluation of Flood Risk Potential

Dams	
Apalachia	Little Bear Creek
Bear Creek	Melton Hill
Blue Ridge	Nickajack
Boone	Normandy
Calderwood	Norris
Cedar Creek	Nottely
Chatuge	Ocoee #1
Cheoah	Ocoee #3
Cherokee	Pickwick
Chickamauga	South Holston
Chilhowee	Tellico
Douglas	Tims Ford
Fontana	Upper Bear Creek
Fort Loudoun	Watauga
Fort Patrick Henry	Watts Bar
Great Falls	Wheeler
Guntersville	Wilson
Hiwassee	
Damage Centers	
Chattanooga, TN	Huntsville, AL
Clinton, TN	Kingsport, TN
Copperhill, TN/McCaysville, GA	Knoxville, TN
Decatur, AL	Lenoir City, TN
Elizabethton, TN	Savannah, TN
Fayetteville, TN	South Pittsburg, TN
Florence, AL	



Source: TVA data 2003.

Figure 4.22-02 Simulated Peak Flow under Existing Reservoir Operations Policy for the Historical Inflows at Six Flood Damage Centers in the Tennessee Valley Region



Source: TVA data 2003.

Figure 4.22-03 Simulated Peak Discharges from Hypothetical Design Storms for Chickamauga Dam (Scaling Factor 1.50)

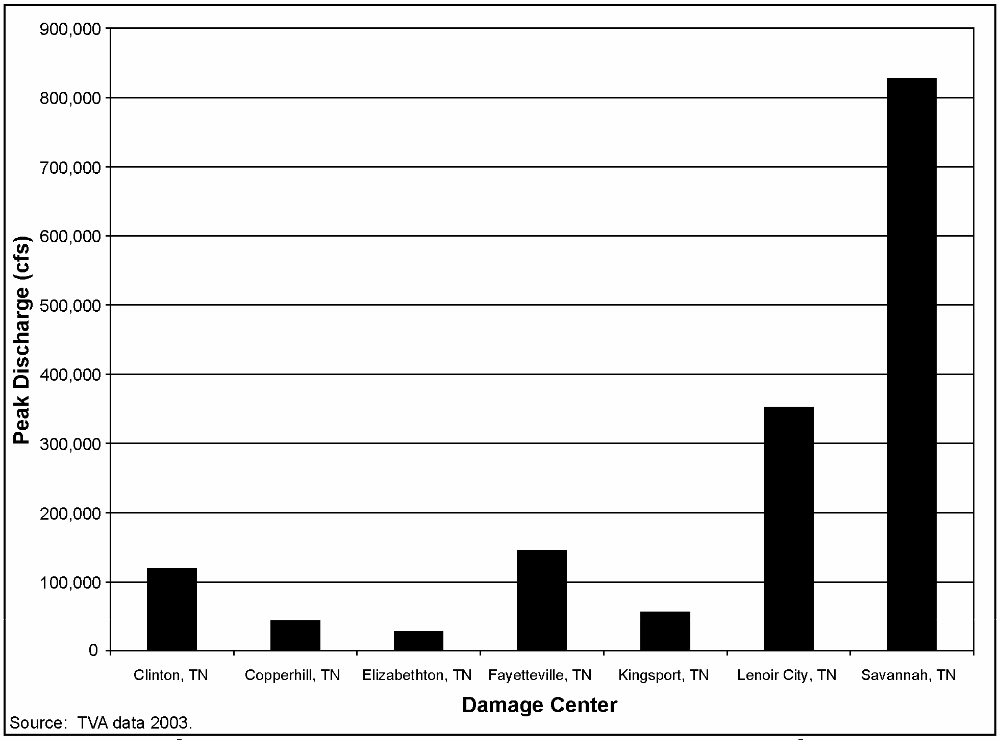


Figure 4.22-04 Simulated Peak Discharge from 69 Hypothetical Design Storms (Scaling Factor 2.0) at Seven Flood Damage Centers in the Tennessee Valley Region

In addition to the inflow observed historically, it is also important to understand the peak flows and elevations for larger storms such as the MPF and the PMF. These larger storms are typically the design basis for the facilities within and adjacent to the rivers, including TVA's dams and coal-fired and nuclear facilities. The MPF and the PMF are much larger storms and are sometimes called "synthetic" storms because they are developed by imposing the worst-case hydrologic conditions on a watershed and modeling the basin response. TVA formalized its Dam Safety program in 1982, adopting an Inflow Design Flood (IDF) as the design storm for TVA projects. Since that time, TVA has evaluated all of their projects for their adequacy to safely pass the IDF event (see Section 4.20.04 for additional discussion of the IDF).

Future Trends

The primary factors that could affect peak flows in the Tennessee Valley are changes in precipitation and the runoff characteristics of the watershed. The changes that might be anticipated during the next 30 years that could affect these two factors are:

- **Precipitation.** The analysis performed for this EIS took into consideration 99 years of estimated historical inflows resulting from precipitation, with the assumption that this length of record would be representative of the range of expected inflow conditions. Although no explicit climate change study was undertaken as a part of the flood risk analysis, TVA has observed no measurable changes in precipitation and runoff during this period that would suggest climate changes significant enough to result in impacts to the flood risk will occur through 2030.

- **Watershed Runoff Characteristics.** Extensive land development or change in land use in the Tennessee River basin has the potential to change the rainfall runoff volume and rate. While localized areas of rapid development may result in changes to local runoff characteristics, changes in basin-wide land use anticipated through 2030 are not expected to result in a measurable change in watershed runoff characteristics during this period (see Section 4.15, Land Use).

Comparison with FEMA Flood Insurance Studies

Other flow frequency studies have been performed over the years to define flood risk in the Tennessee Valley, the most well-known and recognized being the Flood Insurance Studies funded by FEMA. As a part of their NFIP, flow frequency studies were developed to delineate floodplain areas and to determine a premium cost structure for FEMA's federally backed flood insurance policies. In the Tennessee Valley, TVA has served as a contractor to FEMA in this effort, performing the flood studies to develop flood profile data and preparing inundation maps that define 100- and 500-year floodplains. The Flood Insurance Studies were developed over a period of years and were based on historical discharge records, which reflect reservoir system changes over time. Flood Insurance Studies for different locations within the Tennessee Valley were also completed at different times, using varying periods of observed hydrologic records.

The impediments in using historical data and the need to assess impacts on a regional basis necessitated TVA using a different approach. This approach is described earlier in this section. The approach TVA adopted allowed a rigorous, consistent comparison of the incremental flood risk impacts associated with alternative operations policies throughout the system.

4.22.4 Potential Flood Damage

Existing Conditions

The consequences of the peak flows were determined by converting the flows to corresponding water levels and evaluating the resulting potential flood damage at the flood damage centers. The potential flood damage is a function of the extent of development in the floodplain and varies widely depending on location within the Tennessee Valley. The impact assessment included an estimate of the direct flood damage for each of 11 flood damage centers in the Tennessee Valley. The basis for the estimate was an inventory, compiled by TVA from actual field surveys of the properties located in the floodplain that includes the value of the structures and their contents. The indirect effects are more difficult to quantify and include damage to transportation facilities, communication and other infrastructure, disruption of businesses, jobs, and other economic losses. For the impact assessment, TVA estimated indirect losses at 20 percent of the direct losses.

The potential damage associated with the largest historical storm in the 99-year period of record at 10 flood damage centers is depicted in Figure 4.22-05.

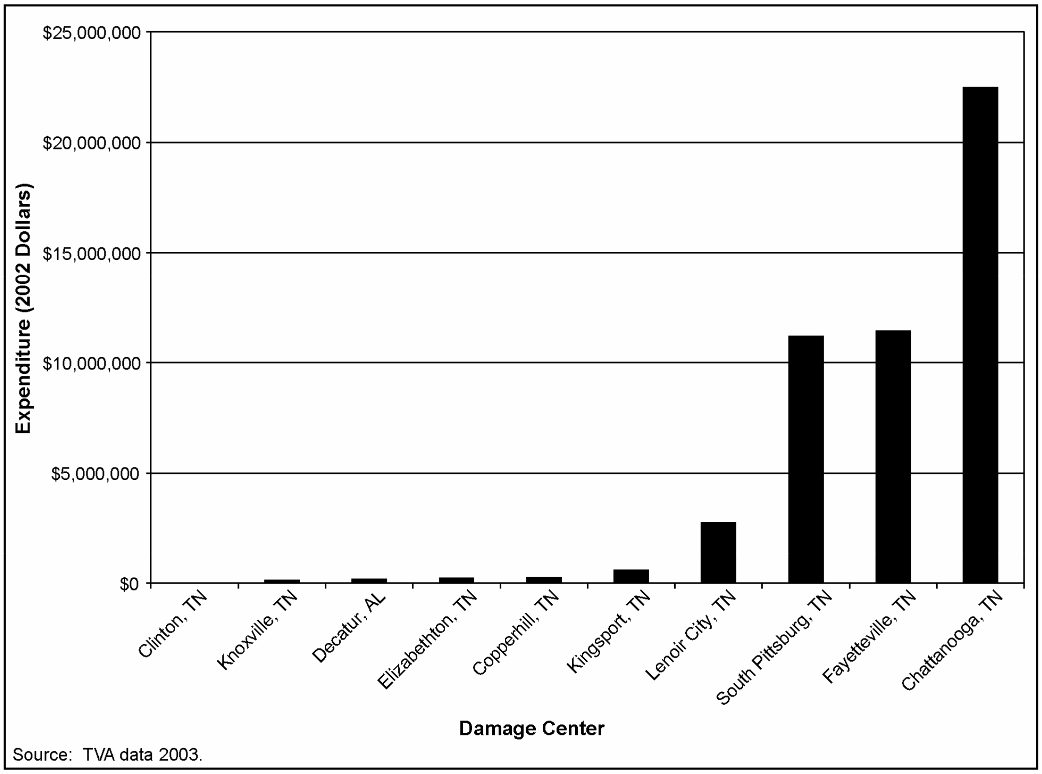


Figure 4.22-05 Estimated Peak Flood Damage from 99-Year Continuous Simulation at Ten Flood Damage Centers in the Tennessee Valley Region

Future Trends

The primary factor affecting potential flood damage in the Tennessee Valley is the floodplain management policy of flood-prone communities. As development pressures increase along the streams and rivers within the Tennessee Valley, there is the potential for increased flood damage. The extent of increased damage will depend on continued participation by local governments in the NFIP, enforcement of their local floodplain regulations, and sound floodplain guidance for development in those areas where the flood risk has not been defined (flood elevations have not been determined and/or inundation maps are not available). TVA expects to continue its focus on floodplain management support below TVA dams and work closely with FEMA through 2030. TVA maintains an inventory of the value of structures and contents within the 500-year floodplain for the 11 major flood damage centers and estimates avoided flood damage after each flood event. The potential flood damage would be greater for larger events because most development today is built at, or above, the minimum 100-year standard.

4.22.5 Flood Recovery

Existing Conditions

During flood control operations (i.e., when downstream flooding is forecast and use of the flood storage volume can reduce downstream flooding) the flood operating policy permits TVA to fill the tributary storage reservoirs above their flood guide levels, temporarily storing floodwaters and reducing downstream flood crests. When the danger of flooding has passed, the water stored above the flood guide is released until the reservoir levels are returned to the flood guide level. The existing policy for flood recovery is to bring reservoir levels back to flood guide levels without causing additional downstream flooding, typically within 7 to 10 days after the flood event. Sometimes this drawdown can be accomplished by operating only the hydroelectric plants. However, it is often necessary to release additional water through sluiceways or spillways to lower the reservoir levels more quickly and regain the flood storage space needed for future rainfall events. This recovery policy restores available flood storage volume to reduce flood risk in the event of back-to-back flood events.

To aid fish spawning in the spring for several key popular sport fish species, TVA makes an effort to stabilize reservoir levels to support the spawn. This generally occurs in late-April to mid-May depending on water temperature. The criteria used include attempting to limit the change in reservoir levels to a maximum of 1 foot per week for a 2-week period. Because this is also the time of year when the reservoirs can be in flood recovery mode, it is often difficult to achieve this limit while also maintaining adequate flood storage volume.

Future Trends

No trends exist that would affect the existing flood recovery policy.

4.23 Power

4.23.1 Introduction

Resource Issues

- Power generation dispatch
- Cost of power
- Power system reliability

TVA's operation of its power system focuses on providing reliable, low-cost power to its customers in the 201-county TVA Power Service Area. To provide for the total energy needs of its Power Service Area customers, TVA's generating resources include coal, nuclear, hydropower, oil, gas, pumped storage, and other renewable sources. TVA's management of the Tennessee River and its tributaries to provide flood control and navigation in accordance with the TVA Act, as well as other benefits, affects both hydropower and non-hydropower generation. Water discharged from the reservoirs for other purposes is released through the hydro turbines, if possible, and is scheduled during times of peak power demand to maximize its value. Coal and nuclear generating units also rely on the water released from the reservoirs to provide cooling water for their operation. The availability of adequate cooling water is a key element in TVA's ability to provide reliable power generation.

The construction and operation of TVA's integrated electric power and transmission systems are described in detail in TVA's Energy Vision 2020 Final EIS (December 1995). That document also discusses how TVA estimates future demand for energy from its system, what TVA's estimates for demand through 2020 are, and how TVA could meet those demands. In addition, the Final EIS analyzes the potential environmental impacts of TVA's current operations and alternative ways of meeting future demands.

To the extent that any changes in reservoir operations may alter the amount or timing of water releases, TVA's ability to provide reliable power generation may be affected. While hydropower generation is most directly affected by changes in reservoir operations, the changes may also affect the use or operation of TVA's coal and nuclear generating resources, and energy customers within the TVA Power Service Area may be affected. A substantial reduction in the availability of cooling water, particularly during periods of higher water temperatures in the Tennessee River and its tributaries, could negatively affect TVA's ability to generate energy at its coal and nuclear power plants. The effects on both hydropower and non-hydropower generation may cause an increase in the cost of power in the Power Service Area.

The key factors related to system-wide costs of power generation are:

- **Power Generation Dispatch—**changes in the availability of hydropower generation resources (the timing and amount of energy generated) and any offsetting increase or decrease in the use or "dispatch" of other generating resources; ancillary services; additional operating and maintenance costs for operating existing cooling towers for longer durations to reduce coal or nuclear plant derates; and derates or shutdowns of coal or nuclear generating units due to water temperature effects.

- **Power System Reliability—**availability of specific generating facilities to operate when required to provide generating reserves, system voltage support, and other system requirements as needed to ensure a reliable power supply.

Other factors that can affect power cost are:

- **Non-Generating Costs—**the costs of purchase, installation, and operations and maintenance of additional oxygenation equipment to maintain planned DO concentrations in selected tailwaters; additional capital costs for construction of new cooling towers, if necessary to reduce coal or nuclear plant derates; changes to the cost of shipping coal to fuel TVA's coal generating plants; and additional transmission costs.

To the extent that the changes may alter the amount and timing of TVA's use of either hydropower or non-hydropower generation, the mix of generating resources used to meet the power demand would be altered, changing the cost of power. Because power costs affect the cost of production and living in the Tennessee Valley, changes in power cost would affect the regional economy. For this study, the change in the cost of power was measured as a single value, a potential change in power rates. This potential rate change served as a basis of comparison of the alternatives. It also was used as an input for the regional economic model to estimate the indirect effects of potential changes in power costs on the regional economy. It should not be assumed, however, that the calculated change in the cost of power would be implemented as a rate change.

Changes in reservoir operations could directly affect power production in the TVA Power Service Area. As a result, the affected environment for power generation is bounded geographically by this 201-county area. All of TVA's power generation assets were included in the power generation studies.

4.23.2 Regulatory Programs and TVA Management Activities

Congressional acts and federal agencies that regulate or influence operation of TVA's power generation resources include:

- **TVA Act.** Section 9a of the TVA Act provides the legal context for the policies that guide the operation of TVA's dams and reservoirs today. Section 9a requires that the reservoir system be operated primarily to promote navigation and flood control and, to the extent consistent with these purposes, for power production.

- **Clean Air Act.** Power plant air emissions are controlled under the CAA and are addressed in Section 4.2, Air Resources.

- **Federal Energy Regulatory Commission.** The Federal Energy Regulatory Commission (FERC) regulates, among other things, the transmission and sale of wholesale electric power by public utilities under the Federal Power Act. Although TVA is not a public utility and thus is not subject to FERC's general regulatory jurisdiction, in certain cases FERC has jurisdiction to hear complaints against TVA concerning power transmission and related matters. TVA has chosen to voluntarily follow FERC rules and orders to the extent they are consistent with meeting TVA's obligations under the TVA Act.

- **North American Electric Reliability Council.** The North American Electric Reliability Council (NERC) is a voluntary, not-for-profit corporation formed in 1968 to further the reliable operation of the bulk electric system in North America. Among other things, NERC promotes cooperative efforts among various segments of the electric industry to develop voluntary standards, guidelines, and policies for both the operation and planning of the bulk electric system. NERC coordinates its work with its 10-member regional reliability councils and other organizations. TVA is a member of the Southeastern Electric Reliability Council (SERC), which is one of the 10 NERC regional councils.

- **Clean Water Act.** Under Section 316(a) of the CWA, which regulates cooling water intake structures, alternative thermal limits may be established based on a satisfactory demonstration that a balanced indigenous population of fish and shellfish is maintained in the receiving waterbody. With respect to TVA's coal and nuclear generating plants, CWA Section 316(a) is implemented by the authorized states, which issue NPDES permits that limit the thermal impact of the cooling water discharges. Each of TVA's coal and nuclear generating plants that discharge into the Tennessee River system has been issued and complies with an NPDES permit.

- **Nuclear Regulatory Commission License.** The Nuclear Regulatory Commission (NRC) licenses Sequoyah, Browns Ferry, and Watts Bar nuclear generation plants. To allow safe shutdown of the reactors in an emergency, the license limits the maximum temperature of each plant's essential raw cooling water, known as the ultimate heat sink. The Tennessee River is the ultimate heat sink for all three nuclear plants.

- **Homeland Security Act.** Consistent with this act, TVA is responsible for ensuring that the power supply system is protected from potential terrorist attacks.

4.23.3 Power Generation Dispatch

Existing Conditions

TVA operates its generating units to minimize power cost to the consumer, bringing generation on line as needed, and beginning with generating units with the lowest production costs. As demand increases, the next more costly unit is brought online until demand is met. The reverse is true as demand decreases. This economic dispatch of generating units is based on each unit's marginal cost of generating power. Fixed costs of a unit sitting idle include interest on funds used to construct the unit and provide its basic maintenance. When started up, additional costs are incurred for fuel, maintenance, and the economic value of emission allowances.

These additional costs are the marginal costs of generation. The largest factor in the marginal cost is usually fuel. Because hydropower generation's marginal costs are very low, it is a generation resource that is dispatched whenever it is most valuable. Any alternatives that affect the timing or amount of the availability of hydropower generation would increase the marginal power cost.

TVA must also consider the operating characteristics of each type of generating unit—hydropower, nuclear, fossil-fired (coal, oil, and gas) and pumped storage—when selecting which units to operate to meet the demand. Operating characteristics considered include the time required to start or stop a unit and whether a unit can be operated at less than full capacity (and if so, how quickly the load changes can be made). Hydropower generation's operational flexibility makes it a valuable generation source. Table 4.23-01 summarizes the various types of generating units in the power system, their key operating characteristics, and the use of each unit type (whether as base load or peaking).

Present Load

TVA balances the different operating costs and characteristics of its generating units to meet the power demand at the lowest cost. Figure 4.23-01 illustrates how the different types of generating units are dispatched to meet the power demand as it varies over a 24-hour period. Base load, the level of demand that occurs throughout the day, is provided largely by nuclear and coal units, units that are suited to continued running and have low marginal costs. Peaking power, the portion of the load that varies throughout the day, is generated by hydropower, pumped storage, purchased power, and combustion turbines, units that are suited to cycling their output up and down. Coal units are also used to provide peaking power, by increasing output to maximum capacity for short periods.

Although all of TVA's customers are affected by changes in the production cost of power regardless of the rate structure, approximately 15 to 20 percent of TVA's current demand is by customers who purchase power on a rate structure that varies hourly based on the marginal power cost. These customers are likely to be sensitive to changes in marginal power costs caused by changes in the availability of hydropower generation.

Present Supply

TVA currently has over 31,000 MW total winter net dependable generating capacity comprised of a combination of coal-fired, hydroelectric, nuclear, combustion turbine, and pumped storage hydropower plants. Table 4.23-02 shows the capacity mix and the percentage of annual generation supplied by each resource type for fiscal year 2002.

Table 4.23-01 Key Characteristics of the Power System Generation Resources

Generation Resource [1]	Operating Costs and Characteristics
Hydropower	The least marginal cost form of electricity Can be started and brought to full load more quickly and reliably than other sources of generation, making it ideal for peaking power[2] Can be made available almost instantaneously to cope with system emergencies or to provide system voltage regulation, enhancing power system reliability
Nuclear	Relatively low fuel costs, the next least-cost generation resource Principally operated as baseload[3] generating units because they cannot be brought online quickly nor can the output of energy be adjusted quickly
Coal	Next in cost are coal-fired units that vary in operating costs, depending on the installed technology at the various plants and type of coal used Best used to supply baseload generation but can be used for peaking at increased operating and maintenance costs
Pumped storage[4]	Uses excess baseload power to pump water to upper reservoir during off-peak periods, then generates to meet peak power requirements and other system needs, such as operating reserve Limited to only a set number of hours of operation at full output by the upper reservoir's storage volume Hours required to pump exceed hours of generation Net energy loss but net revenue producer
Combustion turbines (simple cycle)	Relatively high in cost to operate, burning natural gas or fuel oil—both high-cost fuel sources Lower efficiency compared to other types of generating resources Used sparingly to meet peak demands; rapid start-up relative to coal
Non-hydropower renewables	High-cost form of generation Various sources include wind, solar, and landfill gas generation Availability of wind and solar is intermittent; landfill gas is baseload

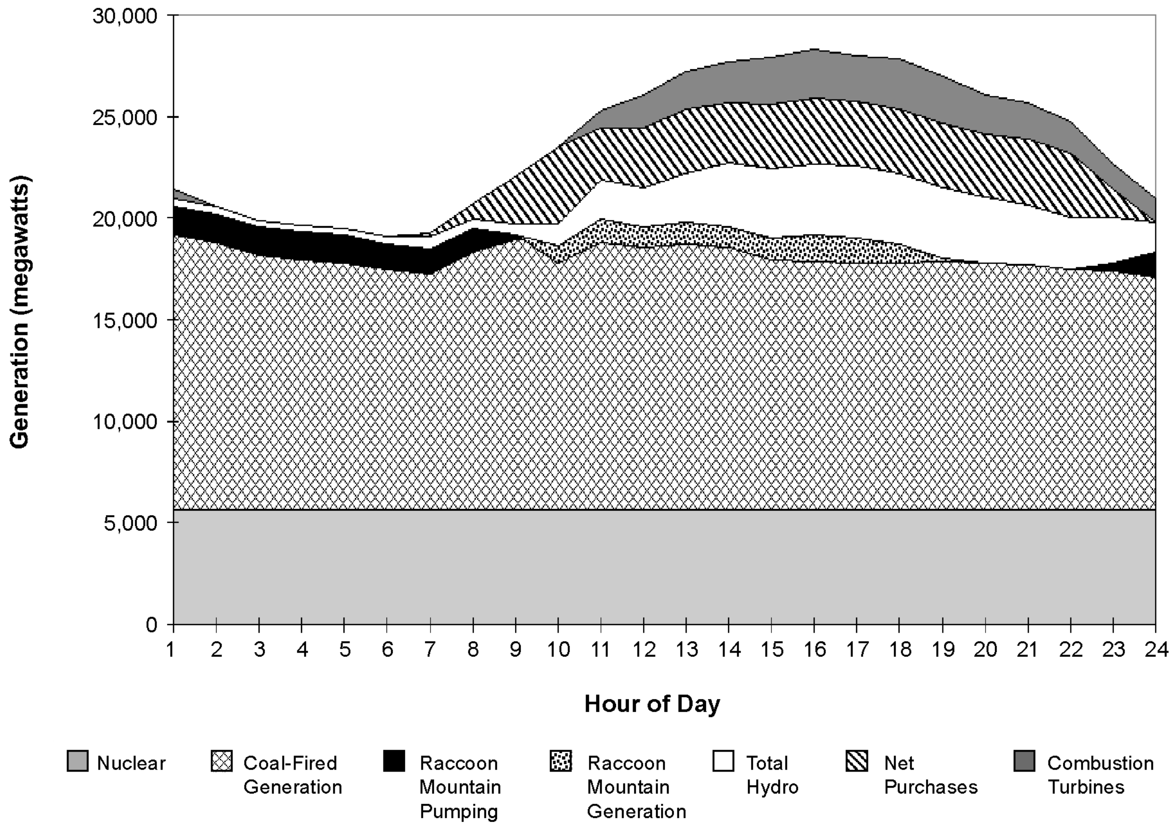
Notes:

[1] Ranked in order from least to greatest marginal cost.

[2] Peak power refers to supplying additional power quickly for those times when daily power demands are the highest.

[3] Base load is the power that is provided around the clock to meet demand.

[4] Raccoon Mountain Pumped Storage Project.



Source: TVA data 2003.

Figure 4.23-01 Typical Dispatch of TVA Generating Resources to Meet Daily Power Demand (July 11, 2000)

The nuclear and coal units total over 20,000 MW (or 65 percent of TVA's total capacity) and generated 140,000 MWhrs (or 85 percent of the annual energy) in 2002. In contrast, TVA's hydropower capacity comprised approximately 10 percent of TVA's total capacity and generated approximately 6.6 percent of the annual energy in 2002. This difference between percent capacity and percent energy indicates that the nuclear and coal units are run almost continuously to meet baseload demand while hydropower is operated less than continuously to meet peak demand.

Future Trends

Load Growth

As a part of its power planning process, TVA prepares long-term load forecasts. Load forecasts are developed for high, medium, and low growth rates to account for the uncertainties inherent in predicting future power needs. For the medium forecast performed in January 2003, the energy load was expected to grow 1.6 percent on an average annual basis from 2004 through 2022.

Table 4.23-02 Power Generation Resources

Generation Resource	Net Winter Dependable Capacity (MW)	Percent of Total Capacity	Annual Generation (Million KWhrs)	Percent of Total Energy
Coal	15,023	47.7	94,930	57.5
Nuclear	5,751	18.2	45,179	27.4
TVA hydropower	3,305	10.5	10,879	6.6
Purchased power[1]	440	1.4	10,424	6.3
Purchased hydropower[2]	731	2.3	3,175	1.9
Combustion turbines	4,643	14.7	1,190	0.7
Green power	-	-	18	-
Pumped storage[3]	1,624	5.2	-674	-0.4
Total	**31,517**		**165,121**	

Notes: Fiscal Year 2002 capacity and generation statistics.

1 Red Hills (includes other purchases in generation).

2 USACE Hydro Capacity and APGI's Tapoco Project.

3 Raccoon Mountain Pumped Storage Project.

Source: TVA file data.

In addition to the energy load growth projected for 2022, a shift in demand among energy users is projected. Growth in industrial demand is expected to slow; commercial and residential demand is expected to increase as a percentage of the total load to be served. Because industrial demand is relatively constant over time and the residential/commercial demand varies daily, weekly, and seasonally, this shift would increase the percentage of peaking capacity needed in the generation mix by 2030.

While planning for the future load growth, TVA also is aware of the potential for deregulation of power generation markets in the Southeastern United States and nationally. In a deregulated market, TVA customers could purchase their power from other energy providers, increasing the uncertainty in the load forecast. In the medium forecast, TVA has assumed that the net effect of competition is that TVA will retain its current customers.

Supply Growth

In response to the long-term load forecast, power system capacity additions currently planned include improvements to the hydropower plants and the restart of Browns Ferry Unit 1 (see Section 3.3.1). For additional new generation, TVA's options as described in Energy Vision 2020 for meeting additional peaking generation needs include combustion turbines and power purchases. For meeting new base load generation needs, options include improvements to the existing hydropower system, construction of a combined-cycle plant, purchases from independent power producers, and combined cycle repowering of existing coal-fired plants. For the purpose of analyses for this EIS, all new generation except the Browns Ferry and hydropower improvements described above, was assumed to be gas-fired combined-cycle (base load) or gas-fired simple-cycle (peaking) as the current technology of choice for new capacity.

4.23.4 Power System Reliability

Existing Conditions

Power system reliability is the ability of the system to withstand high peak demands, extended drought periods, or sudden changes in the power system—such as generation or transmission equipment failures or large industrial plant shutdowns—and still provide uninterrupted power. To ensure power system reliability, TVA maintains extra standby generation capacity, known as a reserve margin. The amount of reserve margin is determined by balancing the cost of providing the additional capacity with the cost of power interruptions to TVA customers. Also, during critical power system situations, which include but are not limited to Power System Alerts and implementation of the ELCP, reservoir operations may temporarily deviate from normal system operating guidelines to meet power system needs. In such situations, water stored in the reservoirs may be used to the extent practicable to preserve the reliability of the TVA power system. The operating characteristics described in Table 4.23-01, such as its rapid start and stop capabilities, allow hydropower generation to play an important role in helping the power system withstand such system changes, enhancing its reliability.

One condition that TVA must address to ensure power system reliability is the effect of high Tennessee River water temperatures on operations of the power facilities. Each of TVA’s coal and nuclear generating plants that discharge into the Tennessee River system has been issued and complies with an NPDES permit that limits the thermal impact of the cooling water discharge on the river. Historically, some coal and nuclear units have had to derate on occasion to comply with NPDES thermal limitations. In addition, each nuclear generating plant has as a condition of its NRC operating license, an upper limit on the temperature of the plant’s ultimate heat sink. This limit ensures that, in the event of an emergency, adequate cooling water is available to safely shut down the nuclear reactor. The Tennessee River is the ultimate heat sink for each of TVA’s nuclear plants; if its temperature exceeds the maximum temperature limit, one or more nuclear units must be shut down entirely. Shutdown of a single nuclear unit would represent a loss of over 1,100 MW of generating capacity. Since TVA’s nuclear plants have been in operation, no nuclear plant shutdowns have occurred as a result of the ultimate heat sink temperature limitations of the NRC license.

Future Trends

The reserve margin proposed for the period through 2010 is 13 percent, declining to 12 percent for the period 2011 through 2030.

4.23.5 Coal and Nuclear Unit Derates

Existing Conditions

As a part of the process of converting fuel to electricity, many of TVA's plants withdraw water from the Tennessee River or its tributaries, use this water for cooling various plant systems, and then return the water to the river. During this process, the cooling water temperature rises. To protect the receiving water, the NPDES permit for each plant includes limits on the maximum discharge temperature and, in some cases, the instream temperature regime. To comply with these NPDES permits, TVA monitors water temperatures at each plant and manages water releases to assist in meeting permit requirements. If the quantity of water available for release is limited or its temperature is elevated (a condition that typically occurs in late summer months when rainfall and runoff is low and ambient temperatures are high), options to either alter river flows or derate the plants are evaluated. The most favorable option is implemented and can vary from day to day.

If the generating plant's output must be derated to meet thermal limitations due to constraints on available water releases, the energy must be provided by an alternate, and typically more expensive, generation source. Under extreme conditions, it is possible that the system load requirements would not be met and brownouts or blackouts could result. Under the existing reservoir operations policy, it is not uncommon for TVA to derate its coal-fired plants for some period of time each summer to meet NPDES permit requirements. Nuclear plants are derated only occasionally.

Future Trends

The changes to the power system that are expected to occur through 2030 that could affect derating coal-fired generation include the restart of Browns Ferry Nuclear Unit 1, expected as early as 2007. Restart and operation of Unit 1 would require construction of an additional cooling tower system and increasing intake flow rates by approximately 10 percent of the original Unit 3 flow, or about 50 percent from the present flow rate. The plant would be operated to ensure that the maximum cooling water discharge temperature and the temperature rise between intake and discharge remain within approved regulatory limits. Use of cooling towers would increase and, on infrequent occasions when the cooling towers are unable to meet thermal limits, the plant would be derated to remain in compliance with the established limits. This additional unit's cooling water discharge would increase the amount of heat that would need to be assimilated by the Tennessee River.

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4.24 Recreation

4.24.1 Introduction

Reservoirs and tailwaters in the TVA system offer a broad range of water- and land-based recreational opportunities. TVA projects span the landscape from high-elevation reservoirs near the Smoky Mountains to reservoirs over 1,000 feet lower in elevation on the Tennessee River, not far from its confluence with the Ohio River. The reservoir and river environments span an equally diverse range of conditions, from cold-water discharges supporting trout fisheries to warm-water discharges supporting bass, walleye, and trophy catfish.

Resource Issues

- Public recreation use
- Commercial recreation use
- Private recreation use

TVA reservoirs and tailwaters attract recreation visitors who live within and outside the TVA region. There are 49 projects in the TVA system; 35 of these projects are the focus of the ROS. These reservoirs provide over 647,000 acres of reservoir surface area, about 11,000 miles of shoreline for recreation, and cumulatively over 1,200 river miles.

The 35 projects in the ROS (Table 4.24-01) provide opportunities for three groups of recreation users: the general public who use existing public access sites along the shoreline; individuals who use commercial recreation facilities, such as marinas, rental companies, and outfitters; and shoreline property and condominium owners who have private access to the resource. Each of these three groups of recreation users may be affected differently by proposed reservoir operations policy alternatives, and changes in recreation use patterns by these three user groups may result in different regional economic effects. The three key recreation groups evaluated in this section are:

- **Public recreation use—**at public access sites;
- **Commercial recreation use—**at commercial facilities; and,
- **Private recreation use—**at private access sites.

To estimate existing recreation use of TVA projects, these three types of recreation use (public, commercial, and private) were studied at 13 project reservoirs and six project tailwater areas (Table 4.24-01). Recreation use data gathered from these areas were used to statistically estimate recreation use on the remaining 22 project reservoirs and the 29 project tailwater areas that were not surveyed. Separate estimates of use were developed for various types of recreational activities and by user type (public access users, commercial patrons, and private property owners) and were then summed to estimate total recreation use (measured in user days[1]) of the TVA reservoirs and tailwater areas.

[1] A user day is equivalent to a recreation day, defined as a visit by one individual to a recreation area for recreation purposes during all or part of a 24-hour period of time.

Table 4.24-01 General Characteristics of the ROS Projects

Project Name	Recreation Classification: Mainstem (M), Run-of-River (ROR), or Tributary (TR)[1]	Population: Urban (U), Rural (R), or Remote (RE)[2]	Total Reservoir Use Level: High (H), Medium (M), or Low (L)[2]	Start of Annual Drawdowns—Existing Operations[3]	Number of Sampling Days
Chickamauga	M	U	H	Jul 1 (1.5 ft) / resumes Oct 1	15
Fort Loudoun	M	U	H	Nov 1	
Guntersville	M	R	H	Jul 1 (1.0 ft) / resumes Nov 1	15[9]
Kentucky	M	R	H	Jul 5 sloped to Dec 1	15
Nickajack[4]	M	U	H	–	
Pickwick	M	R	M	Jul 1	15[9]
Tellico[5]	M	R	H	Nov 1	15
Watts Bar	M	R	M	Aug 1 (1.0 ft) / resumes Sep 1	
Wheeler	M	U	H	Aug 1	
Wilson[4]	M	U	H	Dec 1	
Apalachia	ROR	RE	L	–	
Fort Patrick Henry	ROR	U	L	–	
Great Falls[6]	ROR	R	L	Oct 1	
Melton Hill	ROR	U	M	–	15[9]
Ocoee #1[7]	ROR	R	L	Nov 1	
Ocoee #2	ROR	R	--	–	
Ocoee #3	ROR	RE	L	–	
Wilbur	ROR	RE	L	–	
Bear Creek	TR	R	L	Nov 15	
Blue Ridge	TR	R	M	Aug 1	10
Boone	TR	U	L	Sep (Labor Day)	
Cedar Creek	TR	R	L	Nov 1	
Chatuge	TR	R	M	Aug 1	15
Cherokee	TR	R	M	Aug 1	15
Douglas	TR	R	M	Aug 1	10[9]
Fontana	TR	RE	L	Aug 1	
Hiwassee	TR	RE	L	Aug 1	10
Little Bear Creek	TR	R	L	Nov 1	
Normandy	TR	R	L	Nov 1 (earlier minimum flow drops)	

Table 4.24-01 General Characteristics of the ROS Projects (continued)

Project Name	Recreation Classification: Mainstem (M), Run-of-River (ROR), or Tributary (TR)[1]	Population: Urban (U), Rural (R), or Remote (RE)[2]	Total Reservoir Use Level: High (H), Medium (M), or Low (L)[2]	Start of Annual Drawdowns—Existing Operations[3]	Number of Sampling Days
Norris	TR	R	H	Aug 1	15[9]
Nottely	TR	R	L	Aug 1	
South Holston	TR	RE	L	Aug 1	10[9]
Tims Ford	TR	R	M	Oct 15	
Upper Bear Creek[8]	TR	R	L	–	
Watauga	TR	RE	L	Aug 1	

1 Reservoirs were stratified to facilitate survey sampling for the recreation study. The stratification is similar to the project categories provided in Section 1.6.2 but is not identical. For recreation, the projects were stratified primarily by how the water fluctuates at each project. Mainstem projects are generally referred to as mainstem projects, while tributary projects are separated between storage and run-of-river projects.

2 For purposes of estimating recreation use, each project was classified by TVA staff as being urban, rural, or remote, and generally whether existing use was likely to be high, medium, or low.

3 See Appendix A, Water Control System Description Tables, and Chapter 3, Reservoir Operations Policy Alternatives.

4 Nickajack and Wilson are operated as run-of-river projects but are located on the mainstem Tennessee River and are treated here as mainstem projects in the recreation analysis.

5 Tellico is located on the Little Tennessee River but is connected by canal to the mainstem Fort Loudoun project and is treated here as a mainstem project. It is operated in a manner similar to other mainstem projects.

6 Although classified as a tributary-type project, Great Falls is operated more like a run-of-river project once it is filled (June 1); for recreation purposes, it was classified as run-of-river.

7 Although Ocoee #1 does have flood storage volume when at summer pool and releases are being made for whitewater rafting below Ocoee #2, it basically operates as a run-of-river project.

8 Hydropower is not produced at Upper Bear Creek, but the discharge can be controlled by a valve. This valve is used to provide downstream recreation releases and can draw the reservoir in summer months. It therefore was treated as a tributary project for the recreation analysis.

9 Tailwater field surveys were conducted on these TVA projects.

The recreation use data collected at the 13 reservoirs and six project tailwater areas focused on water-based recreational activities or activities that could be affected by changes in reservoir levels or flows. Recreational activities that occur in project areas not immediately adjacent to the reservoir or tailwater areas where participation rates would not be affected by changes in project operations (such as golfing, swimming in pools, mountain hiking, and camping in areas not adjacent to project waters) were not targeted in this study. All preferred activities that could be affected by changes in reservoir levels or flows for the sample period —mid-May through mid-October—were considered in developing recreation use estimates.

For recreation survey purposes, the 35 ROS projects were classified as mainstem projects (located on the mainstem Tennessee River), run-of-river projects (operationally, these reservoirs have little storage volume), and tributary projects (located on tributaries to the

Tennessee River) (Table 4.24-01). All of the run-of-river projects are on tributaries to the Tennessee River except for Great Falls, which is on a tributary to the Cumberland River. Run-of-river projects were categorized separately because of their operational differences. These three categories were used to summarize existing recreation use of affected reservoirs by public, commercial, and private users.

4.24.2 Regulatory Programs and TVA Management Activities

Recreation use of TVA reservoirs and tailwater areas is regulated and managed through state and federal regulations. Section 26a of the TVA Act requires that TVA approval be obtained before carrying out any construction activities affecting navigation, flood control, and public lands, along the shoreline of TVA projects. In addition to policies concerning recreation, the SMI established policies regarding the management of the TVA reservoir shorelines, including vegetation, private access to the water, and other factors that influence the amount and quality of recreational activities. Fishing activity is regulated by state laws and regulations pertaining to fishing seasons and fish catch limits. State laws and regulations also govern boating activity and boating safety within the TVA reservoir system. Commercial rafting activities in several of the TVA tailwaters are managed by TVA, the USFS, and state agencies.

4.24.3 Recreation Use

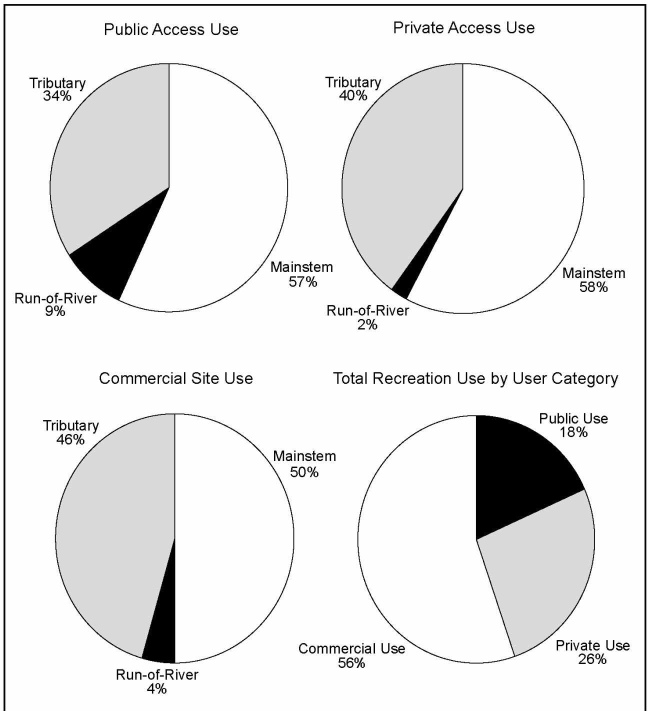
Existing Conditions

Public Recreation Use

Over 6,800 miles of shoreline at TVA projects is public land, or about 62 percent of the total shoreline miles of the projects. The types of recreational activities that were evaluated at public access sites were primarily water-based activities, including:

- Bank fishing (shore fishing);
- Motor boating, including fishing from a boat, pleasure boating, house boating, water skiing, and water tubing or towing;
- Canoeing and kayaking;
- Personal watercraft use;
- Swimming, including beach use;
- Other water-based activities, including sailing, rafting, diving, and hunting; and,
- Non-water activities adjacent to the reservoir or tailwater areas, including tent or vehicle camping, sightseeing, walking and hiking, biking, hunting, and picnicking.

Public recreation use for the 35 ROS projects totaled over 4.0 million user days, which accounted for 18 percent of the total estimated use (Figure 4.24-01). Of the total public recreation use, 57 percent occurred on mainstem projects, while 34 percent occurred on tributary projects and 9 percent occurred on run-of-river projects (Figure 4.24-01). (See Appendix D8 for estimates of use by reservoir.)

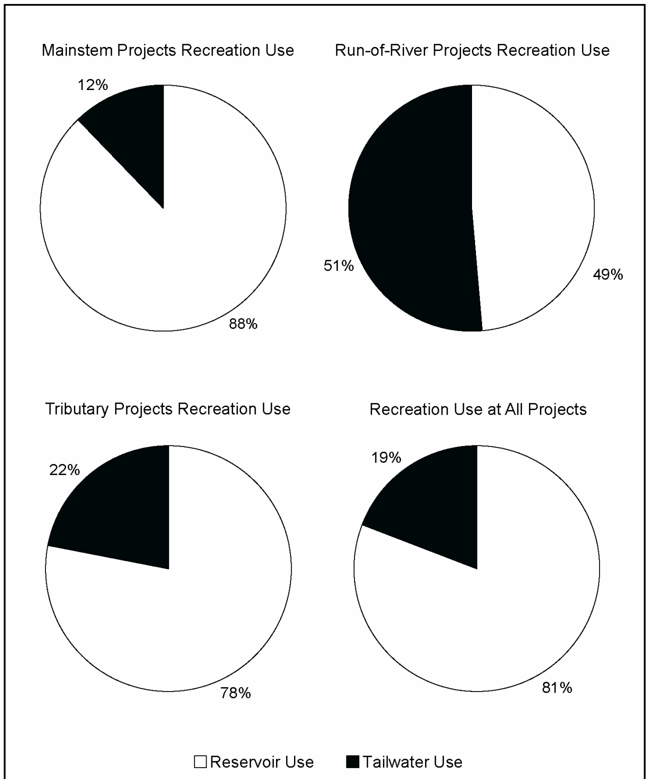


Note: User day = All or part of one day by one person at one reservoir. Includes both reservoir and tailwater use. Total use across all projects by all user types totaled 21.8 million user days.
Source: TVA data 2003.

Figure 4.24-01 Annual Recreation Use (User Days) of the 35 ROS Projects by Public Access, Private Access, and Commercial Site Users (2002)

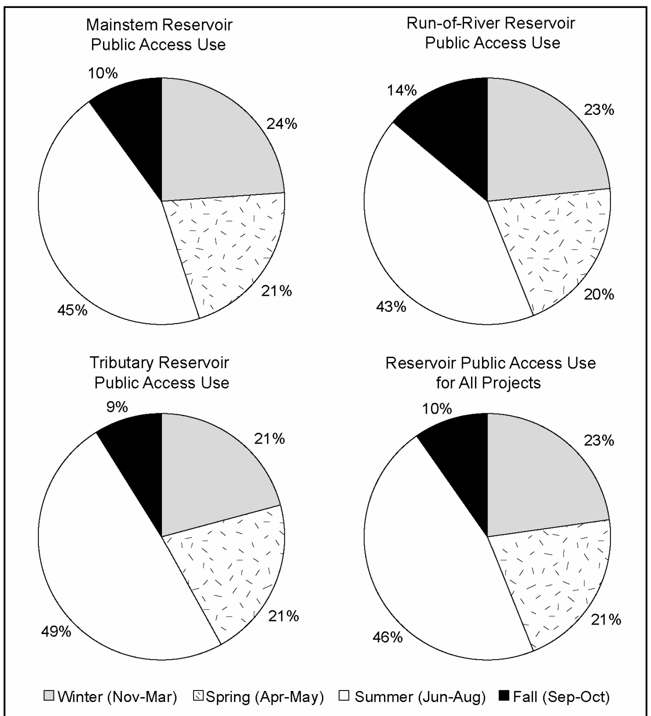
Of the 4.0 million public recreation user days across all 35 ROS projects, 81 percent occurred on reservoirs while 19 percent occurred in tailwater areas (Figure 4.24-02). The preference for reservoir recreation was evident for both mainstem and tributary projects. Public recreation use on run-of-river projects was more equally divided.

On a seasonal basis, public recreation use of reservoirs and tailwater areas was greatest during summer (June through August), representing 46 percent of all public use; and use was at least double that of any other season (Figures 4.24-03 and 4.24-04). This trend was evident for mainstem, run-of-river, and tributary projects. Winter (November to March) and spring (April to May) public use were nearly equal, ranging from 18 to 24 percent of total annual use. Fall (September to October) use ranged from 9 to 14 percent of total annual use.



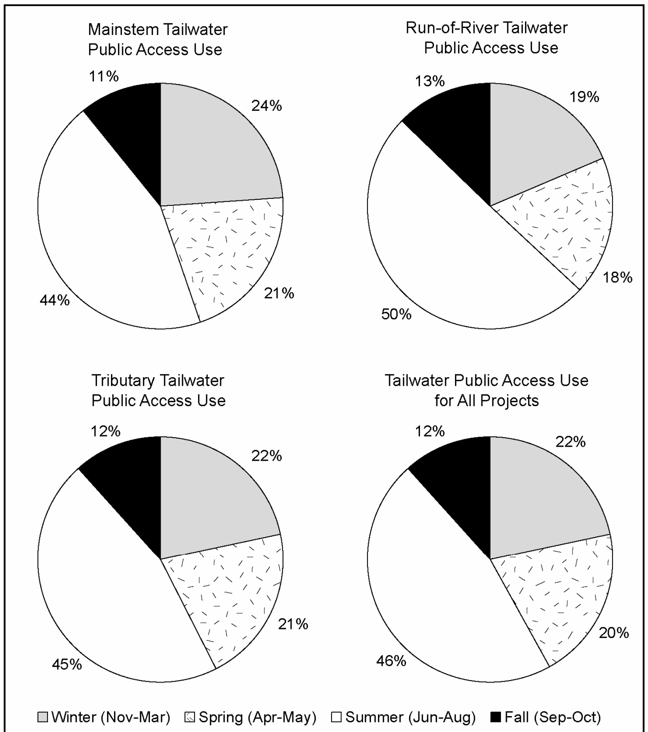
Source: TVA data 2003.

Figure 4.24-02 Comparative Public Access Recreation Use (User Days) at ROS Reservoirs and Tailwaters (2002)



Note: User day = All or part of one day by one person at one reservoir.
Source: TVA data 2003.

Figure 4.24-03 Reservoir Use (User Days) by Season at Public Access Sites (2002)



Note: User day = All or part of one day by one person at one reservoir.
Source: TVA data 2003.

Figure 4.24-04 Public Access Use (User Days) at ROS Tailwaters (2002)

Comparisons of annual public recreation use on reservoirs are shown in Figure 4.24-05. Over 50 percent of system-wide public recreation use on reservoirs was related to motor boating (including fishing from a boat, pleasure boating, house boating, water skiing, water tubing/towing, and waterfowl hunting), while 16 percent was related to non-water-based recreational activities (including horseback riding, picnicking, tent or vehicle camping, sightseeing, hunting, walking/hiking/jogging, biking, and reading/relaxing), 16 percent was related to swimming (including beach use), and 9 percent was related to bank fishing. The remaining recreational activities at reservoir public access sites were personal watercraft use (5 percent), other water-based activities (including sailing, rafting, and diving—3 percent), and canoeing or kayaking (0.5 percent).

Recreation use activity profiles, expressed as user days, at areas below project dams are shown in Table 4.24-02 for the six TVA projects where field survey data were collected on tailwater area use. Public recreation use for these six projects was higher in the reservoir than below the dam for all recreational activities except for canoeing and kayaking, which were similar. For motor boating, the dominant public access recreational activity, 82 percent occurred in the reservoir as compared to below the dam on these six projects. Several recreational activities at particular projects, however, occurred more frequently in tailwater areas than in reservoirs. At Norris, participation in bank fishing, canoeing, and kayaking was greater below the dam than in the reservoir. Bank fishing activity at Douglas was nearly equal in the reservoir and below the dam, as was canoeing and kayaking.

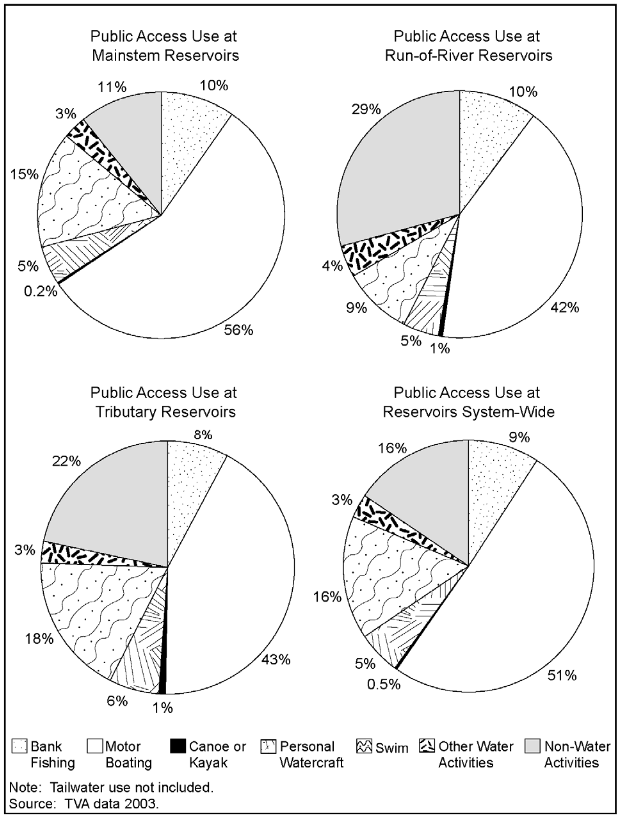


Figure 4.24-05 User Profiles for Public Access Recreation Use at ROS Reservoirs (2002)

<u>Commercial Recreational Use</u>

A variety of commercial recreational facilities and providers located on or near TVA reservoirs and tailwater areas provide access and services to recreation users. Recreation use attributable to commercial operations, such as marinas, watercraft rental operations, and outfitters who provide direct access to a project, was derived from surveys of commercial operators on the 13 projects that were sampled.

The types of recreational activities that were evaluated in the commercial operator survey included:

- Boat launches;
- Boat slip rentals;
- Personal watercraft rentals;
- Motor boat rentals;
- House boat and pontoon boat rentals;
- Paddle boat, raft, float tube, sail boat, and other rentals;
- White-water rafting services;
- Electric and non-electric campsites; and,
- Guide services.

Table 4.24-02 Comparisons of Types of Recreation Use at Public Access Sites at Six TVA Projects

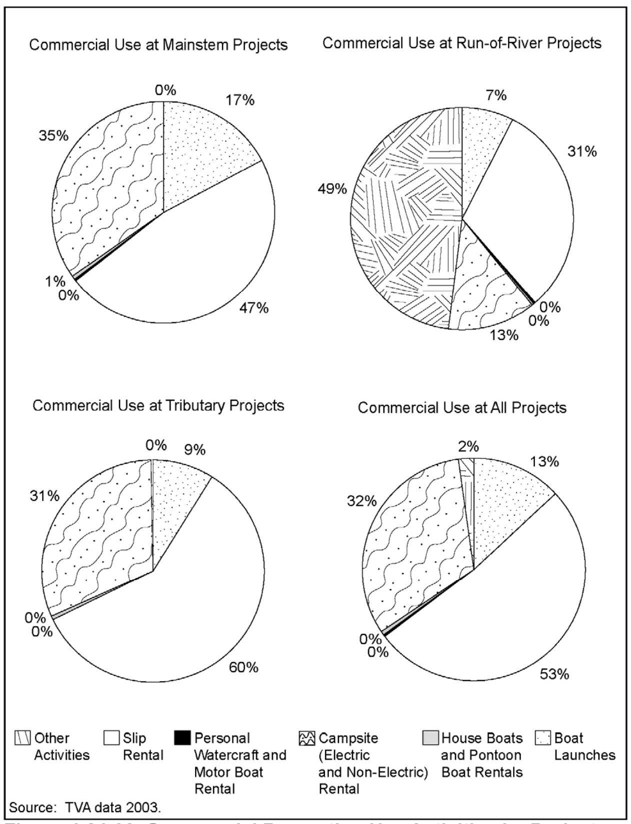
TVA Project	Bank Fishing		Motor Boating		Canoeing or Kayaking		Personal Watercraft		Swim		Other Water-Based Activities		Non-Water-Based Activities	
	Total (user days)	%	Total (user days)	%	Total (user days)	%	Total (user days)	%	Total (user days)	%	Total (user days)	%	Total (user days)	%
Guntersville														
Reservoir	15,207	87.8	96,874	93.9	0	--	3,801	94.9	12,204	99.8	17,553	94.6	21,507	97.1
Tailwater	2,115	12.2	6,290	6.1	0	--	205	5.1	23	0.2	1,000	5.4	648	2.9
Pickwick														
Reservoir	24,557	85.0	93,813	84.0	108	100	6,038	72.2	7,165	100	2,306	80.5	25,213	97.7
Tailwater	4,337	15.0	17,842	16.0	0	0.0	2,320	27.8	0	0.0	559	19.5	588	2.3
Douglas														
Reservoir	4,043	52.1	13,514	65.7	1,619	50.0	694	60.1	724	87.8	176	73.9	6,232	63.4
Tailwater	3,718	47.9	7,040	34.3	1,619	50.0	460	39.9	100	12.2	62	26.1	3,597	36.6
Melton Hill														
Reservoir	4,349	70.8	14,797	68.1	116	76.7	819	57.4	552	62.7	2,515	80.1	17,479	92.3
Tailwater	1,790	29.2	6,933	31.9	35	23.3	607	42.6	329	37.3	626	19.9	1,463	7.7
Norris														
Reservoir	1,166	13.8	20,583	77.3	84	10.2	2,016	100	33,550	99.3	263	91.5	7,933	49.4
Tailwater	7,279	86.2	6,033	22.7	740	89.8	0	0.0	249	0.7	24	8.5	8,112	50.6
South Holston														
Reservoir	3,638	65.0	24,854	65.0	702	65.0	2,152	65.0	1,349	65.0	534	65.0	16,675	65.0
Tailwater	1,959	35.0	13,383	35.0	378	35.0	1,159	35.0	727	35.0	287	35.0	8,979	35.0
Total reservoirs	**52,959**	**71.4**	**264,435**	**82.1**	**2,630**	**48.7**	**15,519**	**76.6**	**55,545**	**97.5**	**23,347**	**90.1**	**95,039**	**80.3**
Total tailwater	**21,197**	**28.6**	**57,520**	**17.9**	**2,772**	**51.3**	**4,751**	**23.4**	**1,428**	**2.5**	**2,559**	**9.9**	**23,386**	**19.7**

Note: For these six TVA projects, recreation use was surveyed below the dam.

4.24 Recreation

Commercial recreation use accounted for more than half of the total recreation use of the 35 ROS projects, accounting for 12.1 million (56 percent) of all user days by the three recreation user types (Figure 4.24-01). Commercial recreation use was more than double private recreation use and more than triple public recreation use. See Appendix D8 for estimates of use by reservoir.

About 53 percent of commercial recreation use across all projects was generated from marina boat slips (Figure 4.24-06). Camping accounted for 32 percent of commercial recreation use, and 13 percent of commercial use was generated through boat launches. These three activities accounted for about 98 percent of all commercial recreation across the 35 projects. This use pattern was evident for mainstem and tributary projects. Run-of-river project use showed lower use percentages for boat slip rentals, campsite rentals, and boat launches, but a higher use percentage for other activities.



Source: TVA data 2003.

Figure 4.24-06 Commercial Recreation Use Activities by Project Type (2002)

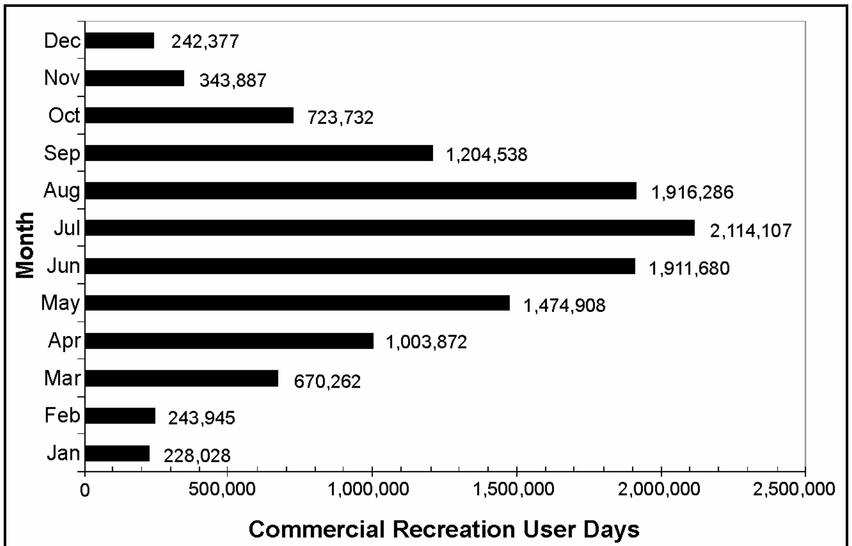
Of the commercial recreation use across the 35 ROS projects, 50 percent occurred on mainstem projects (6.1 million user days) while 46 percent occurred on tributary projects (5.4 million user days, Figure 4.24-01). Commercial recreation use on run-of-river projects was minor, accounting for only 4 percent of the total commercial recreation use across the 35 ROS projects.

Of the 35 ROS projects, 64 percent of the commercial recreation use occurred at five projects:

- Norris, with 2.3 million user days (19 percent);
- Kentucky, with 2.2 million user days (18 percent);
- Guntersville, with 1.4 million user days (12 percent);
- Cherokee, with 1.0 million user days (8 percent); and,
- Watts Bar, with 0.9 million user days (7 percent).

A total of 7.7 million commercial recreation user days was reported at these five projects, with boat slip use accounting for 4.0 million user days and camping accounting for 2.8 million user days. These two commercial uses also dominated the commercial use across the 35 ROS projects.

The majority of commercial recreation use occurred during the May through August period, with 7.4 million user days (or 61 percent of the total commercial use) across the 35 projects (Table 4.24-03). The June through August months accounted for 49 percent of total commercial use, with July being slightly higher than both August and June (Figure 4.24-07). Boat slip rentals, as noted previously, accounted for a majority of commercial recreation use during these months (Table 4.24-03).



Note: User day = All or part of one day by one person at one reservoir.
Source: TVA data 2003.

Figure 4.24-07 Commercial Recreation Use at the 35 Reservoirs Studied in the ROS (2002)

Table 4.24-03 Commercial Recreational Activities across All Affected Reservoirs

Recreational Activity	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Annual
Boat launches	56,574	210,469	465,469	558,177	209,471	63,561	1,563,720
Slips	249,252	751,887	1,731,530	2,214,599	1,008,881	311,260	6,267,410
Paddle boats	301	622	4,058	4,276	1,414	292	10,963
Rafts	0	0	0	0	0	0	0
Sail boats	0	22	204	240	166	5	637
Personal watercrafts	32	390	2,950	5,447	1,180	267	10,268
Motor boats	273	2,090	3,659	4,346	1,857	332	12,557
House boats	32	105	298	413	209	49	1,106
Pontoon boats	387	5,300	17,539	23,059	7,224	949	54,458
Float tubes	0	0	194	441	80	0	715
Other rentals	24	86	41	46	95	24	316
Whitewater rafting	0	6,479	67,641	143,364	37,151	114	254,749
Electric campsites	161,246	655,453	976,577	962,337	606,893	202,991	3,565,497
Non-electric campsites	2,915	39,258	114,054	111,499	52,247	5,610	325,582
Hunting or fishing guides	936	1,974	2,374	2,148	1,400	811	9,644
All recreational activities	**471,973**	**1,674,133**	**3,386,588**	**4,030,393**	**1,928,270**	**586,264**	**12,077,622**

Private Recreation Use

Approximately 4,200 miles (38 percent) of the shoreline adjacent to TVA reservoirs and tailwater areas is either privately owned with direct access to the water or subject to reservoir access rights held by private landowners whose property adjoins TVA waterfront property. Some of these private lands have been developed for residential uses, including single-family homes and condominiums. Users of these residential areas include permanent, seasonal, and weekend residents. In many cases, seasonal, permanent, and weekend residents contribute significantly to the use of TVA reservoirs and, to a lesser degree, to the tailwater areas. Recreation users with private water use facilities on the reservoir and tailwater project areas were surveyed as to their recreation use of these projects. These users included shoreline property owners and condominium owners.

The types of recreational activities that were evaluated in terms of private use were:

- Pleasure boating (including house boating);
- Sailing;
- Water skiing, tubing or other towing activities;
- Personal watercraft use;
- Canoeing or kayaking;
- Fishing from a boat;
- Fishing from shore;
- Tent or vehicle camping;
- Sightseeing;
- Swimming or beach use; and,
- Windsurfing.

Private recreation use by shoreline property owners totaled 5.7 million user days, or 26 percent of the total of all recreation user types across the 35 projects (Figure 4.24-01). Private recreation use across all projects occurred primarily from May through August, with 29 percent of user days occurring during May through June, and 32 percent occurring during July through August (Figure 4.24-08). This pattern in time of use by shoreline property owners was evident for mainstem, run-of-river, and tributary projects. Private recreation use was greatest during July (1.0 million user days), followed by June and August (0.9 million user days each) (Figure 4.24-09). See Appendix D8 for estimates of use by reservoir.

Private recreation use on mainstem projects totaled 3.3 million user days, or 58 percent of the total private recreation use (Figure 4.24-01). Recreation use by shoreline property owners on tributary projects totaled 2.3 million user days, or 40 percent of the total private recreation use. Run-of-river projects had fewer than 130,000 private recreation user days, or 2 percent of the total private recreation use. Two projects accounted for 23 percent of the total private recreation use: Watts Bar (12 percent) and Wheeler (11 percent) (see Appendix D8 for estimates of use by reservoir).

Recreation activity profiles for shoreline property owners at the 13 surveyed projects were dominated by pleasure boating/house boating (92 percent of respondents participated in this activity), fishing from a boat (75 percent participated), water skiing/tubing/towing (70 percent participated), fishing from shore (65 percent participated), swimming or beach use (60 percent participated), personal watercraft use (54 percent participated), and sightseeing (49 percent participated) (Table 4.24-04).

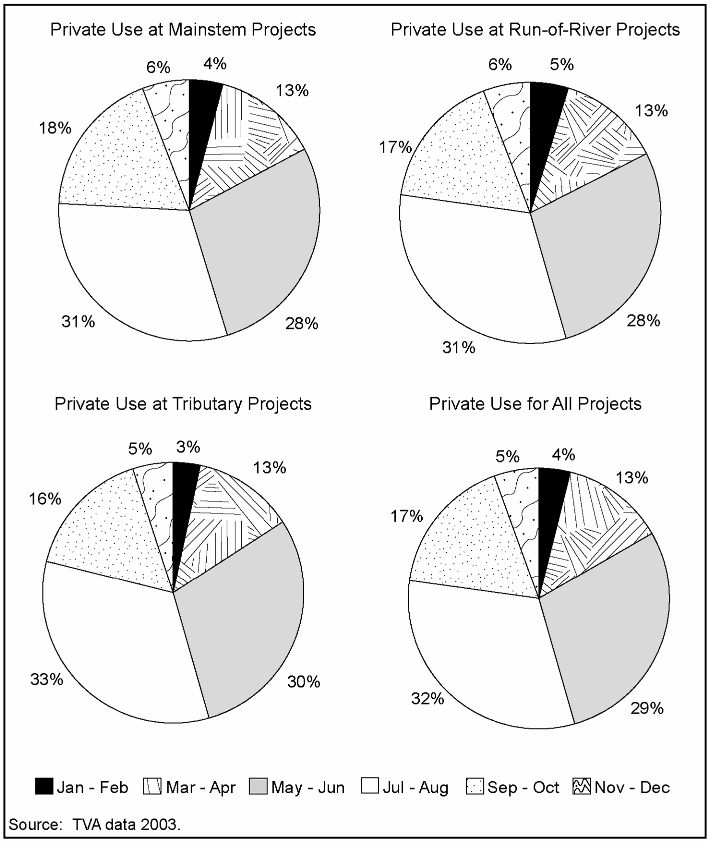


Figure 4.24-08 Private Recreation Use by Project Type (2002)

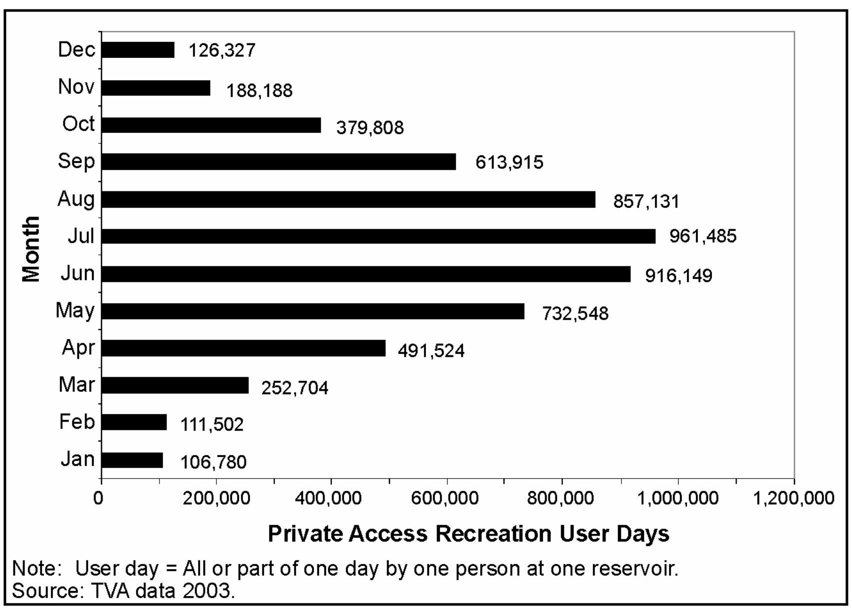


Figure 4.24-09 Private Recreation Use at the 35 Reservoirs Studied in the ROS (2002)

Future Trends

Recreation use of the TVA reservoir system is projected to increase through the year 2030. Outdoor recreation use of federal reservoir projects managed by the U.S. Forest Service, for the types of recreational activities considered for the 35 ROS projects, is expected to increase by 28 percent from 2000 to 2030 (English et al. 1993). The activities with the smallest increases over this three-decade period include fishing (16 percent), boating (16 percent), and swimming (18 percent).

The fishing activity projections may be optimistic, however, as the number of fresh-water anglers nationally (not including Great Lakes fishing) decreased by 8 percent from 1991 to 2001 (USFWS 2002a). The number of fishing days nationally decreased by 11 percent from 1996 to 2001, with a 17 percent decrease in fishing expenditures over the same time period (English et al. 1993). These national trends for angling are evident for the group of seven states encompassing the 35 TVA reservoirs analyzed (USFWS 2002b–e, 2003a–c). Tennessee, however, showed higher numbers of anglers and angling days but lower total angling expenditures from 1996 to 2001 (the differences were not statistically significant [USFWS 2003a]).

Other recreational activities are expected to increase significantly from 2000 to 2030. These activities, including canoeing, rafting, water skiing, sailing, and camping, are anticipated to increase in the range of 27 percent (water skiing) to 105 percent (sailing) (English et al. 1993). Camping, a popular activity in the TVA system, is expected to increase nationally by 44 percent (English et al. 1993). Outdoor recreation, which has grown consistently in importance to the American life style since the early 1960s, is projected to continue and increase in importance. The main attractor for outdoor recreation is, and will continue to be, the presence of water (Cordell et al. 1999).

Table 4.24-04 Private Recreation Activity Profiles at the 13 Surveyed Projects

Surveyed Project	Pleasure Boating (Includes House Boating)	Sailing	Water Skiing, Tubing, or Other Tow	Private Watercraft Use	Canoeing or Kayaking	Fishing (from Boat)	Fishing (from Shore)	Tent or Vehicle Camping	Sight-Seeing	Swimming or Beach Use	Wind-Surfing
Blue Ridge	96.9%	9.2%	84.7%	63.4%	52.7%	71.8%	60.3%	7.6%	53.4%	61.8%	0.0%
Chatuge	95.6%	11.7%	77.6%	47.0%	33.1%	71.6%	59.6%	6.9%	53.9%	62.1%	3.2%
Cherokee	93.0%	3.0%	67.0%	52.0%	19.0%	84.0%	68.0%	19.0%	44.0%	61.0%	1.0%
Chickamauga	89.1%	6.6%	62.5%	61.3%	28.4%	63.8%	66.3%	9.4%	46.3%	50.9%	1.9%
Douglas	93.7%	6.9%	68.8%	55.0%	17.5%	85.2%	73.5%	8.5%	54.0%	63.0%	0.5%
Guntersville	87.9%	13.5%	68.6%	51.2%	27.5%	72.9%	66.7%	6.8%	38.6%	55.6%	2.9%
Hiwassee	100.0%	3.4%	79.3%	31.0%	51.7%	82.8%	69.0%	3.4%	62.1%	79.3%	0.0%
Kentucky	91.1%	10.1%	61.6%	50.8%	12.0%	88.4%	67.4%	7.8%	53.5%	57.8%	1.6%
Melton Hill	77.8%	1.6%	55.6%	34.9%	49.2%	54.0%	54.0%	6.3%	42.9%	50.8%	0.0%
Norris	95.8%	2.1%	80.0%	54.7%	24.2%	69.5%	60.0%	8.4%	53.7%	67.4%	1.1%
Pickwick	91.9%	5.7%	77.2%	61.8%	14.6%	74.0%	69.1%	4.1%	48.0%	60.2%	1.6%
South Holston	93.9%	4.1%	71.4%	53.1%	14.3%	79.6%	63.3%	16.3%	51.0%	53.1%	2.0%
Tellico	92.3%	5.8%	59.1%	37.2%	24.8%	62.4%	47.5%	5.4%	56.6%	57.0%	1.7%
All surveyed projects	**92.3%**	**7.1%**	**70.3%**	**53.6%**	**23.8%**	**75.0%**	**65.4%**	**8.7%**	**49.3%**	**59.6%**	**1.6%**

4.25 Social and Economic Resources

4.25.1 Introduction

Resource Issues

- Population
- Employment
- Economic activity measures—total personal income and gross regional product

This section considers the potential social and economic effects in the ROS analysis area resulting from alternative reservoir operations policies.

Economic impacts in the ROS analysis area were assessed quantitatively. Changes to the existing reservoir operations policy would result in direct economic effects in five pathways: navigation, power, water supply, recreation, and property values. The direct effects of changes in reservoir operations may stimulate changes in the existing regional economy. Changes to the regional economy are the key issues in this section and are measured as changes in:

- Population;
- Employment; and,
- Economic activity measures—total personal income (PI) and gross regional product (GRP).

This section presents the existing conditions of the five pathways and the four regional economic variables in the ROS analysis area, as well as their trend projections through 2030. Existing conditions and the trends through 2030 were forecasted by TVA, using a system of models and forecasting processes of which the Regional Economic Model, Inc. (REMI) model is an integral part. The forecast process uses over 30 years of historical data, taking into account national economic and demographic trends as well as region specific conditions. The process incorporates plant announcements and other recent data to capture new and upcoming trends in the forecast. The navigation, power, water supply, and recreation pathways are discussed in their respective sections (Sections 4.21, 4.23, 4.5, and 4.24).

The geographic scope of this study consists of the 201-county area bounded by the TVA Power Service Area and the Tennessee River watershed. The economic effects on this area were represented by the use of an existing model that includes 191 of these counties. The economic effects on the 10 counties not included in the modeling work would be similar to those that were included. These 191 counties have been aggregated into nine sub-regions, and the aggregate of these nine sub-regions constitutes what is referred to as the ROS analysis area. For a breakdown of the individual counties that make up each sub-region, refer to Appendix D10.

The potential social impacts of changes to the existing reservoir operations policy would take place at local scales (e.g., at the county level or smaller). For example, changes in the existing reservoir operations policy may place pressure on the provision of local community public services and infrastructure to meet the demands of population changes. Such effects are typically associated with rapid population movements into or out of local communities. These and other social parameters usually considered in EISs are realized at the local level. Because this programmatic EIS addresses broad socioeconomic effects in the ROS analysis area as a whole, social effects in local communities are not addressed further in this EIS.

4.25.2 Regulatory Programs and TVA Management Activities

TVA's operating priorities are governed by policies established in the 1991 Lake Improvement Plan, and in general by the priorities listed in the TVA Act (1933). Sections 22 and 23 of the TVA Act include language that directs the agency to focus on economic development and the economic well being of the people living in the ROS analysis area. TVA manages and operates 49 projects on the Tennessee River and its tributaries. The existing reservoir operations policy provides multiple public benefits—navigation, flood control, power supply, water quality/supply, and recreation.

4.25.3 Population

Existing Conditions

During the 1980s, the population of the ROS analysis area increased at an average annual rate of 0.6 percent, adding on average more than 42,000 people annually, to a level of almost 8 million residents by 1990. The regional population increase was lower than the United States as a whole, which increased at an average annual rate of 0.9 percent over the same period (Table 4.25-01). Between 1990 and 2000, the population of the ROS analysis area increased at a rate greater than that for the United States, averaging over 120,000 residents annually, to a level of just over 9 million. This represents an average annual increase in the regional population of 1.4 percent, compared to 1.2 percent for the United States over the same period.

In both decades, the Nashville sub-region had the largest population growth rate across the TVA sub-regions. Other than Nashville, the Chattanooga, Knoxville, and North Carolina non-Power Services Area sub-regions also had strong growth in the 1990s.

Future Trends

Table 4.25-02 presents the trend in projected population increases across the ROS analysis area between 2004 and 2030. The projected increase in population of the ROS analysis area follows the trend of the last decade, whereby it will exceed that of the United States as a whole. Over the 27-year period, the population of the ROS analysis area is forecast to rise at an annual rate of 1.1 percent, reaching a level of approximately 12 million by 2030. The projected annual increase in the national population is roughly 1.0 percent over the same period. The greatest rate of population growth is expected to occur in the North Carolina, Nashville, and Knoxville sub-regions.

Table 4.25-01 Population in the ROS Analysis Area (1980–2000) (thousands)

Sub-Region	1980	1990	2000	Average Annual Rate for 1980–1990 (%)	Average Annual Rate for 1990–2000 (%)
Alabama	777.9	844.2	964.5	0.8	1.3
Chattanooga	813.5	853.7	988.6	0.5	1.5
Knoxville	864.3	913.7	1,074.8	0.6	1.6
Mississippi	695.0	706.9	780.0	0.2	1.0
Nashville	1,772.1	1,956.6	2,385.5	1.0	2.0
North Carolina non-Power Service Area	430.8	469.1	558.6	0.9	1.8
Tri-cities	524.0	528.6	584.6	0.1	1.0
Virginia non-Power Service Area	257.6	239.9	244.2	-0.7	0.2
Western	1,400.4	1,447.2	1,593.9	0.3	1.0
Region total	**7,535.5**	**7,960.0**	**9,174.7**	**0.6**	**1.4**
U.S. total	226,546.0	248,791.0	281,421.9	0.9	1.2

Source: U.S. Department of Commerce, Bureau of the Census.

4.25.4 Employment

Existing Conditions

Between 1980 and 1990, employment levels in the ROS analysis area increased at an average annual rate of approximately 2.1 percent—exceeding the national growth rate, which was 2.0 percent over the same period (Table 4.25-03). Over the next ten years, the average annual growth rate of the region was roughly 2.1 percent, again exceeding the national average. By 2000, regional employment reached a level of 5 million. The regional unemployment rate at this time was 4.1 percent, slightly above the national average of 4.0 percent (Table 4.25-04). The Virginia non-Power Service Area sub-region experienced the highest unemployment rate (5.9 percent) in the region, and the North Carolina non-Power Service Area region the lowest (3.1 percent).

Table 4.25-02 Population Forecast for the ROS Analysis Area (2004 to 2030) (thousands)

Sub-Region	2004	2005	2006	2007	2008	2009	2010	Average Annual Rate for 2004–2010 (%)	2030	Average Annual Rate for 2010–2030 (%)
Alabama	1,007.2	1,018.1	1,028.8	1,039.5	1,050.2	1,061.0	1,071.8	1.0	1,305.4	1.0
Chattanooga	1,030.2	1,040.5	1,050.7	1,060.8	1,070.9	1,081.2	1,091.5	1.0	1,321.3	1.0
Knoxville	1,137.3	1,152.9	1,168.4	1,183.8	1,199.2	1,214.8	1,230.4	1.3	1,532.8	1.1
Mississippi	803.7	810.0	816.0	821.9	828.1	834.3	840.5	0.8	997.9	0.9
Nashville	2,533.7	2,570.6	2,607.0	2,643.4	2,679.7	2,716.4	2,753.0	1.4	3,450.1	1.1
North Carolina non-Power Service Area	589.2	596.8	604.4	611.9	619.4	627.1	634.6	1.2	795.3	1.1
Tri-cities	599.6	603.6	607.5	611.5	615.4	619.4	623.5	0.7	734.0	0.8
Virginia non-Power Service Area	247.4	248.3	249.2	250.1	251.0	251.9	252.8	0.4	273.7	0.4
Western	1,647.0	1,660.8	1,674.5	1,688.0	1,701.5	1,715.3	1,729.1	0.8	2,065.8	0.9
Region total	**9,595.4**	**9,701.5**	**9,806.4**	**9,911.0**	**10,015.4**	**10,121.4**	**10,227.2**	**1.1**	**12,476.3**	**1.0**
U.S. total	293,347.0	296,254.0	299,053.0	301,940.0	304,834.0	307,726.0	310,644.0	1.0	375,948.0	1.0

Source: U.S. Department of Commerce, Bureau of the Census.

Table 4.25-03 Employment in the ROS Analysis Area (1980 to 2000) (thousands)

Sub-Region	1980	1990	2000	Average Annual Rate for 1980–1990 (%)	Average Annual Rate for 1990–2000 (%)
Alabama	351.5	463.4	548.4	2.9	1.7
Chattanooga	383.6	468.2	581.5	2.0	2.2
Knoxville	393.7	499.1	624.0	2.4	2.3
Mississippi	304.6	339.0	397.7	1.1	1.6
Nashville	886.5	1,135.5	1,510.9	2.5	2.9
North Carolina non-Power Service Area	201.2	254.2	321.1	2.4	2.4
Tri-cities	238.9	280.1	321.3	1.6	1.4
Virginia non-Power Service Area	94.7	101.5	108.0	0.7	0.6
Western	710.0	843.0	1,003.1	1.7	1.8
Region total	**3,564.8**	**4,381.9**	**5,416.0**	**2.1**	**2.1**
U.S. total	114,231.2	139,426.9	166,168.4	2.0	1.8

Source: U.S. Department of Commerce, Bureau of Economic Analysis, establishment data.

Compared to the United States as a whole, the ROS analysis area has a higher share of its workers employed in the goods-producing sectors (Table 4.25-05). The manufacturing sector accounts for 17.0 percent of the region's employment compared to 11.4 percent nationwide. The share of workers in the mining and construction sector is also slightly above the national average. Conversely, the region's share of workers in the service sector is below the national average. The service sector and the government sector provide 26.7 and 13.3 percent, respectively, of the region's employment compared to 31.8 and 13.6 percent, respectively, nationwide.

Future Trends

Employment in the ROS analysis area through 2010 is forecast to continue its trend of increasing at a rate above the national average (Table 4.25-06). The number of jobs in the region is forecast to increase by an average annual rate of 1.6 percent between 2004 and 2010, compared to 1.2 percent nationwide. Between 2010 and 2030, the average annual employment growth rate in the ROS analysis area is forecast to be 1.0 percent, increasing regional employment to a level of 8 million. The average annual employment growth rate of the nation is also forecast to be 1.0 percent over this period. The Nashville and Knoxville sub-regions are expected to experience the greatest rate of employment growth.

Table 4.25-04 Labor Force and Unemployment in the ROS Analysis Area (2000) (average annual in thousands)

Sub-Region	Civilian Labor Force	Unemployed	Unemployment Rate (%)
Alabama	482.5	20.1	4.2
Chattanooga	482.3	17.3	3.6
Knoxville	531.9	19.5	3.7
Mississippi	358.2	20.7	5.8
Nashville	1,201.5	44.6	3.7
North Carolina non-Power Service Area	262.6	8.0	3.1
Tri-cities	275.4	12.1	4.4
Virginia non-Power Service Area	106.0	6.2	5.9
Western	771.3	34.8	4.5
Region total	**4,471.6**	**183.4**	**4.1**
U.S. total	140,863.0	5,655.0	4.0

Source: Tennessee Department of Labor and Workforce Development Employment Security Division, Research and Statistics, household data.

Table 4.25-05 Employment by Economic Sector in the ROS Analysis Area (2000) (thousands)

Sub-Region	Total Employment	Mining and Construction (%)	Manufacturing (%)	Services (%)	Wholesale and Retail (%)	Government (%)
Alabama	548.4	6.2	20.5	24.3	20.5	15.9
Chattanooga	581.5	6.1	24.4	22.9	20.0	11.3
Knoxville	624.0	7.2	14.3	28.1	22.7	12.9
Mississippi	397.7	5.9	25.7	20.6	18.1	15.2
Nashville	1,510.9	6.3	15.2	29.1	20.3	12.8
North Carolina non-Power Service Area	321.1	8.8	12.9	30.5	21.8	13.3
Tri-cities	321.3	7.0	18.6	25.2	21.3	12.0
Virginia non-Power Service Area	108.0	9.5	14.1	22.3	20.5	17.2
Western	1,003.1	5.6	13.0	28.0	21.7	13.0
Region total	**5,416.0**	**6.5**	**17.0**	**26.7**	**20.8**	**13.3**
U.S. total	166,168.4	6.2	11.4	31.8	20.8	13.6

Source: U.S. Department of Commerce, Bureau of Economic Analysis.

Table 4.25-06 Employment Forecast in the ROS Analysis Area (2004 to 2030) (thousands)

Sub-Region	2004	2005	2006	2007	2008	2009	2010	Average Annual Rate for 2004–2010 (%)	2030	Average Annual Rate for 2010–2030 (%)
Alabama	563.0	572.6	580.6	588.6	598.0	606.8	616.3	1.5	718.6	0.8
Chattanooga	594.9	604.7	612.4	620.4	629.3	637.2	644.9	1.4	805.3	1.1
Knoxville	646.3	658.6	668.9	679.7	692.1	703.7	715.8	1.7	894.9	1.1
Mississippi	402.5	409.2	413.7	417.6	422.3	426.3	430.6	1.1	507.0	0.8
Nashville	1,559.9	1,589.5	1,616.2	1,644.8	1,677.2	1,708.2	1,740.0	1.8	2,183.9	1.1
North Carolina non-Power Service Area	329.9	335.8	340.9	346.6	353.2	359.4	365.8	1.7	441.2	0.9
Tri-cities	327.3	332.6	336.9	341.5	347.2	352.5	357.9	1.5	439.8	1.0
Virginia non-Power Service Area	109.3	110.5	111.3	112.2	113.5	114.6	115.8	1.0	132.3	0.7
Western	1,020.7	1,034.8	1,046.8	1,060.3	1,076.7	1,091.8	1,108.0	1.4	1,359.9	1.0
Region total	**5,553.8**	**5,648.3**	**5,727.8**	**5,811.8**	**5,909.4**	**6,000.4**	**6,095.2**	**1.6**	**7,483.0**	**1.0**
U.S. total	172,010.0	174,162.1	175,959.2	177,922.2	180,145.8	182,211.4	184,701.8	1.2	224,923.4	1.0

Source: TVA file data.

4.25.5 Total Personal Income

Existing Conditions

Over the 10-year period leading up to 2000, PI (wages and salary income, including transfer payments, dividend interest, and rent less personal social security payments) in the ROS analysis area increased by an average annual rate of 3.0 percent to a level of $235 billion (Table 4.25-07). This compares to the national growth rate of 2.7 percent. Foremost in driving this increase were PI increases in the Nashville and Knoxville sub-regions, and North Carolina non-Power Service Area sub-region.

Table 4.25-07 Total Personal Income in the ROS Analysis Area (2002 dollars in billions)

Sub-Region	Total Personal Income 1980	Total Personal Income 1990	Total Personal Income 2000	Average Annual Rate for 1980–1990 (%)	Average Annual Rate for 1990–2000 (%)
Alabama	$13.5	$19.4	$23.9	3.7	2.1
Chattanooga	$14.1	$18.7	$24.7	2.9	2.8
Knoxville	$14.2	$19.2	$26.5	3.1	3.3
Mississippi	$9.8	$12.1	$15.8	2.1	2.7
Nashville	$32.0	$44.8	$65.5	3.4	3.9
North Carolina non-Power Service Area	$7.3	$10.5	$14.4	3.7	3.2
Tri-cities	$8.5	$10.9	$13.5	2.5	2.2
Virginia non-Power Service Area	$4.6	$4.4	$4.8	-0.4	0.9
Western	$26.1	$34.2	$44.9	2.7	2.8
Region total	**$130.1**	**$175.1**	**$234.6**	**3.0**	**3.0**
U.S. total	NA	$6,747.5	$8,784.3	NA	2.7

Notes:

NA = Not applicable.

Source: U.S. Department of Commerce, Bureau of Economic Analysis.

Future Trends

Table 4.25-08 provides forecasts of total PI changes in the region. The forecast increase in PI for the ROS analysis area follows the historical trend of exceeding the national increase.

Table 4.25-08 Total Income Forecast in the ROS Analysis Area (2004 to 2030) (2002 dollars in billions)

Sub-Region	2004	2005	2006	2007	2008	2009	2010	Average Annual Rate for 2004–2010 (%)	2030	Average Annual Rate for 2010–2030 (%)
Alabama	$25.7	$26.3	$27.1	$27.8	$28.6	$29.5	$30.3	2.8	$49.0	2.4
Chattanooga	$26.9	$27.6	$28.5	$29.3	$30.3	$31.3	$32.2	3.0	$57.3	2.9
Knoxville	$29.8	$30.7	$31.7	$32.7	$33.8	$35.0	$36.1	3.3	$63.7	2.9
Mississippi	$16.9	$17.3	$17.8	$18.2	$18.7	$19.2	$19.7	2.6	$33.1	2.6
Nashville	$71.4	$73.5	$75.9	$78.4	$81.3	$84.3	$87.2	3.4	$157.6	3.0
North Carolina non-Power Service Area	$15.7	$16.1	$16.6	$17.1	$17.7	$18.3	$18.9	3.1	$31.8	2.6
Tri-cities	$14.6	$15.0	$15.5	$15.9	$16.4	$17.0	$17.5	3.1	$30.4	2.8
Virginia non-Power Service Area	$5.2	$5.3	$5.4	$5.6	$5.7	$5.9	$6.0	2.4	$10.0	2.6
Western	$47.7	$48.6	$49.8	$51.0	$52.5	$54.0	$55.4	2.5	$96.9	2.8
Region total	**$253.8**	**$260.5**	**$268.3**	**$276.1**	**$285.1**	**$294.4**	**$303.3**	**3.0**	**$529.8**	**2.8**
U.S. total	$9,328.6	$9,508.7	$9,738.1	$9,986.3	$10,277.8	$10,584.7	$10,926.5	2.7	$18,602.4	2.7

Source: TVA file data.

Between 2004 and 2010, the forecast average annual rate of growth for the region is 3.0 percent compared to a rate of 2.7 percent for the nation. Between 2010 and 2030, regional PI (2.8 percent) is forecast to continue to increase at a greater annual rate than that of the nation (2.7 percent). The Nashville sub-region will experience the fastest rate of growth in PI, followed by the Knoxville and Chattanooga sub-regions.

4.25.6 Gross Regional Product

Existing Conditions

Gross regional product (GRP) is the sum dollar value of goods and services created in the region. Because the GRP measures the sum of wages income and corporate profit, it is a broad measure of full economic effects. Between 1990 and 2000, GRP in the ROS analysis area rose at an average annual rate of 4.1 percent, to a level of $274 billion (Table 4.25-09). This growth rate exceeded that of the national gross domestic product (GDP) (a corresponding national measure of final goods and services production).

Table 4.25-09 Gross Regional Product in the ROS Analysis Area (2002 dollars in billions)

Gross Product	1990	2000	Average Annual Rate for 1990–2000 (%)
Gross regional product	$183.6	$273.8	4.1
U.S. gross domestic product	$7,427.9	$10,178.0	3.2

Future Trends

This trend is forecast to continue through 2030 (Table 4.25-10). Between 2004 and 2010, the forecast rate of growth for regional GRP is 3.6 percent, compared to a 3.2-percent growth rate for the national GDP. Between 2010 and 2030, the regional growth rate is forecast to fall to 3.2 percent, to a level of $695 billion—still representing a growth in regional value of production at a rate above the national average.

4.25.7 Environmental Justice

TVA addresses environmental justice in its environmental reviews. For the ROS, the primary issue was to determine whether an alternative reservoir operations policy could result in adverse environmental or human health impacts that would disproportionately affect minority or low-income populations.

Table 4.25-10 Gross Regional Product Forecast (2004 to 2030) (2002 dollars in billions)

Region	2004	2005	2006	2007	2008	2009	2010	Average Annual Rate for 2004–2010 (%)	2030	Average Annual Rate for 2010–2030 (%)
Gross regional product	$301.3	$312.0	$322.4	$333.3	$345.4	$358.6	$372.7	3.6	$694.7	3.2
U.S. gross domestic product	$11,121.9	$11,422.9	$11,749.6	$12,104.4	$12,512.1	$12,951.4	$13,444.8	3.2	$24,724.5	3.1

As indicated in Table 4.25-11, the ROS analysis area has a smaller percentage of the population considered minority (nonwhite and Hispanic—19.5 percent) than the United States (30.9 percent). Only two of the nine sub-regions within the ROS analysis area have a higher minority population than the United States: the Mississippi (34.6 percent) and Western (39.2 percent) sub-regions. The poverty rate for the ROS analysis area (14.0 percent) is slightly higher than the national rate (12.4 percent). All the sub-regions except the Nashville sub-region and the North Carolina non-Power Service Area sub-region exceed the national poverty rate, although Mississippi (19.8 percent) is the only one that exceeds it by a substantial margin.

4.25.8 Direct Economic Drivers

This section provides a description of the existing conditions of the direct effects in the economic sectors corresponding to the five economic drivers as well as trends through 2030.

Power Supply

With a generating capacity of over 31,000 MW—TVA provides wholesale power to 158 distributors and directly serves 61 large industrial and federal customers. In partnership with the distributors, the TVA power system serves more than 8 million people in an 80,000-square-mile area that covers parts of seven Southeastern states. TVA currently dispatches its diverse mix of power generating resources—fossil-fired (coal, oil and gas), nuclear, hydro, and pumped storage to minimize the cost of power. Changes in this reservoir operations policy that changes the amount or timing of water releases may affect TVA's ability to provide hydropower during periods of peak demand when it is most valuable. The implementation of an alternative reservoir operations policy may also affect the use or operation of TVA's non-hydropower generating resources, and energy customers in the TVA Power Service Area may be affected (see Section 4.23, Power). To the extent that the alternatives change the amount and timing of either hydropower or non-hydropower generation, the mix of generating resources used to meet the power demand would change and the cost of power would change. Because power costs affect the cost of living and working in the Tennessee Valley, this change in power cost would affect the regional economy. Based on the 2002 data, TVA's energy generation revenues totaled $6,835 million. Based on TVA's January 2003 forecast, and the existing reservoir operations policy, total energy generation revenues are expected to increase by an average annual rate of approximately 2.9 percent between 2004 and 2010, and then by 3.3 percent between 2010 and 2030—to a level of $16,111 million (Table 4.25-12).

Navigation

Many industries in the ROS analysis area use waterborne transportation. As this analysis is interested in the economic impacts in the ROS analysis area, only movements that originate or terminate on the Tennessee or Cumberland River systems or their tributaries were considered. In 2000, 58.7 million tons of commerce moved on the system, of which 48.6 million tons either originated or terminated on the Tennessee or Cumberland River systems (Table 4.25-13). Changes in channel depths can result in potential impacts on regional industries and their options for alternative modes of transport, as described in Section 4.21, Navigation.

Table 4.25-11 Environmental Justice Populations in the ROS Analysis Area (thousands)

Sub-Region	Total Population 2000	Nonwhite Population 2000	White Hispanic Population 2000	Percent Minority Population 2000 (%)	Percent of Population below Poverty 2000 (%)
Alabama	964.5	154.7	11.9	17.3	13.0
Chattanooga	988.6	122.3	15.3	13.9	12.8
Knoxville	1,074.8	74.4	7.7	7.6	14.0
Mississippi	780.0	265.3	4.6	34.6	19.8
Nashville	2,385.5	386.2	31.5	17.5	12.1
North Carolina non-Power Service Area	558.6	46.1	7.9	9.7	12.4
Tri-cities	584.6	22.2	3.5	4.4	14.8
Virginia non-Power Service Area	244.2	9.1	1.1	4.1	15.9
Western	1,593.9	609.8	14.6	39.2	15.5
Region total	**9,174.7**	**1,690.1**	**98.1**	**19.5**	**14.0**
U.S. total	281,421.9	69,961.3	16,907.9	30.9	12.4

Source: U.S. Department of Commerce, Bureau of the Census.

Table 4.25-12 Total Power Sales Revenue in the TVA Power Service Area (2004 to 2030) (2002 dollars in millions)

Revenue	2004	2005	2006	2007	2008	2009	2010	Average Annual Rate for 2004–2010 (%)	2030	Average Annual Rate for 2010–2030 (%)
Total power sales revenue	$7,106.5	$7,294.8	$7,427.8	$7,596.0	$7,925.1	$8,111.9	$8,416.4	2.9	$16,110.8	3.3

Table 4.25-13 Tennessee River Tonnage That Originated and Terminated on the Tennessee or Cumberland River Systems (1980 to 2000)

Commodity	1980 (millions of tons)	1990 (millions of tons)	2000 (millions of tons)	Average Annual Rate for 1980–1990 (%)	Average Annual Rate for 1990–2000 (%)
Aggregates	3.2	10.6	12.2	12.7	1.4
All other	2.1	3.1	3.9	4.0	2.3
Chemicals	2.5	2.1	2.7	-1.7	2.5
Coal and coke	15.5	21.6	18.6	3.4	-1.5
Grains	2.9	4.0	3.3	3.2	1.9
Iron and steel	0.8	1.2	3.3	4.2	10.5
Ores and minerals	1.1	1.3	2.7	1.7	7.5
Petroleum fuels	1.4	1.6	1.8	1.4	1.2
Total	**29.3**	**45.6**	**48.6**	**4.6**	**0.6**

Direct economic benefits resulting from the system include income, employment and ongoing investments in commercial enterprises producing and transporting commercial goods on the waterway. For purposes of this analysis, economic effects were characterized by costs per ton of cargo, with the economic costs to shippers expressed in dollars per ton shipped. Shipper savings (the difference between barge and the next least-costly mode of transport) vary by commodity, but the average shipper savings for 2000 is valued at $9.24 per ton. Based on the 2000 traffic, total shipper savings to industry was about $355 million. The greatest savings across the ROS analysis area involve the transportation of coal and coke and aggregates. Based on the existing reservoir operations policy, regional traffic on the Tennessee and Cumberland River systems is expected to increase at an average annual rate of 2.0 and approximately 1.7 percent (Table 4.25-14) over the forecast period. Regional shipper savings are also expected to increase over the forecast period, rising by an average annual rate of 2.0 percent between 2004 and 2020, and then by 1.7 percent between 2020 and 2030—reaching a level of $597.1 million by 2030 (Table 4.25-15).

Water Supply

The TVA reservoir system provides a key function for public water supply and private/commercial water intake. Section 4.5, Water Supply, provides a detailed description of these functions. There are potentially two direct effects of changes to the existing reservoir operations policy in the water supply pathway. The first is the impact on intake costs. If changes in the existing reservoir operations policy reduce the minimum reservoir elevations below the level necessary for water intake, direct costs would be incurred in providing the required water supply. Estimated intake costs would be a one-time mitigation outlay for affected industries, as discussed in Section 5.25.

Table 4.25-14 Total Traffic on the Tennessee and Cumberland River Systems Less Through-Movement (2004 to 2030) (millions of tons)

Traffic	2004	2005	2006	2007	2008	2009	2010	Average Annual Rate for 2004–2010 (%)	2030	Average Annual Rate for 2010–2030 (%)
Total traffic	51.6	52.6	53.7	54.8	55.9	57.0	58.1	2.0	81.4	1.7

Table 4.25-15 Total Shipper Savings by Commodity for the TVA Region under Existing Conditions and Future Trends (2002 dollars in millions)

Commodity	2004	2005	2006	2007	2008	2009	2010	Average Annual Rate for 2004–2010 (%)	2030	Average Annual Rate for 2010–2030 (%)
Aggregates	$108.5	$110.7	$112.9	$115.1	$117.4	$119.8	$122.2	2.0	$171.2	1.7
All other	$18.7	$19.1	$19.5	$19.8	$20.2	$20.6	$21.1	2.0	$29.5	1.7
Chemicals	$56.9	$58.0	$59.2	$60.4	$61.6	$62.8	$64.1	2.0	$89.8	1.7
Coal and coke	$106.1	$108.2	$110.4	$112.6	$114.8	$117.1	$119.5	2.0	$167.4	1.7
Grains	$29.4	$30.0	$30.6	$31.2	$31.8	$32.5	$33.1	2.0	$46.4	1.7
Iron and steel	$26.2	$26.7	$27.3	$27.8	$28.4	$28.9	$29.5	2.0	$41.3	1.7
Ores and minerals	$19.7	$20.1	$20.5	$20.9	$21.3	$21.8	$22.2	2.0	$31.1	1.7
Petroleum fuels	$13.0	$13.3	$13.5	$13.8	$14.1	$14.4	$14.6	2.0	$20.5	1.7
Total	**$378.5**	**$386.1**	**$393.8**	**$401.7**	**$409.7**	**$417.9**	**$426.3**	**2.0**	**$597.1**	**1.7**

The second potential impact would relate to industries directly dependent on river flows in order to discharge wastewater. When river flow is low, some industries must store some or all of their wastewater and hold it until river flow is sufficiently high to be able to release discharges. The implication of this impact is that the affected industries would need to shut down their facilities until discharges were possible, incurring lost days of production.

Recreation

Recreational opportunities in the ROS analysis area are associated with the existing reservoir operations policy, as discussed in Section 4.24, Recreation. Changes in the reservoir operations policy may potentially affect water-based recreational opportunities and therefore expenditures in the ROS analysis area. For instance, delaying the late-summer unrestricted drawdown potentially would extend the availability of water-based recreational opportunities in the region, potentially generating additional expenditures. Recreational expenditures are categorized in five broad areas: lodging, food and beverages, transportation, activities, and miscellaneous.

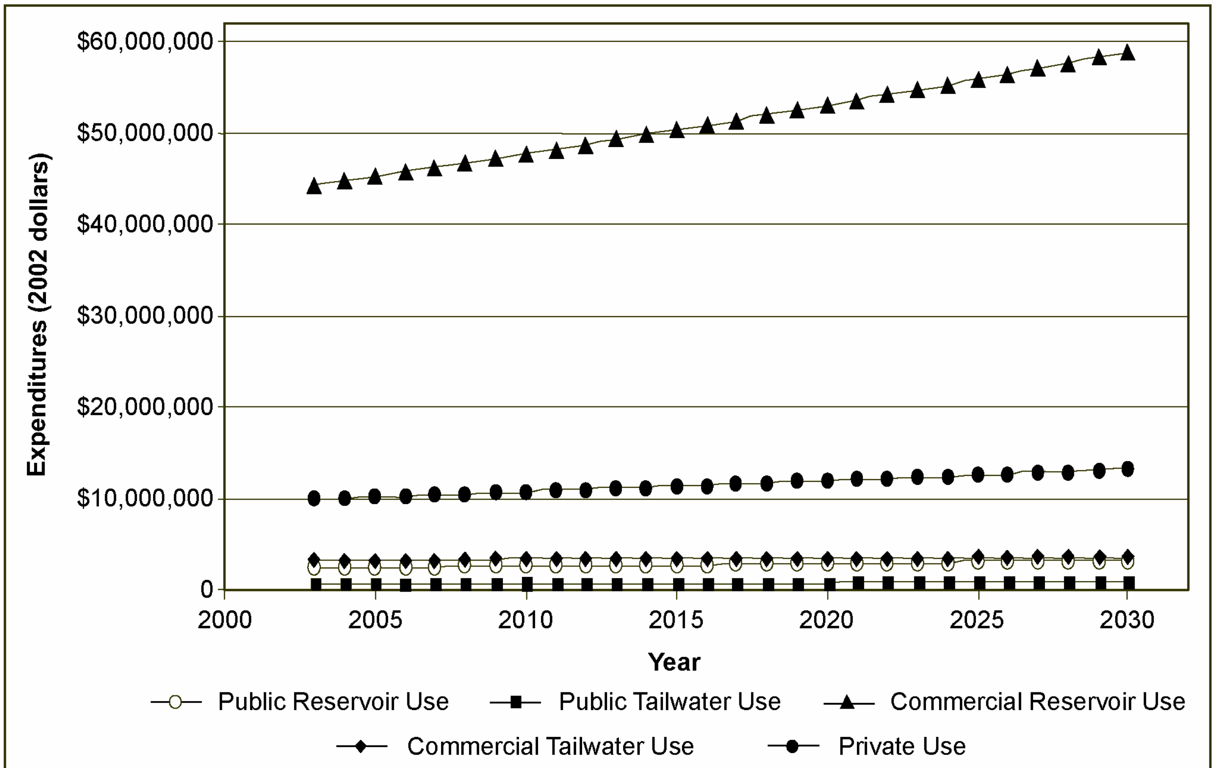
The total current expenditures by recreation users of the TVA reservoir system who come from outside the ROS analysis area (i.e., external expenditures) were estimated for the August through October period. During this period, the existing reservoir operations policy alternatives would result in their greatest effects on spending for recreational activities. Recreation spending by local residents was not considered in this analysis, as any change would merely represent a re-distribution of expenditures within the ROS analysis area, resulting in zero net benefit to the region. External recreation expenditures resulting from use of the TVA reservoir system during August through October totaled about $61 million in 2003 under the existing reservoir operations policy. External recreation expenditures are forecast to increase by an average annual rate of approximately 1.0 percent per year, reaching a level of about $80 million by 2030 (Table 4.25-16).

The majority of external recreation expenditures are associated with commercial providers use (Figure 4.25-01), such as marinas, rental companies, and outfitters that provide direct access to the water. In 2003, 73 percent of recreation expenditures from all types of use (public reservoir use, public tailwater use, commercial reservoir use, commercial tailwater use, and private recreation use) were from commercial reservoir use. Private recreation use accounts for 17 percent of total expenditures, followed by commercial tailwater use at 5 percent, public reservoir use at 4 percent, and public tailwater use at 1 percent. Similar breakdowns across types of use, plus or minus 1 percent, were evident for total expenditures projected for 2030. The dominance of commercial use expenditures reflects a similar dominance in commercial recreation use (user days) as discussed in Section 4.24, Recreation.

Table 4.25-16 Annual Expenditures within TVA Economic Sub-Regions (2004 to 2030) (2002 dollars in millions)

Sub-Region	2004	2005	2006	2007	2008	2009	2010	Average Annual Rate for 2004–2010 (%)	2030	Average Annual Rate for 2010–2030 (%)
Alabama	$14.9	$15.1	$15.3	$15.5	$15.7	$15.9	$16.1	1.3	$20.4	1.2
Chattanooga	$11.9	$12.0	$12.1	$12.2	$12.3	$12.4	$12.5	0.8	$15.1	1.0
Knoxville	$27.0	$27.3	$27.6	$27.8	$28.1	$28.4	$28.7	1.0	$35.0	1.0
Nashville	$3.4	$3.4	$3.4	$3.5	$3.5	$3.5	$3.6	1.0	$4.2	0.8
North Carolina non-Power Service Area	$1.0	$1.0	$1.0	$1.0	$1.8	$1.8	$1.8	10.3	$1.9	0.3
Tri-cities	$1.8	$1.8	$1.8	$1.8	$1.0	$1.0	$1.0	-9.3	$1.3	1.3
Western	$1.4	$1.4	$1.4	$1.4	$1.4	$1.4	$1.4	0.0	$1.7	1.0
Region total	**$61.2**	**$61.9**	**$62.5**	**$63.1**	**$63.8**	**$64.5**	**$65.1**	**1.0**	**$79.6**	**1.0**

Note: Expenditures reflect those made by recreation users coming from outside the TVA region during August through October.



Source: TVA data 2003.

Figure 4.25-01 Projected External Recreation Expenditures during August through October across the TVA System under the Existing Reservoir Operations Policy

Property Values

Values of waterfront properties on TVA reservoirs are potentially affected by the seasonal variation in reservoir pool levels. Changes in the existing reservoir operations policy that expose less (more) area between the summer high pool and winter low pool elevations would potentially increase (decrease) the value of property adjacent to the water, as the value of these properties reflect the recreational and aesthetic benefits of living by the reservoir. The direct effects associated with increases in property values are additional expenditures on durable goods as residents respond to their increased wealth.

Data for shoreline property values adjacent to the reservoirs are not available; however, 2000 Census Bureau data do provide information on the median property values for the specified owner occupied housing units from census block groups adjacent to reservoirs considered in the ROS (Table 4.25-17). The table shows a range of median values from $144,000 for properties in block groups adjacent to Fort Loudoun Reservoir to $65,000 for properties in block groups on Watauga Reservoir. Across all the reservoirs considered in the study, the average property value is approximately $92,000. Section 4.15, Land Use, provides a more detailed description of existing and future conditions related to land use.

Table 4.25-17 Average Median Home Values for Census Block Groups Adjacent to ROS Reservoirs (thousands)

Reservoir	Average Home Value
Fort Loudoun	$143.9
Chatuge	$129.0
Nickajack	$114.8
Nottely	$107.5
Chickamauga	$104.5
Blue Ridge	$103.3
Tellico	$102.6
Wheeler	$92.6
Fontana	$89.1
Cherokee	$88.5
Douglas	$88.2
Tims Ford	$85.8
Watts Bar	$85.7
Hiwassee	$83.1
Guntersville	$83.0
South Holston	$80.7
Norris	$76.7
Pickwick	$75.4
Kentucky	$71.7
Great Falls	$67.4
Watauga	$65.0
Average value	**$92.3**

Source: U.S. Department of Commerce, Bureau of the Census, 2000 Census data.

Chapter 5

Environmental Consequences

of the Alternatives

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5.1 Introduction to Environmental Consequences

The Environmental Consequences of the Alternatives chapter consists of this overview and 24 individual sections that describe the potential impacts of the Base Case and the eight policy alternatives on each of the affected environmental resource areas. The sections are discussed in the same order as Chapter 4, Description of Affected Environment.

5.1.1 Organization of Resource Areas Sections

Each resource area section identifies the resource issues examined, explains the methods used to determine impacts, and describes the anticipated impacts under the Base Case and each policy alternative. Impacts identified for each policy alternative are based on the incremental change between the Base Case and the changes in each policy alternative. Impacts identified for the Base Case are based on changes associated with the existing environment plus future trends through the year 2030 and the projects and commitments made by TVA, as described in Chapter 3, Reservoir Operations Policy Alternatives.

5.1.2 Weekly Scheduling Model

The Weekly Scheduling Model (WSM) was a central tool in the analysis and impact assessment. This model was used to convert reservoir operations policy changes into predicted future changes in reservoir levels and discharges from each of the projects in the TVA water control system.

TVA developed the WSM to model major water control projects in the Tennessee and Cumberland River basins. Rainfall, runoff, and river flow data from the Tennessee River basin over the past 99 years (1903 through 2001) were used to develop and calibrate the model. The WSM output graphically depicts how elevation and flow would change under various scenarios. See Appendix C, Model Descriptions and Results, for additional details about the WSM and a presentation of modeling results for each of the reservoir policy alternatives.

It is important to note that the WSM is based on a weekly analysis. That is, the model provides predictions of average weekly reservoir levels, discharges, and power generation. The WSM does not predict how the reservoir levels, flows, or patterns of power generation would occur on an hourly or daily basis. For environmental analyses that required estimates of the effects of different alternatives on hourly and daily flows, a separate database was developed. This is described further in Section 5.4, Water Quality.

The WSM provided outputs for each alternative, for different reservoirs, and for different time periods. Depending on the output, a single week, groups of weeks, or an entire year (or years) can be selected. The various outputs that can be generated from the WSM include:

- Elevation and flow plots—show the elevation or flow of a reservoir over a defined period of time.

- Generation and turbine capacity plots—show the generation or turbine capacity of a reservoir release over a defined period of time.
- Probability elevation and flow plots—show the distribution of elevation or flow data over the 99-year record of a reservoir over any defined set of weeks (e.g., Labor Day or the month of June).
- Elevation and flow duration curves—show the percent of time an elevation or flow will occur at a reservoir over any defined set of weeks (e.g., Labor Day or the month of June).

The WSM is important for the ROS EIS because reservoir elevations and reservoir releases and tailwater flows are the drivers for most impacts. This tool quantitatively compares the effects of alternatives on the water control system.

Results of the WSM are presented in Appendix C.

5.2 Air Resources

5.2.1 Introduction

Potential changes in reservoir operations policy may result in changes in the quantity, timing, and location of hydropower generation. Decreases in hydropower generation could result in increased requirements on the thermal generation of electrical power. Increased thermal generation would result in increased fossil-fuel combustion and therefore more emissions of air pollutants. The opposite is true if hydropower generation is increased.

This section analyzes the changes in air pollutant emissions created by each policy alternative being evaluated for the ROS. The air resources analysis addressed potential changes on attainment of the National Ambient Air Quality Standards (NAAQS), Hazardous Air Pollutant (HAP) emissions, and air-quality-related values (AQRVs).

The timing of hydropower changes is important because of the seasonal nature of air pollution problems. The period of concern for ozone is April 1 to October 31 in much of the TVA region. Emissions of volatile organic compounds and nitrogen oxides (NO_x) usually create the most ozone during summer, which is also the season of most concern for fine particles, regional haze, and acidic deposition. The atmosphere is more chemically active in summer. Thus, increasing emissions during summer could result in more adverse air quality consequences than during the rest of the year.

5.2.2 Assessment Methodology and Results

TVA has a variety of methods for generating electricity. Reductions or seasonal shifts in hydropower generation can be replaced by nuclear, coal, or natural gas generation—or even by purchased power from other utilities, especially at times of peak demands. This analysis of air quality impacts required assumptions about which power generation sources would replace reductions or shifts in hydropower generation and which generation sources would be operated less if hydropower generation increased.

The steps in the methodology were as follows:

- Determine the increase or decrease in the monthly and annual hydropower generation for the alternative being considered as compared to the Base Case.
- Determine the likely generation, by fuel type (nuclear, coal, or gas) that would be affected by a change in hydropower generation (either substituting for or being displaced by), and calculate any associated change in air emissions. TVA used a computer code entitled PROSYM (see Appendix C-3) to make these calculations for both monthly and annual periods.
- Provide detailed results for pertinent emissions.

- Compare increases/decreases in emissions with Base Case emissions and present a percentage change.
- Discuss timing of monthly emissions increases/decreases and the effect on air quality.

The analysis of increases/decreases for annual emissions of each pollutant, based on the methodology described above is presented in Table 5.2-01. This shows the annual changes in emissions for each alternative and the percentage of TVA emissions that the increase represents for the maximum increase alternative.

The annual results shown in Table 5.2-01 and Figure 5.2-01 do not, however, adequately describe impacts on regional air quality resources. Using NO_x emissions as an example, Table 5.2-02 and Figure 5.2-02 show the seasonal pattern of NO_x emissions increases and decreases. For Figure 5.2-02, season is defined climatologically as winter being December, January, and February, for example. The seasonal differences for the other emissions are similar. The larger variation in emissions changes by season for the policy alternatives is masked by the annual emissions changes. The evaluations of each alternative examined both annual and seasonal changes.

Table 5.2-01 Summary of Annual Emission Increases/Decreases by Policy Alternative (Based on PROSYM Model Outputs for 2005) (in tons per year)

Alternative	Increase/ Decrease in Non-Hydro Generation (MW hours)	Sulfur Dioxide	Nitrogen Oxide	Particulate Matter	Mercury
Reservoir Recreation A	-89,310	-1,408	-447	-39	-.0028
Reservoir Recreation B	248,370	689	-7	18	.0007
Summer Hydropower	157,850	2,354	690	63	.0053
Equalized Summer/ Winter Flood Risk	906,350	4,172	1,163	113	.0080
Commercial Navigation	-90,930	-26	-109	-1	-.0006
Tailwater Recreation[1]	248,370	689	-7	18	.0007
Tailwater Habitat	298,810	-14,211	-4,700	-386	-.0362
Preferred [2]	Similar to Reservoir Recreation Alternative A				
Maximum Percentage Increase	0.52%	0.89%	0.58%	0.89%	0.49%

[1] Identical to Reservoir Recreation Alternative B, no separate PROSYM run was made for the Tailwater Recreation Alternative.

[2] The Preferred Alternative was assumed to be similar to the results of Reservoir Recreation Alternative A; no separate PROSYM run was made for the Preferred Alternative.

Table 5.2-02 Increases/Decreases of Nitrogen Oxides Emissions by Policy Alternative (in tons)

Alternative	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year	Comparison to Base Case (%)
Base Case	25,670	22,744	20,940	22,357	7,784	7,746	8,620	8,862	6,918	22,105	22,759	25,194	201,698	100%
Reservoir Recreation A	66	-315	-100	-49	-64	172	112	284	-254	-362	-55	117	-447	-0.22
Reservoir Recreation B	28	-499	-256	-101	-245	120	138	390	228	170	148	-128	-7	-0.00
Summer Hydropower	6	-320	-232	69	-121	-380	-188	-74	305	503	567	555	690	0.34
Equalized Summer/Winter Flood Risk	101	-622	-246	-416	-228	238	125	265	791	424	389	338	1163	0.58
Commercial Navigation	2	-61	-35	-32	-108	18	-1	-18	23	8	72	25	-109	-0.05
Tailwater Recreation[1]	28	-499	-256	-101	-245	120	138	390	228	170	148	-128	-7	-0.00
Tailwater Habitat	-644	-1075	-802	-712	-472	-2	98	201	546	-438	-919	-482	-4700	-2.33
Preferred[2]	Similar to Reservoir Recreation Alternative A													

[1] The Tailwater Recreation Alternative was assumed to be similar to the results of Reservoir Recreation Alternative B; no separate PROSYM run was made for the Tailwater Recreation Alternative.

[2] The Preferred Alternative was assumed to be similar to the results of Reservoir Recreation Alternative A; no separate PROSYM run was made for the Preferred Alternative. The trends in hydropower generation would be similar to those under Reservoir Recreation Alternative A but with less hydropower generation shifted away from summer months. As a result, the summer increases would be similar to or less than the numbers provided for Reservoir Recreation Alternative A. Unlike Reservoir Recreation A, fall emissions would increase relative to the Base Case.

Source: TVA PROSYM model runs for 2005.

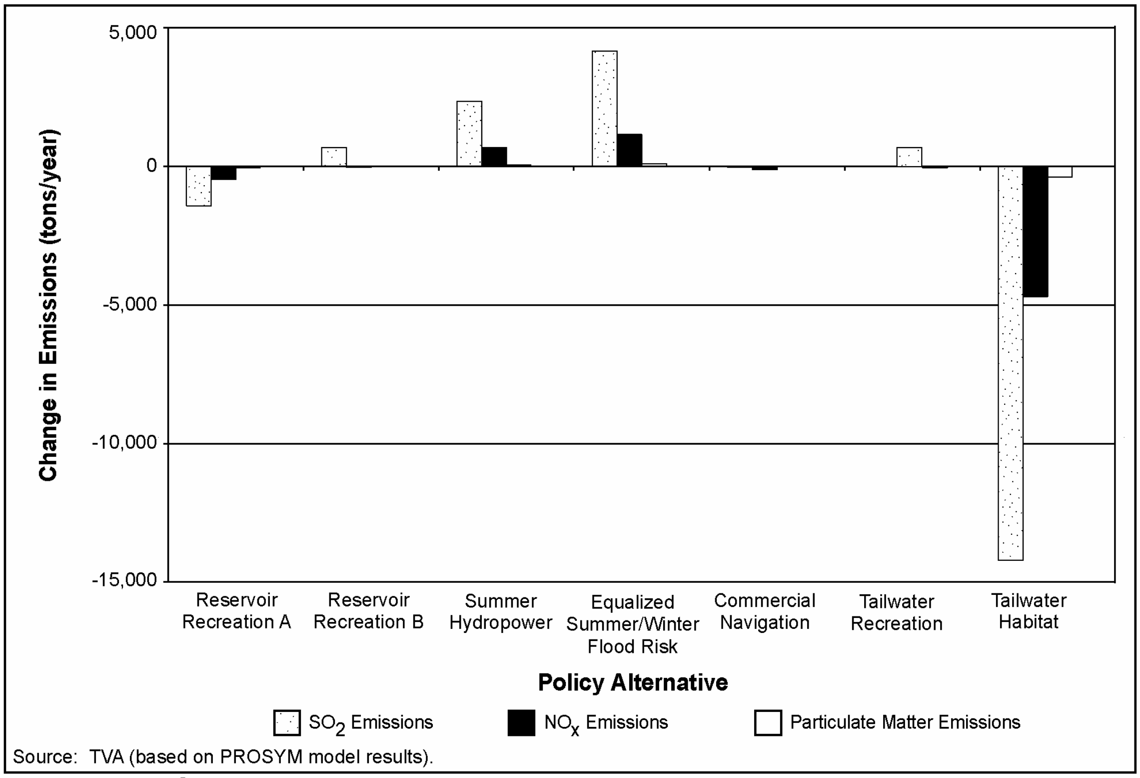

Figure 5.2-01 Comparison of Air Pollutant Emissions by Policy Alternative

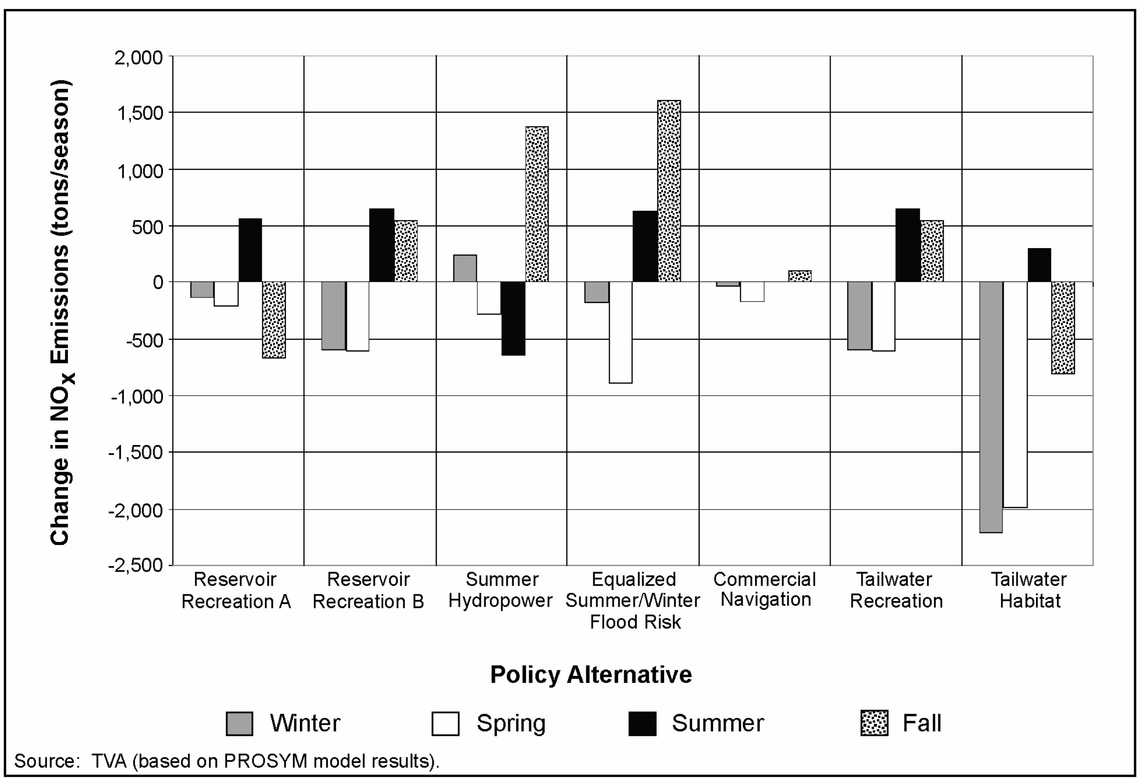

Figure 5.2-02 Comparison of NOx Emissions by Policy Alternative by Season

Increases in emissions were generally assumed to result in a negative impact, and decreases were assumed to result in a positive impact. The year 2005 PROSYM computer program outputs were used for comparison because 2005 is the first full year of assumed implementation of alternatives.

5.2.3 Base Case

Under the existing reservoir operations policy, increases or decreases in air emissions occur due to annual variation of rainfall. These variations would continue to occur under the Base Case.

5.2.4 Reservoir Recreation Alternative A

For Reservoir Recreation Alternative A, the total annual hydropower generation on average would be slightly higher than the hydropower generation expected under the Base Case (see Section 5.23, Power). The amount of hydropower generation, however, would be reduced in summer and increased in the other seasons. In response to this shift in hydropower generation, other peaking generation resources, such as coal, combustion turbines, Raccoon Mountain Pumped Storage, and purchased power, would be dispatched to replace it. In addition, hydropower generation shifted to off-peak in other seasons would likely displace some coal generation.

Due to slightly higher total annual hydropower generation, Reservoir Recreation Alternative A would result in a reduction in annual emissions, with slight reductions in all pollutant emissions because of the shift of hydropower from summer. Reservoir Recreation Alternative A would result in an increase in summer emissions of all pollutants and decreases in the other seasons. Since the summer season is when ozone non-attainment and potential $PM_{2.5}$ non-attainment episodes could occur, Reservoir Recreation Alternative A could result in a potentially negative impact on NAAQS attainment.

Reservoir Recreation Alternative A would result in a slight decrease in mercury emissions, 5.6 pounds per year, although there would be a seasonal increase in the summer. Reservoir Recreation Alternative A would result in a very slight decrease in HAP emissions.

Reservoir Recreation Alternative A would result in an increase in nitrogen oxide, sulfur dioxide, and particulate matter emissions during summer. The alternative could result in a slight increase in acidic deposition and decrease in visibility in the Class I areas.

5.2.5 Reservoir Recreation Alternative B

The effect on hydropower generation under Reservoir Recreation Alternative B would be similar to Reservoir Recreation Alternative A, although more adverse. The total annual hydropower generation would be somewhat lower than the hydropower generation expected under the Base Case. The timing of the generation would shift from summer peak to other seasons similar to, although to a greater extent than, Reservoir Recreation Alternative A. TVA's response to this shift in hydropower generation would also be similar to Reservoir Recreation Alternative A.

Due to losses in annual hydropower, Reservoir Recreation Alternative B would result in slight increases in all NAAQS emissions (except nitrogen oxides) on an annual basis, similar to Reservoir Recreation Alternative A. On a seasonal basis, these increases would be disproportionately higher in summer and fall, as shown in Figure 5.2-02. Reservoir Recreation Alternative B would add 1.6 percent to TVA's nitrogen oxide summer emissions and similar percentages to the other emissions. Thus, this alternative could result in a negative impact on attainment of NAAQS.

Reservoir Recreation Alternative B could create an increase in mercury emissions of about 0.04 percent per year, or about 1.4 pounds.

Reservoir Recreation Alternative B would result in increases in summertime emissions of sulfur dioxide and nitrogen oxides, with air quality effects similar to those discussed for Reservoir Recreation Alternative A.

5.2.6 Summer Hydropower Alternative

Under the Summer Hydropower Alternative, hydropower generation would increase during the summer and winter peak demand periods and decrease in fall, relative to the Base Case. The total annual hydropower generation on average would be somewhat lower.

Because the Summer Hydropower Alternative would supply increased hydropower during summer, it would substantially decrease summer emissions of NAAQS emissions. Reduced hydropower generation in late September would increase emissions in fall. The Summer Hydropower Alternative might positively affect NAAQS attainment.

The Summer Hydropower Alternative could result in an increase in emissions of mercury of 10.6 pounds per year, or about a 0.33-percent increase from emissions under the Base Case.

The Summer Hydropower Alternative could, in general, benefit AQRVs in Class I areas because of its reduced emissions in summer.

5.2.7 Equalized Summer/Winter Flood Risk Alternative

The Equalized Summer/Winter Flood Risk Alternative would result in the most adverse effect on total annual hydropower generation, producing almost 5 percent less on an average annual basis. In addition, hydropower generation would shift relative to the Base Case, decreasing in summer and fall and increasing during winter. As in Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and to a greater extent, the Tailwater Recreation Alternative, other higher cost peaking generation units would need to be run to replace the shifted hydropower generation in summer and fall; and hydropower generation would likely displace coal generation in other seasons.

Due to the impacts on hydropower generation, the Equalized Summer/Winter Flood Risk Alternative would result in the largest increase in both annual and seasonal emissions of NAAQS pollutants. Annual emissions increases would be twice as large as under any other alternative, with increases of nearly 1 percent for sulfur dioxide and particulate matter, and nearly 0.5 percent for nitrogen oxide and mercury. The seasonal increases occur in summer and fall.

The Equalized Summer/Winter Flood Risk Alternative could result in an increase in mercury emissions of about 16 pounds annually, or about 0.49 percent of the Base Case emissions.

The Equalized Summer/Winter Flood Risk Alternative could also produce the highest negative impact on AQRVs, not only because of the higher annual total emissions but also because of their imbalance toward summer and fall.

5.2.8 Commercial Navigation Alternative

The Commercial Navigation Alternative would result in an increase in hydropower generation and thus a slight reduction in coal-fired emissions. This reduction is slightly skewed toward winter and spring, with fall emissions increasing slightly.

The Commercial Navigation Alternative could result in a slight decrease in mercury emissions.

The Commercial Navigation Alternative would result in a potential reduction in annual emissions and only a slight increase in fall.

5.2.9 Tailwater Recreation Alternative

The Tailwater Recreation Alternative could result in a slight increase in annual emissions similar to those under Reservoir Recreation Alternative B. The PROSYM results shown in the tables are identical to those under Reservoir Recreation Alternative B because the effects of the hydropower operation would be very similar to that of Reservoir Recreation B. However, a disproportionate amount of this increase would occur in summer and fall.

The Tailwater Recreation Alternative could lead to an increase in mercury emissions of approximately 1.4 pounds annually.

The Tailwater Recreation Alternative could result in a moderate annual increase in pollutants. The seasonal nature of the potential increases, mostly in summer, could increase the degree of negative impacts.

5.2.10 Tailwater Habitat Alternative

The effect on hydropower generation under the Tailwater Habitat Alternative would be similar to Reservoir Recreation Alternative B, although more adverse. The total annual hydropower generation would be somewhat lower, and the timing would shift from summer peak to other seasons similar to, although to a greater extent than, Reservoir Recreation Alternative B.

The Tailwater Habitat Alternative would result in an annual decrease of NAAQS emissions. This decrease is the consequence of displacing more coal generation than any other alternative. The Tailwater Habitat Alternative would shift the greatest amount of hydropower generation away from May through September, the period when coal and gas plant emissions are most costly. TVA's response to this shift in hydropower generation would be to reduce coal generation during the May through September period to avoid costly emissions and replace it with combustion turbines, pumped storage, or purchased power. The hydropower that is shifted out of the summer period would likely also displace coal generation. This alternative would, however, result in increased summer emissions due to greater combustion turbine generation during that time.

The Tailwater Habitat Alternative would result in a substantial decrease (72.4 pounds per year) in mercury emissions.

The Tailwater Habitat Alternative could negatively affect AQRVs in the Class I areas because its increase in emissions would occur in summer.

5.2.11 Preferred Alternative

For the Preferred Alternative, the total annual hydropower generation is expected to be slightly less than the Base Case. Hydropower would be slightly reduced in summer and fall, and increased in other seasons. In response to this shift in hydropower generation, other peaking generation resources, such as coal, combustion turbines, Raccoon Mountain Pumped Storage, and purchased power, would be dispatched to replace it. In addition, hydropower generation shifted to off-peak in other seasons would likely displace some coal generation.

The Preferred Alternative would result in a slight increase in summer emissions of all pollutants and decreases during the other seasons. Because ozone non-attainment and potential $PM_{2.5}$ non-attainment episodes are greatest in summer, the Preferred Alternative could result in a potentially negative impact on NAAQS attainment.

The Preferred Alternative would result in a slight increase in nitrogen oxide, sulfur dioxide, and particulate matter emissions during summer. The alternative could result in a slight increase in acidic deposition and a decrease in visibility in the Class I areas, compared to the Base Case.

The Preferred Alternative could result in a slight change in mercury and HAP emissions, as compared to the Base Case.

5.2.12 Summary of Impacts

The air quality resources of the TVA region could be negatively affected by decreases in hydropower generation due to changes in operations (Table 5.2-03). The Equalized Summer/Winter Flood Risk Alternative could result in the largest negative impact. Reservoir Recreation Alternative B, the Summer Hydropower Alternative, and the Tailwater Recreation Alternative would result in small annual impacts when compared to the Equalized Summer/Winter Flood Risk Alternative. The summer seasonal impacts of the Preferred Alternative, Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative would be negative. However, Reservoir Recreation Alternative A, the Commercial Navigation Alternative, and the Tailwater Habitat Alternative would tend to result in positive impacts on an annual basis. The Commercial Navigation Alternative would be relatively neutral concerning overall impacts on air quality resources. The Preferred Alternative would result in no change to slightly adverse air quality impacts on an annual basis.

Table 5.2-03 Summary of Impacts on Air Resources by Policy Alternative

Alternative	Description of Impacts
Base Case	Under the existing reservoir operations policy, increases or decreases in air pollutant emissions would not occur.
Reservoir Recreation A	Seasonal Adverse in summer, otherwise beneficial Annual Slightly beneficial
Reservoir Recreation B	Seasonal Adverse in summer and fall, otherwise beneficial Annual Slightly adverse
Summer Hydropower	Seasonal Adverse in fall and winter, otherwise beneficial Annual Slightly adverse
Equalized Summer/ Winter Flood Risk	Seasonal Adverse in summer and fall, otherwise beneficial Annual Slightly adverse
Commercial Navigation	Seasonal Minimal change, but slightly adverse in fall and beneficial in spring Annual No change
Tailwater Recreation	Seasonal Adverse in summer and fall, otherwise beneficial Annual Slightly adverse
Tailwater Habitat	Seasonal Adverse in summer, otherwise beneficial Annual Beneficial
Preferred	Seasonal Slightly adverse in summer, otherwise beneficial Annual No change to slightly adverse

5.3 Climate

Because no direct link between greenhouse gas emissions and changes in regional climate has been demonstrated, impacts on regional climate cannot be estimated. Instead, changes in greenhouse gas emissions were used as a surrogate for potential impacts on the global climate. For the purposes of this analysis, TVA assumed that increases in greenhouse gas emissions would negatively affect climate. This could be untrue, however, especially for the Tennessee Valley region, which has been experiencing a cooling (not warming) trend.

5.3.1 Impact Assessment Methods

Because balancing among generation sources is both an economic decision (the marginal cost of power) and a physical decision (the availability of generation units to run), calculating the generation mix and related emissions is complex. TVA developed a computer model (PROSYM) that calculates the effect on fossil-fuel generation for each of the policy alternatives (see Appendix C-3). When hydropower is not available compared to existing operations (the Base Case), PROSYM identifies the most likely sources of replacement power. That portion of the replacement power provided by fossil-fired generation is then used to determine increases or decreases in CO_2 emissions.

The steps in the analysis methodology used to estimate changes in greenhouse gas emissions for the alternatives included:

- Determine the increase or decrease in the annual hydropower generation for the alternative being considered as compared to the Base Case. (Assumed to be 2005 consistent with the first full year for application of the policy alternatives).

- Determine the likely generation fuel (nuclear, coal, or gas) or mix of fuels to be used to satisfy the lost power or fuel to be reduced because of the gained hydropower. TVA has used a computer model, PROSYM, to make this analysis.

- Using PROSYM results, determine the number of MW hours of the increased or decreased non-hydropower requirement and the associated CO_2 emissions.

- Compare the increase or decrease in CO_2 emissions to the annual 2005 CO_2 emissions under the Base Case in order to arrive at a percentage change in TVA emissions. Extend the comparison to U.S. and global CO_2 emissions.

- Compare the increase or decrease in CO_2 emissions to expected reductions in CO_2 emissions over the study period, to 2030.

Figure 5.3-01 shows the changes in CO_2 annual emissions for each alternative. For this figure, the PROSYM model calculated impacts.

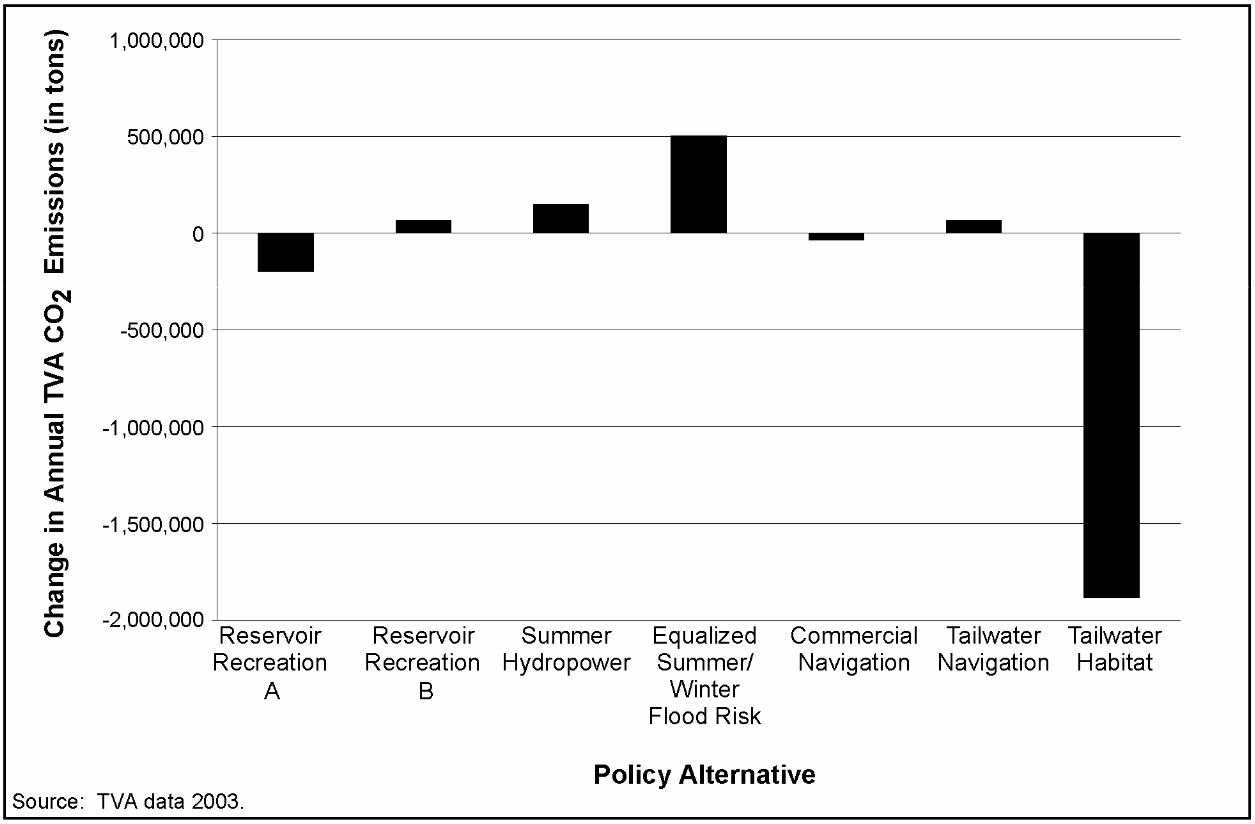

Figure 5.3-01 Comparison of Changes in Annual Total TVA CO_2 Emissions by Alternative

Table 5.3-01 contains numerical values for the increases and decreases in CO_2 emissions for each alternative. The table includes the change in MW hours; the change of CO_2 emissions (calculated by PROSYM); and the percentages of those changes compared to CO_2 emissions under the Base Case for TVA, 2000 emissions for the United States, and 1996 emissions for the 21 reporting countries.

5.3.2 Base Case

If TVA reservoir system operations are not changed, no consequent increases or decreases in CO_2 emissions would result. Increases and decreases in emissions would occur naturally due to annual variations of rainfall.

5.3.3 Reservoir Recreation Alternative A

Reservoir Recreation Alternative A would result in a minor increase in total annual hydropower production; thus, PROSYM calculates a minor decrease in CO_2 emissions (a decrease of 196,593 tons per year, or a reduction of approximately 0.18 percent). Of all the policy alternatives, Reservoir Recreation Alternative A would result in the second largest decrease in CO_2 emissions.

5.3.4 Reservoir Recreation Alternative B

Reservoir Recreation Alternative B would result in a decrease in hydropower production and therefore an increase in non-hydropower generation. Replacement of the lost hydropower generation was calculated by PROSYM to result in an average increase of 66,060 tons per year in CO_2 emissions. This amount represents an increase of approximately 0.06 percent of total annual TVA CO_2 emissions.

5.3.5 Summer Hydropower Alternative

While the Summer Hydropower Alternative would result in more hydropower generation in summer, hydropower generation for the entire year would decrease. The potential annual increase in CO_2 emissions calculated by PROSYM under the Summer Hydropower Alternative is 150,766 tons, representing approximately 0.14 percent of TVA CO_2 emissions.

5.3.6 Equalized Summer/Winter Flood Risk

The Equalized Summer/Winter Flood Risk Alternative would result in the largest decrease in hydropower production and increased CO_2 emissions of all the alternatives. Replacement of lost hydropower as calculated by PROSYM would result in an increase of 502,725 tons of CO_2 emissions. This amount represents an increase of approximately 0.47 percent.

5.3.7 Commercial Navigation Alternative

Because the Commercial Navigation Alternative would result in slightly increased hydropower production, there would be less need for fossil generation and thus corresponding potential decreases in emissions of CO_2. As calculated by PROSYM, the reduction would be 33,130 tons per year of CO_2 (or approximately 0.03 percent), representing a small positive benefit of the Commercial Navigation Alternative.

5.3.8 Tailwater Recreation Alternative

The Tailwater Recreation Alternative would result in a loss of hydropower production similar to that under Reservoir Recreation Alternative B and an increase in demand for fossil generation. PROSYM was not run specifically for this alternative because of its power production similarity to Reservoir Recreation Alternative B. As with Reservoir Recreation Alternative B, the annual increase in CO_2 emissions would be 66,060 tons (or 0.06 percent).

5.3.9 Tailwater Habitat Alternative

The PROSYM results for the Tailwater Habitat Alternative is a decrease of 1,884,347 tons per year of CO_2 emissions, representing an approximately 1.77-percent decrease. This alternative would result in the largest positive impact on climate resources.

5.3.10 Preferred Alternative

The Preferred Alternative would result in a minor decrease in total annual hydropower production. Thus, as for Reservoir Recreation Alternative A, a minor increase in CO_2 emissions is expected.

5.3.11 Summary of Impacts

Table 5.3-01 provides a summary of impacts on climate by policy alternative. Alternatives that would decrease hydropower generation could result in slightly adverse impacts on climate, but on a global scale the change at TVA in greenhouse gas emissions would have no noticeable effect. The severity of impacts associated with each alternative would depend on the amount of fossil-fuel generation used to replace lost hydropower. Implementation of the Equalized Summer/Winter Flood Risk Alternative could result in the largest potential adverse impact on climate. Reservoir Recreation Alternative B, the Summer Hydropower Alternative, and the Tailwater Recreation Alternative would result in lesser impacts on climate when compared to the Equalized Summer/Winter Flood Risk Alternative. The Preferred Alternative, Reservoir Recreation Alternative A, and the Commercial Navigation Alternative most likely would result in slightly beneficial impacts on climate, and the Tailwater Habitat Alternative would result in a beneficial impact on climate.

Table 5.3-01 Summary of Impacts on Climate by Policy Alternative

	Alternative								
	Base Case	**Reservoir Recreation A**	**Reservoir Recreation B**	**Summer Hydropower**	**Equalized Summer/Winter Flood Risk**	**Commercial Navigation**	**Tailwater Recreation[1]**	**Tailwater Habitat**	**Preferred[2]**
Increase/decrease in non-hydropower generation (MW hours)	No change	-89,310	+248,370	+157,850	+906,350	-90,930	+248,370	+298,810	The Preferred Alternative is similar to Reservoir Recreation Alternative A
Change in CO_2 emissions (tons)	No change	-196,593	+66,060	+150,766	+502,725	-33,130	+66,060	-1,884,347	
Percent of total annual TVA CO_2 emissions	100	-0.18	+0.06	+0.14	+0.47	–0.03	+0.06	-1.77	
Percent of total annual U.S. CO_2 emissions	1.64	-0.003	+0.001	+0.002	+0.008	-0.001	+0.001	-0.029	
Percent of total annual CO_2 emissions for 21 reporting countries	0.934	-0.002	+0.001	+0.001	+0.004	–0.0003	+0.001	-0.017	

[1] The Tailwater Recreation Alternative was assumed to be similar to the results of Reservoir Recreation Alternative B; no separate PROSYM run was made for the Tailwater Recreation Alternative.

[2] The Preferred Alternative was assumed to be similar to the results of Reservoir Recreation Alternative A; no separate PROSYM run was made for the Preferred Alternative.

Source: TVA PROSYM model runs for 2005.

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5.4 Water Quality

5.4.1 Introduction

This section represents a summary analysis of the impacts of the policy alternatives on water quality. The primary evaluation tool was a numerical water quality model. A number of reservoir and riverine water quality metrics derived from the model formed the basis of this analysis. Effects of changes in water quality on aquatic resources, threatened and endangered species, water supply, and power (among other resources that are associated with water quality) are discussed in other sections of the EIS.

The representation of existing conditions used to quantify the impacts of the policy alternatives on water quality is called the Base Case. The Base Case is an integration of current conditions and currently scheduled changes to the system. In effect, the Base Case moves the current condition to a point in the future when all reasonably foreseeable, currently scheduled changes in the system have been implemented.

The alternatives under consideration generally vary in the timing and amount of water flow through the system. Changes in this timing may alter the retention times of the reservoirs, the degree and extent of thermal stratification, the temperatures of reservoirs and tailwaters, and DO concentrations in reservoirs and tailwaters. These characteristics and the metrics that describe them represent the majority of anticipated water quality changes associated with the alternatives considered and are the main focus of the water quality analysis. Many of the tailwaters have target DO concentrations set by the Lake Improvement Plan. These targets were incorporated into all of the alternatives because the Lake Improvement Plan targets will be maintained regardless of the policy alternative selected. Release targets and a list of projects included in the Lake Improvement Plan are presented in Appendix A, Table A-05.

Other water quality parameters that could be affected by reservoir operations (as described in Section 4.4) are closely related to residence time, temperature, and DO. Parameters in this category include manganese, sulfides, and ammonia, which are formed or move from reservoir sediments when DO concentrations are low. Analysis of very low DO concentrations (termed anoxia in this analysis) in the reservoirs captures these parameters. Phosphorus is released from sediments when DO concentrations are low—although the majority of the phosphorus in the system comes from sources in the watershed that would be unaffected by any of the policy alternatives under consideration. The relative contribution of sediment-released phosphorus to the total amount present throughout the TVA reservoir system would increase under any alternative that results in lower reservoir DO concentrations.

System-wide turbidity and sediment deposition attributable to reservoir operations are not expected to change substantially under any alternative. Localized erosion related to reservoir operations is discussed in Section 5.16, Shoreline Erosion. Likewise, the fate and transport of contaminants in the sediments throughout the TVA reservoir system are not anticipated to be influenced substantially by a change in reservoir operations, except for those compounds and contaminants mentioned above that are mobilized when DO concentrations are low. The occurrence of bacteria and pathogens in the system would not be substantially affected by any policy alternative.

5.4.2 Impact Assessment Methods and Data Summarization

TVA water quality monitoring has been conducted under various weather and reservoir flow conditions that have resulted in a wide range of water quality conditions. Understanding of the historical variability in water quality throughout the TVA reservoir system has fostered the development of models of water flow and quality. When combined with water quality data, these models are useful as tools to identify differences in water quality between the Base Case and alternative reservoir operations policies. Experience gained from TVA's monitoring program has substantiated the intuitive relationship between reservoir flows and water quality. Although quantifying the extent of these changes under various operating regimes is a job best suited for models, the real-world experience based on TVA's Reservoir Vital Signs Monitoring Program is essential for appropriate interpretation of modeling results. The following evaluation of various policy alternatives is based on this two-pronged approach. The water quality models are used to evaluate flows, temperature, and DO concentrations as they relate to the policy alternatives. The relationship of algae (measured by chlorophyll-a) to water retention time in the reservoirs was evaluated using data from TVA's Vital Signs Monitoring Program.

Water Quality Modeling

TVA developed water quality models of 32 reservoirs and 12 tailwaters using computer programs TVARMS (Hauser et al. 1995), BETTER (Bender et al. 1990), and CE-QUAL-W2 (Cole and Buchak 1995) (Appendix C). The models simulate hydrodynamic and water quality conditions, such as water movement, temperature, thermal stratification, and DO concentrations.

The modeling approach used in this evaluation was to link models of individual reservoirs and tailwaters to simulate nearly the entire TVA river system—using the water quality model SysTempO. The models simulate the physical, chemical, and biological processes in sections of the system. TVARMS is used for the riverine sections, and CE-QUAL-W2 and BETTER are used for the reservoirs. SysTempO links the river and reservoir models. The methodology uses water quality data outputs from upstream waterbodies as input for the next tailwater or reservoir downstream. Existing water quality improvements were not included in models of reservoirs where in some cases aeration equipment injects compressed air or liquid oxygen immediately upstream of the dam. When SysTempO sets upstream inflow water quality for the next downstream dam, the Lake Improvement Plan DO targets are used. Release targets and a list of projects included in the Lake Improvement Plan are presented in Appendix A, Table A-05.

The individual elements in SysTempO were pre-calibrated for at least 1 year of data before being linked. After linking models together in SysTempO, 8 years (1987 to 1994) of modeled temperature and DO were compared to measured data. Calibrations were adjusted to closely approximate observed conditions. Generally, modeled temperatures were within 1 °F of those measured, and modeled DO was within 1 mg/L for most locations. The model was then used to simulate conditions under the Base Case and policy alternatives in order to examine the effects of changes in the existing reservoir operations policy.

The result was a set of tools that enabled the simultaneous evaluation of the policy alternatives on reservoir and tailwater water quality throughout the TVA reservoir system. To help focus evaluation on important water quality impacts associated with operational modifications linked to different alternatives, model results over a broad range of hydrometeorologic conditions represented in the 1987–1994 period were used to generate estimates of the water quality metrics described in Table 5.4-01 for all policy alternatives under consideration. A broad variety of hydrologic and weather conditions were experienced during this period. For example, certain years within this time period could be considered representative of normal conditions (1990), hot and dry conditions (1993), and cool and wet conditions (1994).

Table 5.4-01 Water Quality Metrics Used to Evaluate Policy Alternatives

Parameter	Metric	Target Use Potentially Affected
Reservoirs		
Hydrodynamics	Summer residence time from 6/1 to 9/30 (days)	General water quality
	Days that forebay surface-bottom temperature is ≥4 °C (# days)	General water quality
	Maximum forebay surface-bottom temperature difference (°C)	General water quality
	Sum of daily total reservoir volume (million m^3-days)	General water quality
Dissolved oxygen	Sum of daily volume DO ≤5 mg/L (million m^3-days)	General water quality
	Minimum reservoir volume DO ≥5 mg/L (million m^3-days) on worst-case day	Assimilative capacity
	Sum of daily volume DO ≤2 mg/L (million m^3-days) from 7/1 to 10/31	Tolerant aquatic life support
	Sum of daily volume DO ≤1 mg/L (million m^3-days)	Potential anoxia
Temperature	Sum of daily volume temperature >26 °C (million m^3-days)	Assimilative capacity
	Sum of daily volume temperature ≤10 °C (million m^3-days)	Cold water in storage
Algal activity	Chlorophyll-a concentration (micrograms/L)	Trophic status
Dam Releases		
Dissolved oxygen	Average annual minimum DO (mg/L)	General water quality
	Average number days/year DO <5 mg/L	General water quality
Temperature	Average annual maximum temperature (°C)	General water quality
	Average number of days/year temperature >10 °C	General water quality

Notes:

All results were derived from the water quality model, except for algal activity, which were assessed using Vital Signs Monitoring Program data.

DO = Dissolved oxygen.

This approach was used successfully and consistently for most alternatives. The Summer Hydropower Alternative resulted in flow and elevation conditions that prevented completion of successful model runs during certain dry years; therefore, water quality model results for the Summer Hydropower Alternative were based on 1990 to 1994 rather than the full 8-year period referenced above for the other alternatives. This situation did not allow full evaluation of effects on water quality of operations under the Summer Hydropower Alternative under all flow conditions. Consequently, evaluations of effects under this alternative must be viewed cautiously with this limitation in mind. Also, it is inappropriate to directly compare water quality effects of the Summer Hydropower Alternative to effects resulting from operations under the remaining policy alternatives because of the more limited set of weather and flow conditions used for the Summer Hydropower Alternative.

Use of Vital Signs Monitoring Results

The relationship of algae (measured by chlorophyll-a) to water retention time in the reservoirs was evaluated using Vital Signs Monitoring Program data and linear regression because the water quality model was not calibrated specifically for algal growth. A comparison of long-term average chlorophyll-*a* concentrations to 2002 data (a low-flow year similar to many of the alternatives) supplemented the evaluation, allowing an assessment of the impact of lower flow rates associated with many of the policy alternatives on algal growth.

Selection of Representative Reservoirs/Dam Releases

The integrated SysTempO model was run for 32 reservoirs and 12 tailwaters. Detailed water quality analyses and evaluations were compiled from a subset of reservoirs and dam releases that represent a variety of reservoir types and geographic regions. Specific water quality issues within certain reservoirs may not be reflected in this set of reservoirs; however, the overriding water quality issues appropriate for a programmatic evaluation are represented.

Representative reservoirs for three reservoir categories defined specifically for water quality analyses include:

- **Storage Tributary Reservoirs.** These reservoirs generally have long retention times and substantial winter drawdown for flood control. A total of 13 storage tributary reservoirs could be affected by policy alternatives. South Holston and Douglas Reservoirs initially were selected to represent tributary storage reservoirs. Hiwassee Reservoir was added to this group as a representative reservoir in response to comments received during review of the DEIS that suggested inclusion of a reservoir representative of the high-elevation reservoirs in the nutrient-poor Blue Ridge physiographic region.

- **Transitional Tributary Reservoirs.** This group of reservoirs did not fit with the other tributary reservoirs because the reservoirs have a relatively short retention, have nominal winter drawdown, or are much smaller. Five transitional reservoirs could be affected by policy alternatives. Boone and Melton Hill Reservoirs were selected to represent transitional tributary reservoirs.

- **Mainstem Reservoirs.** These reservoirs are typified by short retention times and nominal winter drawdown. Kentucky is the most downstream reservoir and represents the water quality that leaves the TVA reservoir system. Nine mainstem reservoirs would be potentially affected by policy alternatives. Three reservoirs were initially selected to represent mainstem reservoirs: Guntersville, Pickwick, and Kentucky. Watts Bar Reservoir was added as a representative mainstem reservoir following completion of the DEIS because one of the operational changes considered under the Preferred Alternative is delayed spring fill of three mainstem reservoirs (Fort Loudoun, Watts Bar, and Chickamauga), none of which had been included the initial set of representative reservoirs.

Summarization of Results

Appendix D1 provides detailed results from the water quality model for the Base Case and each policy alternative. In Appendix D1, Table D1-02 presents a compilation of metric results from the water quality model for reservoirs under the Base Case and all policy alternatives except the Summer Hydropower Alternative; Table D1-03 presents this information for the Summer Hydropower Alternative. Tables D1-04 and D1-05 present comparable information for dam releases.

Tables 5.4-02 and 5.4-03 summarize the detailed results from Tables D1-02–05 by using categories to describe the magnitude of relative change in water quality metrics between the Base Case and each policy alternative. Four categories were selected to quantify changes from the Base Case. These include; 0 to10 percent; 11 to 25 percent; 26 to 50 percent; and >50 percent.

In the following text, Section 5.4.3 summarizes Base Case conditions. Sections 5.4.4 through 5.4.11 use the quantitative changes in Tables 5.4-02 and 5.4-03 as the basis for discussion of relative changes for each policy alternative. Section 5.4.12 examines effects of policy alternatives on water quality under low-flow conditions. Flow conditions for 1993 were used in this analysis. The analysis in Section 5.4.12 is parallel to that in Sections 5.4.4 through 5.4.11 in that it provides a quantitative comparison of changes as they relate to the Base Case. A more thorough evaluation of impacts on assimilative capacity and the potential for formation of anoxic products is provided in Sections 5.4.15 and 5.4.16.

Table 5.4-03 reflects the effect and importance of TVA’s commitment to maintain tailwater DO concentrations at or above targets set by the Lake Improvement Plan. Although Table 5.4-02 shows that larger volumes of low DO water would occur in some reservoirs (e.g., Hiwassee) under some policy alternatives, this would not be reflected in downstream tailwater releases. TVA would improve the lower DO levels by a corresponding increase in aeration methods. This explains why, in Table 5.4-03, reservoirs with downstream aeration facilities are listed as “LIP target.”

Categories of change in Tables 5.4-02 and 5.4-03 were subjectively defined as follows:

- Not different from the Base Case = +/-10% of base (shown in these tables as "**o**").
- Increase compared to the Base Case = 11 to 25% change from conditions under the Base Case (shown in these tables as"↑").
- Decrease compared to the Base Case = 11 to 25% change from conditions under the Base Case (shown in these tables as"↓").
- An "*" is used in Tables 5.4-02 and 5.4-03 if changes from the Base Case were from 26 to 50%, and a double "**" is used if changes were >50% change from the Base Case.
- Note - The symbol "∞" is used in these tables to identify occurrences when both Base Case data and alternative data are infinitely small, causing nominal changes from the Base Case to appear quite large proportionally. Caution is needed in interpreting results in this situation, and the reader is urged to refer to tables in Appendix D1, where actual results for each water quality metric under the Base Case and each action alternative are provided.)

This approach facilitates a relative evaluation of each alternative compared to conditions under the Base Case. The up or down direction of arrows should not be construed to indicate improvement or degradation of water quality. The arrows only indicate change from conditions under the Base Case.

It should be noted that 13 tributaries, five transitional, and nine mainstem reservoirs were considered in this analysis. Mainstem and tributary reservoirs are more numerous in the system than transition reservoirs and collectively impound a much greater volume of water. Consequently, impacts on mainstem and tributary reservoirs should carry more weight than impacts on transitional reservoirs.

Table 5.4-02 Summation of Responses for Water Quality Characteristics in Representative Reservoirs by Policy Alternative

Alternative	Reservoir	Change in Reservoir Volume with Dissolved Oxygen Concentrations Compared to Base Case				Change in Reservoir Volume with Water Temperature Compared to Base Case	
		≤5 mg/L	≤2 mg/L	≤1 mg/L	≥5 mg/L	>26 ºC	≤10 ºC
Reservoir Recreation A	South Holston	o	o	o	↑	↑	o
	Douglas	o	↑	↑	↑*	o	↑
	Hiwassee	o	↑	↑**	o	o	↑
	Boone	↑*	↑∞	↑∞	↓	↑	o
	Melton Hill	↑**	↑∞	↑∞	o	↑*	o
	Watts Bar	o	↑*	↑**	o	o	o
	Guntersville	↑	↑**	↑*	o	o	o
	Pickwick	↑	↑*	↑*	o	o	o
	Kentucky	↑	↑	o	o	o	o
Reservoir Recreation B	South Holston	↑	o	o	↑	↑	↑
	Douglas	↑	↑*	↑	↑*	↑	↑*
	Hiwassee	↑	↑*	↑*	o	o	↑
	Boone	↑	↑**	↑∞	o	↑	o
	Melton Hill	↑**	↑∞	↑∞	o	↑**	↑
	Watts Bar	o	↑*	↑**	o	↑	o
	Guntersville	↑*	↑**	↑**	o	o	o
	Pickwick	↑	↑**	↑**	o	o	o
	Kentucky	↑*	↑**	↑**	o	o	↑
Summer Hydropower	South Holston	o	o	↑	↓	o	o
	Douglas	↓	↓*	↓	↑*	o	↑*
	Hiwassee	↓*	↓	↓	↓	↓*	o
	Boone	↓*	↑∞	↑∞	↓*	↓*	o
	Melton Hill	o	↑∞	↑∞	o	↓	↑
	Watts Bar	o	↓	↓*	↓*	o	o
	Guntersville	↓*	↓**	↓**	o	o	o
	Pickwick	↓*	↓**	↓**	o	o	o
	Kentucky	↓*	↓**	↓**	o	o	o

Table 5.4-02 Summation of Responses for Water Quality Characteristics in Representative Reservoirs by Policy Alternative (continued)

Alternative	Reservoir	Change in Reservoir Volume with Dissolved Oxygen Concentrations Compared to Base Case				Change in Reservoir Volume with Water Temperature Compared to Base Case	
		≤5 mg/L	≤2 mg/L	≤1 mg/L	≥5 mg/L	>26 ºC	≤10 ºC
Equalized Summer/ Winter Flood Risk	South Holston	o	o	o	o	o	o
	Douglas	↓*	↓*	↓*	o	o	o
	Hiwassee	o	o	↑	↓	o	o
	Boone	↑	↑∞	↑∞	↓	↓*	↑
	Melton Hill	↑**	↑∞	↑∞	↓	↑**	↑
	Watts Bar	o	↑*	↑**	o	↑*	o
	Guntersville	↑	↑*	↑	o	o	o
	Pickwick	↑	↑*	↑*	o	o	o
	Kentucky	↑	↑**	↑**	o	o	o
Commercial Navigation	South Holston	o	o	o	o	o	o
	Douglas	o	o	o	o	o	o
	Hiwassee	o	o	o	o	o	o
	Boone	o	↑∞	↑∞	o	o	o
	Melton Hill	o	o	o	o	o	o
	Watts Bar	o	o	o	o	o	o
	Guntersville	o	o	↓	o	o	o
	Pickwick	o	o	o	o	o	o
	Kentucky	o	↓*	↓*	o	o	↑
Tailwater Recreation	South Holston	↑	o	o	↑	↑	↑
	Douglas	↑	↑	↑	↑*	↑	↑*
	Hiwassee	↑	↑**	↑**	↓	o	o
	Boone	↑	↑∞	↑∞	o	↑	o
	Melton Hill	↑**	o	↓∞	o	↑*	↑
	Watts Bar	o	↑*	↑**	o	↑	o
	Guntersville	↑*	↑**	↑*	o	o	o
	Pickwick	↑	↑**	↑**	o	o	o
	Kentucky	↑	↑**	↑**	o	o	↑

Table 5.4-02 Summation of Responses for Water Quality Characteristics in Representative Reservoirs by Policy Alternative (continued)

Alternative	Reservoir	Change in Reservoir Volume with Dissolved Oxygen Concentrations Compared to Base Case				Change in Reservoir Volume with Water Temperature Compared to Base Case	
		≤5 mg/L	≤2 mg/L	≤1 mg/L	≥5 mg/L	>26 ºC	≤10 ºC
Tailwater Habitat	South Holston	↑	o	o	↑	↑	o
	Douglas	↑*	↑*	↑*	↑**	↑	↑*
	Hiwassee	↑*	↑**	↑**	↓	↓	↑
	Boone	↑	↑∞	↑∞	o	↑	o
	Melton Hill	↑**	↑∞	↑∞	↓	↑**	o
	Watts Bar	o	↑	↑*	o	↑*	o
	Guntersville	↑*	↑**	↑*	o	o	o
	Pickwick	↑	↑**	↑*	o	o	o
	Kentucky	↑**	↑**	↑**	o	o	o
Preferred	South Holston	o	o	o	o	o	o
	Douglas	o	o	o	↑*	o	↑
	Hiwassee	o	o	o	o	o	↑*
	Boone	↑	↑∞	↑∞	o	↑	o
	Melton Hill	↑**	↓∞	↓∞	o	o	o
	Watts Bar	↑	↑**	↑**	↓	o	o
	Guntersville	o	↓	o	o	o	o
	Pickwick	o	↑*	↑	o	o	o
	Kentucky	↑	↑	o	o	o	o

Notes:

Responses are relative to conditions under the Base Case.

Model results for each water quality metric under the Base Case and each policy alternative are provided in Table D1-02 for all alternatives other than the Summer Hydropower and are based on hydrometeorologic conditions that existed from 1987 to 1994. Table D1-03 provides water quality characteristics for the Base Case and the Summer Hydropower Alternative based on hydrometeorologic conditions that existed from 1990 to 1994.

o = No appreciable change from conditions under the Base Case (+/- 10%).
↑ or ↓ = Used to identify changes (+/-) from conditions under the Base Case from 11 to 25%.
* = Used to identified changes (+/-) from conditions under the Base Case from 26 to 50%.
* * = Used to identify changes (+/-) from conditions under the Base Case >50%.
∞ = Used to identify occurrences when both Base Case data and policy alternative data are infinitely small, causing nominal changes from base to appear quite large proportionally.

Table 5.4-03 Summation of Responses for Water Quality Characteristics in Representative Dam Releases by Policy Alternative

Alternative	Reservoir	Dissolved Oxygen		Temperature	
		Annual Average Minimum DO	Average Number Days/Year DO <5 mg/L	Average Days/Year Temperature >10 °C	Annual Average Maximum Temperature
Reservoir Recreation A	South Holston	LIP target	LIP target	↑	o
	Douglas	LIP target	LIP target	o	o
	Hiwassee	LIP target	LIP target	o	o
	Boone	LIP target	LIP target	o	o
	Melton Hill	↓	↑**	o	o
	Watts Bar	LIP target	LIP target	o	o
	Guntersville	o	↑	o	o
	Pickwick	o	↑*	o	o
	Kentucky	↓	↑	o	o
Reservoir Recreation B	South Holston	LIP target	LIP target	↑*	o
	Douglas	LIP target	LIP target	o	o
	Hiwassee	LIP target	LIP target	o	o
	Boone	LIP target	LIP target	o	o
	Melton Hill	↓	↑**	o	o
	Watts Bar	LIP target	LIP target	o	o
	Guntersville	o	↑*	o	o
	Pickwick	o	↑*	o	o
	Kentucky	↓	↑	o	o
Summer Hydropower	South Holston	LIP target	LIP target	o	o
	Douglas	LIP target	LIP target	o	o
	Hiwassee	LIP target	LIP target	o	o
	Boone	LIP target	LIP target	o	↑
	Melton Hill	o	o	o	o
	Watts Bar	LIP target	LIP target	o	o
	Guntersville	↑	↓**	o	o
	Pickwick	↑	↓**	o	o
	Kentucky	↑	↓**	o	o
Equalized Summer/ Winter Flood Risk	South Holston	LIP target	LIP target	↑	o
	Douglas	LIP target	LIP target	o	o
	Hiwassee	LIP target	LIP target	o	o
	Boone	LIP target	LIP target	o	o
	Melton Hill	↓	↑**	o	o
	Watts Bar	LIP target	LIP target	o	o
	Guntersville	o	↑	o	o
	Pickwick	o	↑*	o	o
	Kentucky	↓	↑*	o	o

Table 5.4-03 Summation of Responses for Water Quality Characteristics in Representative Dam Releases by Policy Alternative (continued)

Alternative	Reservoir	Dissolved Oxygen		Temperature	
		Annual Average Minimum DO	Average Number Days/Year DO <5 mg/L	Average Days/Year Temperature >10 °C	Annual Average Maximum Temperature
Commercial Navigation	South Holston	LIP target	LIP target	o	o
	Douglas	LIP target	LIP target	o	o
	Hiwassee	LIP target	LIP target	o	o
	Boone	LIP target	LIP target	o	o
	Melton Hill	o	o	o	o
	Watts Bar	LIP target	LIP target	o	o
	Guntersville	o	o	o	o
	Pickwick	o	o	o	o
	Kentucky	↑	↓	o	o
Tailwater Recreation	South Holston	LIP target	LIP target	↑*	↓
	Douglas	LIP target	LIP target	o	o
	Hiwassee	LIP target	LIP target	o	o
	Boone	LIP target	LIP target	o	o
	Melton Hill	↓	↑**	o	o
	Watts Bar	LIP target	LIP target	o	o
	Guntersville	o	↑*	o	o
	Pickwick	o	↑*	o	o
	Kentucky	↓	↑	o	o
Tailwater Habitat	South Holston	LIP target	LIP target	↑*	o
	Douglas	LIP target	LIP target	o	o
	Hiwassee	LIP target	LIP target	o	o
	Boone	LIP target	LIP target	o	o
	Melton Hill	↓*	↑**	o	o
	Watts Bar	LIP target	LIP target	o	o
	Guntersville	o	↑**	o	o
	Pickwick	↓	↑**	o	o
	Kentucky	↓*	↑*	o	o

Table 5.4-03 Summation of Responses for Water Quality Characteristics in Representative Dam Releases by Policy Alternative (continued)

Alternative	Reservoir	Dissolved Oxygen		Temperature	
		Annual Average Minimum DO	Average Number Days/Year DO <5 mg/L	Average Days/Year Temperature >10 °C	Annual Average Maximum Temperature
Preferred	South Holston	LIP target	LIP target	**o**	**o**
	Douglas	LIP target	LIP target	**o**	**o**
	Hiwassee	LIP target	LIP target	**o**	**o**
	Boone	LIP target	LIP target	**o**	**o**
	Melton Hill	**o**	↑**	**o**	**o**
	Watts Bar	LIP target	LIP target	**o**	**o**
	Guntersville	**o**	↓*	**o**	**o**
	Pickwick	**o**	↑	**o**	**o**
	Kentucky	**o**	↑	**o**	**o**

Notes:

Responses are relative to conditions under the Base Case.

Model results for each water quality metric under the Base Case and policy alternatives are provided in Table D1-04 for all alternatives other than the Summer Hydropower Alternative and are based on hydrometeorologic conditions that existed from 1987 to 1994. Table D1-05 provides metric results for the Base Case and the Summer Hydropower Alternative based on hydrometeorologic conditions that existed from 1990 to 1994.

LIP = Lake Improvement Plan (TVA 1990).
o = No appreciable change from conditions under the Base Case (+/- 10%) .
↑ or ↓ = Used to identify changes (+/-) from conditions under the Base Case from 11 to 25%.
* = Changes (+/-) from conditions under the Base Case from 26 to 50%.
** = Changes (+/-) from conditions under the Base Case >50%.

5.4.3 Base Case

The Base Case represents a continuation of existing reservoir operations throughout the system. The water quality represented by the Base Case is described in detail in Section 4.4, Water Quality.

Under the Base Case, water temperature in the TVA reservoirs would continue to vary depending on the season, the weather, the amount of rainfall and the amount and temperature of water entering each reservoir. Most tributary reservoirs would stratify in summer and surface water temperatures would approach or exceed 30 °C in late summer. Those reservoirs that stratify would mix in early to late fall in response to cooling weather and release of cooler water from deep levels in the reservoirs through the dams. Tailwater temperatures downstream from tributary reservoirs would fluctuate during the summer stratification period as turbines are cycled on and off, periodically releasing cold reservoir water that is subsequently warmed as it moves downstream. During dry years, stratification would be somewhat stronger and possibly persist longer into fall. During wet years, stratification would be weaker and break down earlier in the season. The mainstem reservoirs would not stratify thermally to the extent of the tributary reservoirs due to the mixing created by shallower depths, higher flows, and shorter residence times. Slight vertical temperature differences and weak thermal stratification would occur, particularly during dry years when the upstream water is held back to fill the tributary reservoirs. The stratification that does occur would typically be broken up when flows are increased progressively in June, July, and August.

The deeper strata of the tributary reservoirs would continue to have little or no DO during thermal stratification in summer and late fall. Dissolved oxygen concentrations in the mainstem reservoirs would remain generally higher than in the tributary reservoirs due to shorter residence times in the mainstem reservoirs. Nevertheless, reduced DO concentrations would occur in some mainstem reservoirs during hot, dry periods. The release of water from the lower depths of many reservoirs would result in low concentrations of DO in the releases and downstream in tailwaters without DO mitigation and associated DO targets (Appendix A, Table A-05).

Tributary reservoirs would continue to experience periodic increases in algal growth in response to nutrient inputs from runoff from heavy rainstorms. Mainstem reservoirs would continue to experience increases in algal growth during hot, dry years when flow through the reservoirs is diminished.

5.4.4 Reservoir Recreation Alternative A

Under Reservoir Recreation Alternative A, the mainstem reservoirs would experience an increase in volumes of water with low DO concentrations and essentially no change in the volumes of water with the temperatures examined in the analysis.

The transitional tributary reservoirs would exhibit an increase in the volumes of water with low DO concentrations and an increase in the volume of warm water. Presence of large proportional increases in the volume of water with particularly low DO concentrations (≤2 and ≤1 mg/L) must be interpreted cautiously because these volumes would be quite small under both the Base Case and Reservoir Recreation Alternative A.

The storage tributary reservoirs would tend to react differently to operating conditions under Reservoir Recreation Alternative A. For instance, Douglas and Hiwassee Reservoirs would tend to have an increase in the volume of cool water and little change in the volume of warm water, whereas South Holston would have an increase in the volume of warm water and little change in the volume of cool water. Douglas and South Holston Reservoirs would have an increase in the minimum volume of water available for assimilative capacity (i.e., an increase in the minimum volume of water with DO ≥5 mg/L), whereas Douglas and Hiwassee Reservoirs would have an increase in the volume of water with particularly low DO concentrations (i.e., ≤2 and ≤1 mg/L). The increase in volumes of cool/cold water would result both from higher pool levels in winter and summer, and the increase in volumes with low DO concentrations would result from higher pool levels and decreases in dam releases in late summer.

The operating conditions established under Reservoir Recreation Alternative A would increase the number of days each year in which discharges from the dams would have DO concentrations <5 mg/L for those representative reservoirs without aeration devices (i.e., Melton Hill, Guntersville, Pickwick, and Kentucky). The annual average minimum DO (i.e., the average of the lowest DO concentration that occurred each year in model runs) would be lower under Reservoir Recreation Alternative A than under Base Case conditions at Melton Hill and Kentucky Reservoirs but would be similar to the Base Case on Guntersville and Pickwick Reservoirs.

Generally, effects of Reservoir Recreation Alternative A on release temperature would be similar to those under the Base Case. However, releases at South Holston Reservoir would have fewer days each year when temperatures would exceed 10 °C (Table 5.4-03).

5.4.5 Reservoir Recreation Alternative B

The mainstem reservoirs would experience an increase in volumes of water with low DO concentrations under Reservoir Recreation Alternative B relative to the Base Case, particularly the volume with very low DO concentrations (≤2 and ≤1 mg/L). Changes in volumes of warm water and cool water would be minor on the mainstem reservoirs under Reservoir Recreation Alternative B.

The transitional tributary reservoirs would exhibit an increase in the volumes of water with low DO concentrations as well as an increase in the volume of warm water. As described before, presence of large proportional increases in the volume of water with particularly low DO concentrations (≤2 and ≤1 mg/L) must be interpreted cautiously because these volumes would be quite small in both Base Case and under Reservoir Recreation Alternative B.

The storage tributary reservoirs would exhibit more consistency in response to operational changes under Reservoir Recreation Alternative B than described above for Reservoir Recreation Alternative A. All three representative storage tributary reservoirs would experience an increase in the volume of water with low DO concentrations—Douglas and Hiwassee more so than South Holston. Also, these reservoirs would experience increases in not only volume of warm water but also volume of cool water—likely the result of higher pool levels in winter and in summer compared to the Base Case.

Similar to Reservoir Recreation Alternative A, operations under Reservoir Recreation Alternative B would increase the number of days each year in which dam releases would have DO concentrations <5 mg/L in releases from representative reservoirs that do not have aeration devices. It would reduce the annual average minimum DO in releases from Melton Hill and Kentucky Reservoirs but not those from Guntersville and Pickwick Reservoirs. Release temperatures under Reservoir Recreation Alternative B would be similar to those under Reservoir Recreation Alternative A. The annual average maximum temperature and the average number of days each year with release temperatures >10 °C would be similar to the Base Case except for releases from South Holston Reservoir, which would exhibit fewer days per year with releases above that temperature.

5.4.6 Summer Hydropower Alternative

As described in Section 5.4.2, the evaluation of effects of the Summer Hydropower Alternative on water quality is based on the set of hydrological conditions that existed in 1990–1994, whereas the evaluation for the other alternatives is based on a broader set of hydrological conditions that existed in 1987 to 1994.

The mainstem reservoirs would experience a substantial decrease in volumes of water with low DO concentrations under the Summer Hydropower Alternative. Effects on volumes of warm water and cool water at the temperatures examined for this evaluation would be minor on the mainstem reservoirs under the Summer Hydropower Alternative.

The transitional tributary reservoirs would exhibit an increase in the volumes of water with low DO concentrations under the Summer Hydropower Alternative as well as a decrease in the volume of warm water. As described before, presence of large proportional increases or decreases must be interpreted cautiously.

Response of the storage tributary reservoirs to operation under the Summer Hydropower Alternative would vary among reservoirs, although Douglas and Hiwassee would tend to respond similarly for most water quality characteristics. Douglas and Hiwassee Reservoirs would experience greater changes to water quality characteristics under the Summer Hydropower Alternative operation than would South Holston Reservoir. For example, Douglas and Hiwassee Reservoirs would tend to have a decrease in the volume of water with low DO at all concentrations examined, whereas South Holston Reservoir would have an increase in the volume with particularly low DO concentrations and no change in the volumes at the other concentrations. Douglas Reservoir would have an increase in the minimum volume of water available for assimilative capacity (DO ≥5 mg/L), while South Holston and Hiwassee Reservoirs would experience a decrease. Both Douglas and South Holston Reservoirs would have little change in the volume of warm water, but the volume of warm would decrease on Hiwassee

Reservoir. As for the volume of cool/cold water, South Holston and Hiwassee Reservoirs would be relatively unchanged, while Douglas Reservoir would experience a large increase.

The operating regime under the Summer Hydropower Alternative would increase the annual average minimum DO concentrations in releases from the mainstem reservoirs relative to the Base Case. The average number of days with release DO concentration >5 mg/L would be substantially lower in these same releases. DO concentrations in releases from tributary and transitional reservoirs would be similar to those under the Base Case. Release water temperatures under the Summer Hydropower Alternative would be similar to those under the Base Case.

5.4.7 Equalized Summer/Winter Flood Risk Alternative

The mainstem reservoirs would experience an increase in volumes of water with low DO concentrations and essentially no change in the volumes of warm or cool water under the Equalized Summer/Winter Flood Risk Alternative.

The transitional tributary reservoirs would also exhibit an increase in the volumes of water with low DO. As described above, presence of large proportional increases in the volume of water with particularly low DO concentrations ($\leq$2 and $\leq$1 mg/L) must be interpreted cautiously. The volume of cool water would be larger in these reservoirs under the Equalized Summer/Winter Flood Risk Alternative than under the Base Case; however, the impact on the volume of warm water would differ between the two reservoirs. Boone would have a smaller volume of warm water and Melton Hill a larger volume—most likely due to differing operations of upstream storage tributary reservoirs under the Equalized Summer/Winter Flood Risk Alternative, which is tailored to individual watersheds to equalize flood risk throughout the year.

Water quality characteristics in the storage tributary reservoirs under the Equalized Summer/Winter Flood Risk Alternative would vary depending on watershed-specific flood risks. There would be only nominal differences in water quality characteristics on South Holston Reservoir under this alternative compared to Base Case operations. Hiwassee Reservoir would experience an increase in the volume of anoxic water (as represented by the DO $\leq$1 mg/L metric) and a decrease in the minimum volume of water available for assimilative capacity. Douglas Reservoir would exhibit a decrease in the volume of water with low DO concentrations—most likely due to a decrease in reservoir volume during summer months (compared to the Base Case), when low DO concentrations occur.

Water quality conditions in dam releases under the Equalized Summer/Winter Flood Risk Alternative would be almost identical to those described above for Reservoir Recreation Alternatives A and B. This is true for both DO and temperature measures.

5.4.8 Commercial Navigation Alternative

Mainstem reservoirs would experience only nominal changes to DO and temperature conditions under the Commercial Navigation Alternative. The uncommon exceptions would be a decrease in the volumes of water with particularly low DO concentrations on Kentucky Reservoir and, to lesser extent, Guntersville Reservoir. The transitional tributary reservoirs would exhibit essentially the same temperature and DO conditions under the Commercial Navigation Alternative as under the Base Case. The storage tributary reservoirs would likewise be unchanged under the Commercial Navigation Alternative.

The operating regime under the Commercial Navigation Alternative would be similar to that under the Base Case with only a few changes. Most of the release water quality characteristics under the Commercial Navigation Alternative would be similar to the Base Case, as indicated in Table 5.4-03. The exception to this observation would be at Kentucky Reservoir, where the annual average minimum DO of releases would be increased and the number of days with DO concentrations <5 mg/L would be reduced under the Commercial Navigation Alternative operations.

5.4.9 Tailwater Recreation Alternative

Changes to DO and temperature conditions in reservoirs under the Tailwater Recreation Alternative are sufficiently similar to those described above for Reservoir Recreation Alternative B to not be repeated here.

The operating regime under the Tailwater Recreation Alternative would be similar to that under Reservoir Recreation Alternative B. Similar changes to DO and temperature would also occur. The number of days each year in which discharges would have DO concentrations <5 mg/L would increase, and the average annual minimum DO would be lower at Melton Hill and Kentucky Reservoirs but similar to the Base Case at Guntersville and Pickwick Reservoirs.

The average number of days per year with release temperature >10 °C as well as the average annual maximum temperature in releases would be similar to the Base Case under the Tailwater Recreation Alternative at all representative dams, except South Holston. Releases at South Holston Reservoir would exceed 10 °C for fewer days each year and have a lower average annual maximum temperature.

5.4.10 Tailwater Habitat Alternative

The mainstem reservoirs would experience an increase in volumes of water with low DO concentrations under the Tailwater Habitat Alternative. The increase in volume of water with low DO concentrations (≤2 and ≤1 mg/L) would be substantial, particularly for Kentucky Reservoir. Impacts on volumes of warm water and cool water would be minor on the mainstem reservoirs under the Tailwater Habitat Alternative.

The transitional tributary reservoirs would also exhibit an increase in the volumes of water with low DO concentrations as well as an increase in the volume of warm water. As described before, the presence of large proportional increases must be interpreted cautiously.

All three representative storage tributary reservoirs would experience increases in the volume of water with low DO concentrations under the Tailwater Habitat Alternative. South Holston

Reservoir would be affected the least and Hiwassee Reservoir the most. Douglas and South Holston Reservoirs would tend to have an increase in the minimum volume of water available for assimilative capacity, whereas Hiwassee Reservoir would experience a decrease. Likewise, Douglas and South Holston Reservoirs would have an increase in volume of warm water and Hiwassee a decrease. Douglas and Hiwassee Reservoirs would tend to have an increase in the volume of cool water.

The operating regime under the Tailwater Habitat Alternative would reduce the annual average minimum DO concentrations in releases from Melton Hill, Pickwick, and Kentucky Reservoirs relative to the Base Case. The average number of days each with release DO concentration <5 mg/L would be substantially greater in these same releases and those at Guntersville Reservoir. Temperature impacts would be minor except for South Holston Reservoir, which would experience fewer days, when release temperatures exceed 10 °C.

5.4.11 Preferred Alternative

Section 4.4 describes the relationships between the reservoir operations policy and water quality in reservoirs and in dam releases, particularly as operations affect reservoir flows and residence times. A common concern related to most of the policy alternatives described above is increased residence times resulting from reduced flows during summer months compared to the Base Case, particularly for mainstem reservoirs. The Preferred Alternative would reduce the residence time concern by including higher system minimum flows through Chickamauga Reservoir in June, July, and August compared to Reservoir Recreation Alternatives A and B and the Tailwater Recreation Alternative. These higher summer minimum flows would occur as long as the system minimum operations guide curves are met or exceeded. Table 5.4-04 lists the preferred minimum flows at Chickamauga Dam each week during summer and the frequencies those flows would be expected to be met or exceeded under the Base Case and the Preferred Alternative. Chickamauga Dam was used in this comparison because Chickamauga is the location chosen to measure weekly system-wide minimum flows (see Chapter 3).

Potential water quality effects of these lower-than-preferred flows were evaluated in two ways. First, several of the 8 years included in the analysis (1987–1994) had modeled flows at or below the preferred minimums. These years are identified in Table 5.4-05. Second, one of these years (1993) had low flows representative of near worst-case conditions and was evaluated separately in Section 5.4.12.

The increased summer minimum flows under the Preferred Alternative would provide summer residence times more similar to the Base Case than most of the other policy alternatives. Results for the full 8-year model period indicate that largest increases in average summer residence time under the Preferred Alternative would occur on storage tributary reservoirs, which already have extended residence times under the Base Case. South Holston would experience the greatest increase in summer residence time, with a calculated hydraulic residence time of 483 days under the Preferred Alternative compared to 436 days under the Base Case.

Table 5.4-04 Frequency of Meeting Preferred Minimum Flows at Chickamauga during Summer under the Base Case and the Preferred Alternative

Week	Approximate Date	Preferred Minimum Flow for Preferred Alternative (cfs)	Percentage of Years Flows Would Be Met or Exceeded under Base Case (%)	Percentage of Years Flows Would Be Met or Exceeded under Preferred Alternative (%)
23	1st Week of June	14,000	83	86
24	2nd Week of June	15,000	82	86
25	3rd Week of June	16,000	76	82
26	4th Week of June	17,000	79	77
27	1st Week of July	19,000	76	60
28	2nd Week of July	21,000	77	52
29	3rd Week of July	23,000	76	40
30	4th Week of July	25,000	77	48
31-35	August	29,000	74	50

Table 5.4-05 Water Quality Model Years with Modeled Flows at or below Preferred Minimum Flows under the Preferred Alternative

Week	Preferred Minimum Flow (cfs)	1987	1988	1989	1990	1991	1992	1993	1994
23	14,000		X					X	
25	16,000	X	X					X	
27	19,000	X	X		X			X	
29	23,000	X	X		X	X	X	X	
30	25,000	X	X		X	X	X	X	
31	29,000	X	X		X	X	X	X	
33	29,000	X	X	X	X	X	X	X	

Residence time for representative transitional tributary reservoirs would be increased by 4 days or less under the Preferred Alternative. Average summer residence time on representative mainstem reservoirs would be increased by only 1 or 2 days under Preferred Alternative operations. A noteworthy point about residence time is that, as shown in Table 5.4-05, the occurrence of reservoir flows above the preferred minimum is higher than the Base Case in early summer and lower in late summer. Hence, residence time under the Preferred Alternative is expected to be longer in late summer than under the Base Case.

Operational changes under the Preferred Alternative would result in only minor changes in volumes of either warm or cool water in mainstem reservoirs. However, compared to the Base Case, three of the four representative mainstem reservoirs would experience an increase in the volume of water with low DO concentrations under the Preferred Alternative. Of these three, Watts Bar would experience the greatest increases. There would be more water in Watts Bar Reservoir with DO ≤5, ≤2, and ≤1 mg/L. Additionally, there would be a decrease in the minimum volume of water available for assimilative capacity (i.e., minimum volume with DO ≥5 mg/L on a “worst-case” day). Guntersville Reservoir would differ from the other three representative mainstem reservoirs—with an apparent reduction in the volume of water with particularly low DO concentrations (i.e., ≤2 mg/L and ≤1 mg/L) under the Preferred Alternative and only nominal changes in the volume available for assimilative capacity. Modeling results indicate that low DO concentrations in Guntersville Reservoir occur primarily during low-flow (drought) conditions, such as those that occurred during 1988. Reservoir flows do not have to be that low for low DO concentrations to occur on the other mainstem reservoirs. For most years, the Preferred Alternative would have slightly lower reservoir flows during summer than under the Base Case. However, flows during particularly dry years like 1988 would be greater under the Preferred Alternative than under the Base Case—if the reservoir system is operated as specified during extreme drought conditions such as those that occurred in 1988.

The transitional tributary reservoirs would also vary in response to operations under the Preferred Alternative. Under the Base Case, Boone Reservoir has a fairly large volume of water with DO ≤5 mg/L yet quite small volumes of water with particularly low DO concentrations (i.e., ≤2 and ≤1 mg/L). Although volumes of all three of these concentrations would increase on Boone Reservoir under the Preferred Alternative, the volume of water with particularly low DO concentrations would still be relatively small. Operation under the Preferred Alternative would tend to increase the volume of warm water in Boone but would result in little change in the volume of cool/cold water. Melton Hill Reservoir also has only a small volume of low DO water under the Base Case. Model results indicate that the volume with very low DO concentrations (i.e., ≤2 and ≤1 mg/L) might be even less under the Preferred Alternative. The volume of water with DO ≤5 mg/l would increase under the Preferred Alternative, but the actual volume would still be small in comparison to total reservoir volume. Temperature characteristics of Melton Hill Reservoir, as well as the minimum volume of water available for assimilative capacity, would be essentially unaffected by Preferred Alternative operations.

Operation under the Preferred Alternative would produce few changes in DO and temperature characteristics for the three storage tributary reservoirs examined. Water quality metrics (both DO and temperature) for South Holston Reservoir under the Preferred Alternative would be similar to those that would exist under the Base Case. For Hiwassee Reservoir, DO metrics under the Preferred Alternative would be similar to those under the Base Case, but the volume of cool/cold water would increase—probably due to higher elevation (and volume) in winter. For Douglas Reservoir, the volume of water available for assimilative capacity would increase, with no measurable changes in volumes of water with low DO concentrations. There would be essentially no change in the volume of warm water, but the volume of cold water would increase—similar to the situation on Hiwassee Reservoir.

The average annual minimum DO concentrations in releases from representative reservoirs that do not have aeration devices (i.e., Melton Hill, Guntersville, Pickwick, and Kentucky) would be similar under the Preferred Alternative to those that would occur under the Base Case. The other DO metric (average number of days/year with DO <5 mg/L) would be increased by the Preferred Alternative for Melton Hill, Pickwick, and Kentucky Reservoir releases, yet decreased for Guntersville releases. The reason that Guntersville Reservoir differs is the dramatic effects of very low-flow conditions due to drought, as described above for 1988. The Preferred Alternative would have no appreciable effect on either of the water temperature metrics (average number of days/year with temperature >10 °C and average annual maximum temperature).

5.4.12 Impacts of Policy Alternatives on DO under Low-Flow Conditions

In evaluating the potential effects of reservoir operations policy alternatives on water quality, it is important to consider a broad range of weather and reservoir conditions. In particular, it is important to consider a situation approximating a scenario that would be expected to occur periodically under hot, low-flow conditions. For the 8 years modeled, the system inflows above Chickamauga Dam for 1988 were the lowest in the last 100 years. Instead of focusing on such a severe drought year, TVA chose to examine a less extreme event. System inflows above Chickamauga Dam for another modeled year (1993) were the seventh-lowest of the last 100 years. This situation can be expected to occur more frequently than the 1988 drought; consequently, modeled flows and water quality conditions for 1993 were used to examine potential effects of the various alternatives under low-flow conditions.

This analysis focuses on effects of low flows on DO because DO is the water quality parameter expected to be most affected under these conditions and because DO is critical to maintaining acceptable water quality conditions in reservoirs. The volume of water with a DO concentration ≤1 mg/l, the metric representing potential anoxic conditions, was selected as the basis of comparison. Table 5.4-06 provides predicted volumes of water with low DO concentrations under each policy alternative, including the Base Case, for 1993 flow conditions. It also expresses those volumes as a percentage of the total reservoir volume during the periods when water quality modeling results predicted this condition would occur.

These results are summarized for each category of TVA reservoir, comparing the effects of operation under the various policy alternatives to the Base Case. Any substantial increase in volume of water with low DO concentration is undesirable.

Table 5.4-06 Predicted Water Volumes and Percentage of Total Reservoir Volume with Low DO Concentration by Policy Alternative (1993 Flows)

Reservoir	Sum of Daily Volumes of Water with DO ≤1 mg/L (million m3-days) and Percent of Total Reservoir Volume with DO ≤1 mg/L (1993 Conditions)								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
South Holston									
Volume	4,257	4,282	4,216	4,294	4,195	4,066	3,969	4,324	4,131
Percent of total volume	3.6%	3.6%	3.6%	4.1%	3.4%	3.5%	3.4%	3.7%	3.5%
Douglas									
Volume	33,948	33,084	39,551	14,259	19,942	33,983	39,275	45,089	33,032
Percent of total volume	19.8%	19.3%	20.7%	12.3%	17.0%	19.7%	20.6%	21.9%	19.4%
Hiwassee									
Volume	975	990	1,489	616	1,133	944	1,699	2,374	1,141
Percent of total volume	2.7%	2.7%	3.7%	2.7%	3.4%	2.6%	4.2%	5.9%	3.0%
Boone									
Volume	0	0	0	0	0	0	7	0	0
Percent of total volume	0%	0%	0%	0%	0%	0%	0.4%	0%	0%
Melton Hill									
Volume	10	141	61	0	79	11	4	261	28
Percent of total volume	0.6%	2.3%	0.9%	0%	1.1%	0.6%	0.1%	3.0%	0.5%
Watts Bar									
Volume	13,996	15,818	23,759	2,443	20,439	13,810	22,940	13,776	23,371
Percent of total volume	11.1%	12.2%	16.3%	2.7%	17.5%	11.1%	15.8%	11.2%	16.9%
Guntersville									
Volume	2,737	5,098	5,608	252	4,979	2,752	5,620	5,133	3,243
Percent of total volume	2.7%	4.9%	5.3%	0.3%	5.0%	2.7%	5.3%	4.7%	3.0%
Pickwick									
Volume	7,374	9,787	12,227	1,121	10,850	6,975	12,091	10,374	9,241
Percent of total volume	7.3%	9.3%	11.5%	1.3%	10.1%	6.9%	11. 4%	9.9%	8.8%
Kentucky									
Volume	863	2,702	3,341	237	3,118	319	3,332	9,890	1,648
Percent of total volume	0.3%	0.9%	1.1%	0.1%	1.0%	0.1%	1.1%	2.4%	0.4%

Storage Tributary Reservoirs

- Increase in low DO volume compared to the Base Case: Reservoir Recreation B, Tailwater Recreation Alternative, and Tailwater Habitat Alternative.
- Low DO volume similar to the Base Case: Reservoir Recreation Alternative A, Commercial Navigation Alternative, and Preferred Alternative.
- Decreased low DO volume compared to the Base Case: Summer Hydropower Alternative.
- Inconsistent response among reservoirs compared to the Base Case: Equalized Summer/Winter Flood Risk Alternative.

Transitional Tributary Reservoirs

- Model results indicate that volumes of water with low DO concentrations would be quite small relative to total reservoir volume under the Base Case and all the action alternatives.
- The largest increase in volume of low DO water would occur under the Tailwater Habitat Alternative, and a decrease would occur under the Summer Hydropower Alternative.

Mainstem Reservoirs

- The predicted volume of water with DO <1 mg/L and percentage of total reservoir volume would vary considerably among the representative mainstem reservoirs. Watts Bar Reservoir would have the largest low DO volume as well as the greatest proportion of total reservoir volume with DO <1 mg/L, and Kentucky would have the smallest volume and portion. Kentucky is the largest among all TVA reservoirs, with a total reservoir volume much greater than any of the other reservoirs.
- Increase in low DO volume compared to the Base Case: Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Equalized Summer/Winter Flood Risk Alternative, Tailwater Recreation Alternative, Tailwater Habitat Alternative, and the Preferred Alternative.
- Low DO volume similar to the Base Case: Commercial Navigation Alternative.
- Decrease in low DO volume compared to the Base Case: Summer Hydropower Alternative.

In summary, operation under the different policy alternatives under 1993 flow conditions would have varying effects on the volumes of low DO water, depending on alternative and reservoir.

Under the Commercial Navigation Alternative, the volume of low DO water in most reservoirs would be similar to those under the Base Case, and decreases would occur in most reservoirs under the Summer Hydropower Alternative. Under the other policy alternatives, low DO volumes appear to increase for most reservoirs—particularly the mainstem Tennessee River reservoirs.

Another important consideration is how alternatives affect summer hydraulic residence times, especially on mainstem reservoirs during low-flow years such as 1993. Table 5.4-07 shows the changes in summer residence times (days) for the representative mainstem reservoirs under each policy alternative.

Table 5.4-07 Summer Residence Time Changes for Representative Mainstem Reservoirs (1993 Flows)

Reservoir	Base Case (days)	Residence Time Changes Relative to Base Case (days)							
		Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Watts Bar	24.8	+3.9	+10.4	-7.9	+13.6	+0.1	+9.7	+17.0	+3.3
Guntersville	21.3	+2.8	+7.9	-6.0	+9.9	0	+7.8	+11.6	+3.0
Pickwick	19.8	+3.3	+8.2	-6.5	+11.6	-0.2	+8.1	+11.7	+3.7
Kentucky	46.5	+7.2	+17.7	-10.2	+12.6	-0.8	+17.5	+16.9	+3.2

Notes:

Summer represents June 1 through September 30.

+ = Indicates an increase in residence time relative to the Base Case.

5.4.13 Impacts of Policy Alternatives on Algae

Impacts of alternative operations policies on algal activity are not included in Table 5.4-02 or the discussion of each alternative. Absence of an appropriate, alternative-specific predictive tool prevents such a presentation of potential effects. The water quality models used in this evaluation were not specifically calibrated for algal activity. As a result, the evaluation of potential effects of various alternatives was based on an examination of Vital Signs Monitoring Program results. A regression analysis for chlorophyll-a (a measure of the amount of algae) concentrations predicted generally small increases in chlorophyll-a among the alternatives, with a maximum increase less than 10 percent. Based on past monitoring experience, a larger increase was expected in reservoirs with relatively short residence times because operation under most alternatives would result in increased residence time, which should be sufficient to result in increased chlorophyll-a concentrations. Further analysis compared chlorophyll-a concentrations in each representative reservoir in 2002 to their respective long-term averages. The basis of this comparison was that low flows, because of drought conditions in 2002, were generally similar to those that would occur under several alternatives. In effect, the long-term average represents the Base Case, and 2002 represents alternatives that result in decreased summer flows (Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative and, to a lesser extent, the Preferred Alternative). That comparison showed higher concentrations in all representative reservoirs in 2002 than the long-term average, with greatest increases in reservoirs with short retention times and least increases in reservoirs with long retention times. These results indicate that increased retention times due to lower flows associated with several alternatives could result in higher chlorophyll-a concentrations in several reservoirs, especially mainstem reservoirs. Based on 2002 results, some of the increases could be substantial.

5.4.14 General Water Quality Impacts

The water quality metrics described above provide a quantitative comparison among policy alternatives and are useful in determining the relative difference between the Base Case and the action alternatives. The focus of the analysis was on hydrodynamics, DO, and temperature. Of primary interest among these metrics are those that describe changes in DO concentrations. The presence, absence, and concentrations of DO in a reservoir both control and are controlled by many physical, chemical, and biological processes. Clearly, adequate DO concentrations are essential for many water uses such as support for a healthy and robust aquatic community and for assimilating oxygen demanding wastes.

The quantitative evaluation provided above for each policy alternative indicated that several of the operations policies would increase the volume of water with low DO concentrations. Potential implications of these increases could include loss of habitat for aquatic life, increased water treatment costs, loss in assimilative capacity, and increase in anoxic products. These changes would be expected to be of greater concern in reservoirs and tailwaters that never or rarely experience low DO concentrations than in those that experience such conditions routinely. Impacts of changes in water quality on aquatic resources are discussed in Section 5.7 (Aquatic Resources), impacts on threatened and endangered species are discussed in Section 5.13 (Threatened and Endangered Species), and impacts on water supply are discussed in Section 5.5 (Water Supply). Impacts of increases in volumes of water with low DO concentrations on assimilative capacity and the potential for anoxic products are described in Section 5.4.15.

5.4.15 Assimilative Capacity and Anoxic Products

The evaluation summarized in Table 5.4-08 uses the following criteria to describe relative impacts of alternatives on assimilative capacity and the extent of anoxia compared to the Base Case. These categories are similar in magnitude to those used previously, but include a judgment of whether the change would result in a beneficial or adverse impact on water quality. In addition to these quantitative changes, the evaluation considers other factors such as existence of low DO conditions under the Base Case, availability of an ample supply of water with adequate DO concentrations, and existence of aeration systems.

- Not different from the Base Case – +/-10% of Base Case (shown as No Change).
- Slightly Beneficial – 11 to 25% increase in the volume of water with DO ≥5 mg/L for assimilative capacity and 11 to 25% decrease in the volume of water DO ≤1 mg/L for evaluation of anoxia.
- Beneficial – 26 to 50% increase in the volume of water with DO ≥5 mg/L for assimilative capacity and 26 to 50% decrease in the volume of water DO ≤1 mg/L for evaluation of anoxia.
- Substantially Beneficial – >50% increase in the volume of water with DO ≥5 mg/L for assimilative capacity and >50% decrease in the volume of water DO ≤1 mg/L for evaluation of anoxia.
- Slightly Adverse – 11 to 25% decrease in the volume of water with DO ≥5 mg/L for assimilative capacity and 11 to 25% increase in the volume of water DO ≤1 mg/L for evaluation of anoxia.
- Adverse – 26 to 50% decrease in the volume of water with DO ≥5 mg/L for assimilative capacity and 26 to 50% increase in the volume of water DO ≤1 mg/L for evaluation of anoxia.
- Substantially Adverse – >50% decrease in the volume of water with DO ≥5 mg/L for assimilative capacity and >50% increase in the volume of water DO ≤1 mg/L for evaluation of anoxia.
- Note: The volume of water associated with certain metrics under certain alternatives for certain reservoirs could be quite small, causing nominal changes from the Base Case to appear quite large proportionally. Consequently, absolute volumes in Appendix D1 also were considered. Where this occurred, the judgment was labeled as Slightly Beneficial or Slightly Adverse regardless of the actual percentage change.

Assimilative Capacity

The analysis on impacts of reservoir operations on assimilative capacity was accomplished using the metric that measured the minimum volume of reservoir water that exceeded 5 mg/L oxygen on the "worst-case" day for each of the 8 years examined by the water quality model. It was assumed that this condition would provide a constraint on the amount of oxygen consuming waste a reservoir could accept. The analysis used this parameter as an indicator of the system-wide impacts of policy alternatives on the ability of the reservoirs to assimilate oxygen consuming wastes. The analysis did not evaluate specific discharges, it did not evaluate potential discharges to tailwaters or free-flowing sections, nor did it evaluate the ability of the system to assimilate other wastes that do not consume oxygen. A beneficial impact under this category of uses is defined as an increase in assimilative capacity while an adverse impact is defined as a loss in assimilative capacity.

Table 5.4-08 Summary of Impacts on Assimilative Capacity and Anoxia by Policy Alternative

Alternative	Assimilative Capacity	Potential for Anoxic Products
Reservoir Recreation A	This policy alternative would result in a slight increase in the minimum volume of water available to assimilate oxygen consuming wastes on tributary storage reservoirs (Slightly Beneficial). For the transitional tributary reservoirs, there would either be no change or a slight reduction in this volume (No Change – Slightly Adverse). This volume would be relatively unchanged from the Base Case for the mainstem reservoirs (No Change).	The volume of water with oxygen concentrations favoring development of anoxic products would increase somewhat on the storage tributary reservoirs and transitional tributary reservoirs compared to the Base Case (Slightly Adverse). Even greater proportional increases would occur on most representative mainstem reservoirs (Adverse).
Reservoir Recreation B	This policy alternative would result in essentially the same changes in representative reservoirs described for Reservoir Recreation A. The only difference is that the transitional tributary reservoirs would be rated No Change because the minimum volume available would be similar to the Base Case.	This policy alternative would result in essentially the same changes in storage tributary and transitional tributary reservoirs described for Reservoir Recreation A. For the mainstem reservoirs, the increase in volume compared the Base Case would be substantial for all representative reservoirs (Substantially Adverse).
Summer Hydropower	Changes under this alternative in the minimum volume of water available to assimilate oxygen-demanding materials were evaluated only for normal- to high-flow years. Impacts under low flows during dry years could not be evaluated because conditions created insufficient water availability for completion of model runs. For the flow conditions that could be evaluated, most representative reservoirs would have essentially the same volume of water with this characteristic as the Base Case or would have a slight reduction (No Change to Slightly Adverse).	Changes under this alternative in the volume of water with oxygen concentrations favoring development of anoxic products were evaluated only for normal- to high-flow years. Impacts under low flows during dry years could not be evaluated because conditions created insufficient water availability for completion of model runs. For the flow conditions that could be evaluated, volume reductions would occur more often than increases on the storage tributary reservoirs (Slightly Beneficial). Transitional tributary reservoirs would experience increases (Slightly Adverse). High summer flows through the mainstem reservoirs would result in large reductions compared to the Base Case (Substantially Beneficial).
Equalized Summer/ Winter Flood Risk	This policy alternative would result in essentially no change in the minimum water available to assimilate oxygen-demanding wastes in two of the storage tributary reservoirs and a slight reduction in the other (No Change to Slightly Adverse); a slight reduction in both transitional tributary reservoirs (Slightly Adverse); and similar volumes to Base Case operations for all representative mainstem reservoirs (No Change).	Changes under this alternative in the volume of water with oxygen concentrations favoring development of anoxic products would vary among storage tributary reservoirs from a slight increase to a decrease (overall rating Slightly Beneficial). The transitional tributary reservoirs would experience a slight increase under this alternative (Slightly Adverse). This volume would increase on all representative mainstem reservoirs, with proportional increases being substantial on some reservoirs (Adverse – Substantially Adverse).

Table 5.4-08 Summary of Impacts on Assimilative Capacity and Anoxia by Policy Alternative (continued)

Alternative	Assimilative Capacity	Potential for Anoxic Products
Commercial Navigation	The minimum volume of water available to assimilate oxygen-demanding wastes would be relatively unchanged compared to the Base Case for all representative reservoirs (No Change).	This policy alternative would result in about the same volumes of water with oxygen concentrations favoring development of anoxic products as the Base Case on storage tributary reservoirs (No Change). This volume would be slightly increased on some transitional tributary reservoirs and unchanged compared to the Base Case on others (No Change – Slightly Adverse). Mainstem reservoirs would either remain similar to the Base Case or experience a slight decrease in volume (overall rating Slightly Beneficial).
Tailwater Recreation	Effects of this policy alternative would be the same as those described for Reservoir Recreation B.	This policy alternative would result in either similar volumes of water with potential anoxic conditions on storage tributary reservoirs compared to the Base Case or a notable increase (No Change – Adverse). Some transitional tributary reservoirs would experience an increase, while others would experience a decrease (Slightly Adverse – Slightly Beneficial). Most mainstem reservoirs would encounter a large increase in this volume (Substantially Adverse).
Tailwater Habitat	Effects of this policy alternative would vary among the storage tributary reservoirs. There would be a notable increase in the minimum volume of water available to assimilate oxygen consuming wastes on one tributary storage reservoir and a slight decrease on another (overall rating Slightly Beneficial). For the transitional tributary reservoirs, there would either be no change or slight reduction in this volume (No Change – Slightly Adverse). This volume would remain relatively unchanged on the mainstem reservoirs (No Change).	The volume of water with oxygen concentrations favoring development of anoxic products would increase on almost all representative reservoirs. The increase would be sufficiently large as defined in this context to be rated Adverse on the storage tributary reservoirs; No Change to Slightly Adverse on transitional tributary reservoirs; and even larger increases on mainstem reservoirs would be rated Adverse to Substantially Adverse.
Preferred	This policy alternative would result in either an increase in the volume of water available for assimilating oxygen-demanding wastes or volumes similar to the Base Case for the storage tributary reservoirs (Slightly Beneficial). Volumes on the transitional tributary reservoirs would be similar to the Base Case (No Change). Volumes on three of the four mainstem reservoirs would be similar to the Base Case and slightly reduced compared to the Base Case on the other representative mainstem reservoir (overall rating No Change).	This policy alternative would result in about the same volumes of water with oxygen concentrations favoring development of anoxic products as the Base Case on storage tributary reservoirs (No Change). This volume would be slightly increased on some transitional tributary reservoirs and slightly decreased compared to Base Case on others (Slightly Adverse – Slightly Beneficial). Mainstem reservoirs would remain similar to the Base Case, experience a slight decrease in volume, or experience a large increase in volume (overall rating Slightly Adverse).

Anoxic Products

In addition to the direct impacts on aquatic life (discussed in Section 5.7, Aquatic Resources) low concentrations of DO approaching anoxia have the potential to introduce iron, manganese, sulfides, and ammonia into deeper strata of reservoirs. Because this process is so closely tied to DO concentrations, the potential for these compounds to be mobilized or formed was evaluated by looking at the volume of water in the reservoirs having a DO concentration less than 1 mg/L. A decrease in the potential for anoxic product formation or mobilization is designated as a beneficial impact while an increase is designated as an adverse impact.

5.4.16 Summary of Impacts

Table 5.4-04 identified relatively few changes in the minimum volume of water available to assimilate oxygen-demanding wastes compared to Base Case conditions. This metric was selected to be an indicator of system-wide impacts of policy alternatives on assimilative capacity. It was not intended to be a detailed evaluation of policy alternatives on assimilative capacity, nor was it intended to examine site-specific impacts. From this perspective, this analysis indicates that none of the alternative operations policies would result in substantial impacts on assimilative capacity.

Increases in anoxia and potential anoxic products are of particular concern, especially on mainstem reservoirs. Presence of anoxia on storage tributary reservoirs is an expected condition because of long residence times and thermal stratification. However, frequency, duration, and extent of anoxia are much less on most of the mainstem reservoirs than on the storage tributary reservoirs because of shorter residence times and lack of thermal stratification. This analysis shows that most policy alternatives would affect DO more in mainstem reservoirs than in storage tributary reservoirs.

Of the policy alternatives that were evaluated for the complete 8-year model period (i.e., all but the Summer Hydropower Alternative), several policy alternatives would result in a relative increase in the potential for anoxic products on most or all representative mainstem reservoirs and thus be considered an adverse to substantially adverse impact. Only one, the Commercial Navigation Alternative, would result in volumes of potential anoxic water either similar to or slightly less than the Base Case. The Preferred Alternative would affect each mainstem reservoir differently, ranging from a volume of potential anoxic water similar to the Base Case to a volume substantially larger than the Base Case. The increase would occur on Watts Bar Reservoir, which experiences relatively large volumes of low DO water on a more frequent basis than any of the other mainstem reservoirs. Watts Bar Reservoir presently has aeration equipment to maintain its Lake Improvement Plan target for the tailwater.

Analysis of the effects of policy alternatives on water quality under low-flow conditions acknowledged that the volume of water with low DO concentrations was greater on most representative reservoirs during dry years with low reservoir flows under the Base Case operations. Several policy alternatives would increase this volume beyond what would occur under the Base Case, especially on mainstem reservoirs. Flows for 1993 were used to represent low-flow conditions. Water quality model runs were completed for all policy alternatives under 1993 conditions. Results indicate that the Summer Hydropower Alternative would reduce the volume of low DO water on mainstem reservoirs compared to the Base Case; the Commercial Navigation Alternative would result in volumes similar to the Base Case; and all other alternatives would increase the volume of low DO water compared to the Base Case. Among the alternatives that would result in increased volume, the Preferred Alternative would create the smallest increase.

Conditions that exist under low flows are often a good predictor of future conditions under normal flow. This analysis indicates that most policy alternatives would tend to increase volumes of water with low DO concentrations, especially on mainstem reservoirs under low-flow conditions. The results of this analysis indicate that any operations policy that would reduce flows on mainstem reservoirs beyond those under the Preferred Alternative—whether one of the alternatives considered here or a future alternative—could compromise water quality in unacceptable ways.

5.5 Water Supply

5.5.1 Introduction

This assessment of environmental consequences focuses on whether implementation of a new reservoir operations policy would change reservoir elevations or tailwater minimum flows in a manner that would:

- Limit supply by constraining withdrawals for municipal and industrial uses;
- Increase the cost of obtaining supplies, as expressed in pumping costs or costs for new or modified intake structures; or
- Degrade water supply quality and thereby limit water supply through increased treatment requirements.

5.5.2 Impact Assessment Methods

The analysis for water supply is based on output from the WSM, which provided (among other things) changes in reservoir elevations, and output from the Water Quality Model, which provided data relative to changes in DO and algae formation. Using these data, the Base Case and action alternatives were evaluated using the methods of analysis described below.

Reservoir Elevations and Intake Structures

Changes in reservoir elevation were evaluated to determine whether:

- Alternative minimum reservoir elevations would fall below water supply intake structure elevations; or,
- Changes in elevations would affect the energy requirements for pumping water from the reservoirs and thereby constrain supply.

For all reservoirs with public supply and industrial water intakes, the proposed minimum reservoir elevations under each action alternative were compared to the TVA-published minimum reservoir elevation for the reservoir. A summary is shown in Table 5.5-01. All intakes in the reservoir were installed to be below the published normal minimum operating level. Footnoted entries in Table 5.5-01 indicate that five alternatives would result in elevations below the published minimum elevation. It should be noted that not all 35 reservoirs in the system were subjected to simulated elevations. Some, such as Fort Patrick Henry, Melton Hill, Apalachia, and the Ocoee Reservoirs, were not expected to experience elevation changes under any of the alternatives. The reservoirs that are discussed in the following pages were selected because their intakes were sufficiently large that mitigation costs could be substantial if an alternative would result in an adverse effect.

Table 5.5-01 Comparison of TVA-Published Minimum Reservoir Elevations to Existing and Proposed Elevations

Reservoir	TVA-Published Minimum Elevation (ft)	Base Case and Action Alternative Minimum Reservoir Elevations (ft)								
		Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Watauga	1,915	1,920.9	1,931	1,932	1,778.9[1]	1,913.4[1]	1,890.9[1]	1,924.9	1,936	1,913.8[1]
South Holston	1,675	1,681.3	1,688	1,694	1,676	1,676	1,676	1,698.1	1,679.7	1,676
Boone	1,330	1,355.7	1,355.7	1,355.7	1,354.9	1,361	1,355.7	1,355.7	1,355.7	1,361.2
Cherokee	1,020	1,026.6	1,027.6	1,029	981.0[1]	1,025.1	1,010.1[1]	1,029.4	1,030	1,020
Douglas	940	940	940	940	910.0[1]	940.5	932.8[1]	940	940	935[1]
Norris	960	970.8	974.6	978.3	900.0[1]	959.2	946.1[1]	977.5	973.2	960
Fontana	1,575	1,575	1,575	1,575	1,518.0[1]	1,575	1,553.4[1]	1,575	1,575	1,575
Chatuge	1,905	1,909.3	1,910.3	1,911.2	1,860.0[1]	1,906.4	1,893.3[1]	1,903.7[1]	1,904.9[1]	1,905
Nottely	1,735	1,741.1	1,742.6	1,743.9	1,690.0[1]	1,739	1,721.9[1]	1,733.5[1]	1,734.8[1]	1,735
Hiwassee	1,450	1,458.8	1,461.2	1,463.4	1,413.2[1]	1,451.3	1,438.5[1]	1,447.9[1]	1,450	1,450
Blue Ridge	1,590	1,639.6	1,642.5	1,646.7	1,611.7	1,626.6	1,644.8	1,647.5	1,618.5	1,644.8
Tims Ford	865	870	871.2	871	855.0[1]	864.6	863.1[1]	871	871.2	870
Fort Loudoun	807	808	809.5	809.5	808	807	809.5	809.5	809.5	808
Watts Bar	735	736	737.5	737.5	736	735	737.5	737.5	737.5	736
Chickamauga	675	676	677.5	677.5	676	675	677.5	677.5	677.5	676
Nickajack	632	632.5	632.5	632.5	632.5	632.5	632.5	632.5	632.5	632.5
Guntersville	593	593.3	593.3	593.3	593.3	593.3	593.3	593.3	593.3	593.3
Wheeler	550	551	552.5	552.5	551	551	552.5	552.5	552.5	551
Wilson	504.5	505.5	505.5	505.5	505.5	505.5	505.5	505.5	505.5	505.5
Pickwick	408	409	410.5	410.5	409	409	410.5	410.5	410.5	409
Kentucky	354	354.3	354.3	356	354.3	354.3	356	356	354.3	354.3

[1] Indicates elevations below the published minimum elevation.

Cherokee Reservoir

Morristown on Cherokee Reservoir has a municipal intake designed for operation with a minimum water level of 1,020 feet. Under both the Summer Hydropower Alternative and the Commercial Navigation Alternative elevations would be lower than 1,020 feet. Should reservoir elevations fall below 1,020 feet, an old intake at Morristown that is at the level of the original river channel could be used to supply some water when the reservoir level is as low as 1,000 feet.

Under the Summer Hydropower Alternative, the elevation of Cherokee Reservoir is predicted to be below elevation 1,020 feet for 125 weeks during 100 years and below elevation 1,015 feet for 94 weeks during 100 years. The minimum elevation during the 100-year period is expected to be 980 feet. The minimum elevation was found to occur during August and September, when peak demand conditions occur. Because of the frequency and duration of occurrence of elevations below the existing operating level, there is no practical way to modify the existing intake either on a permanent or temporary basis to provide the required water supply reliability. In these circumstances, it was assumed that a new intake would be required. Based on recent construction costs of other intakes similar to the existing Morristown design, the cost of a new intake would be about $5 million.

Under the Commercial Navigation Alternative, it is expected that the reservoir elevation would be below 1,020 feet for 16 weeks out of 100 years and below elevation 1,015 feet for 5 weeks out of 100 years. The approximate minimum elevation would be about 1,010 feet. Reservoir levels below 1,020 feet would all occur in the October–November time frame, when municipal demands are near or below the annual average demand. With the existing intake, it was assumed that approximately one-half of the projected 2030 demand of approximately 12 mgd could be produced under the Commercial Navigation Alternative. It was further assumed that the existing intake and pumps could be modified to provide the remaining 6 mgd. Installation of temporary pumps might also be required to pump into the existing intake wet well for a limited period of time. These modifications were estimated to cost approximately $1 million.

Norris Reservoir

The two alternatives with elevations below the published minimum elevation (960 feet) were the Summer Hydropower Alternative, with a minimum elevation of 900 feet, and the Commercial Navigation Alternative, with a minimum elevation of 946 feet. (Although the minimum elevation under the Commercial Navigation Alternative would be below the published minimum elevation, its minimum elevation would not affect Lafollette.) The Lafollette intake has a provision for the installation of a temporary pump should elevations go below 900 feet, the elevation of the City of Lafollette's intake. Therefore it was assumed that the Summer Hydropower Alternative would incur a cost of approximately $20,000 for temporary pumping for the period that the reservoir elevation reached elevation 900 feet.

Douglas Reservoir

The Sevier Water Board has an intake in Douglas Reservoir. According to plans approved by TVA for this intake, the lowest elevation for the intake was to be 926.5 feet. The Summer Hydropower Alternative has a minimum elevation of 910 feet. Because it is unlikely that the reservoir is sufficiently deep at the intake's location to allow the existing intake to be extended to a depth to accommodate an elevation of 910 feet, it was assumed that the intake would need to be moved approximately 2 miles and a new intake would need to be constructed. The total cost was expected to be $3 million. Under the Commercial Navigation Alternative, the minimum reservoir elevation was projected to be 932.8 feet, which is above the 926.5-foot elevation to which the intake was supposed to be functional. To allow for the uncertainty at which elevation the intake would continue to function, it was assumed that a cost of $26,000 would be incurred to connect temporary pumps and to modify private and commercial intakes. The Preferred Alternative has a minimum elevation of 935 feet, which is below the minimum published elevation. As for the Commercial Navigation Alternative, a $26,000 cost was assumed for potential temporary pumping and private/commercial intake modification to accommodate the minimum elevation event.

Chatuge Reservoir

The city of Hiawassee, Georgia has a floating intake on Chatuge Reservoir. Based on depth soundings beneath the intake, it was estimated that the reservoir level could drop to elevation 1,895 feet and the intake would still continue to function. Although elevations for the Tailwater Recreation and Tailwater Habitat Alternatives fall below the published minimum elevations, the minimum elevations for these alternatives are still above 1,895 feet. The minimum elevation for the Commercial Navigation Alternative is 1,893.3 feet, which is below the existing limitation of 1,895 feet. It was assumed that this elevation could be reached through a modification of the existing intake at a cost of $50,000. The existing intake cannot be modified to reach elevation 1,860 feet as required under the Summer Hydropower Alternative; therefore, it was assumed that a new intake must be constructed. The cost for the new intake in deeper water plus approximately 2.5 miles of pipeline to carry the water to the treatment plant was estimated at $2.2 million.

Nottely Reservoir

An intake tower for the Notla Water Company has been recently installed in the Nottely forebay. The lowest level from which water can be withdrawn is 1,733 feet. Both the Summer Hydropower and Commercial Navigation Alternatives resulted in minimum pool levels much below this level. Therefore, it was assumed that the intake would need to be reconstructed at a location farther out in the reservoir, at an estimated cost of $2.25 million.

Tims Ford Reservoir

An elevation of 855 feet at Tims Ford was recently experienced due to a drawdown necessary for dam repair. No adverse impacts were reported to TVA. Therefore, it was assumed that an elevation of 855 feet is possible without modification of any intakes.

Fontana and Hiwassee Reservoirs

Three alternatives would result in impacts on a few private or commercial intakes on these reservoirs.

Reservoir Elevations and Pumping Requirements

Table 5.5-02 shows the amount of water projected to be pumped from selected reservoirs in 2030. The difference in pumping energy required to lift water from the reservoir between the Base Case and each action alternative was computed. The computation was conducted by determining the difference in median elevation between each action alternative and the Base Case for each month for each reservoir.

Table 5.5-03 compares the difference in pumping energy required for each action alternative compared to the Base Case.

Table 5.5-02 2030 Total Average Water Supply Pumping Rates

Reservoir	Average 2030 Annual Water Pumping Affected by Reservoir Level (mgd)
South Holston	4.5
Chatuge	1.4
Cherokee	25.9
Douglas	5.1
Fort Loudoun	74.9
Norris	2.5
Watts Bar	50.0
Chickamauga	49.3
Nickajack	89.9
Guntersville	98.0
Wheeler	412.1
Wilson	53.0
Pickwick	92.2
Tims Ford	2.8
Nottely	1.0
Kentucky	136.1

Table 5.5-03 Change in Pumping Energy Required by Policy Alternatives

Action Alternative	Difference in Pumping Energy Compared to the Base Case (millions of KWh/yr)[1]
Reservoir Recreation A	-1.4
Reservoir Recreation B	-2.0
Summer Hydropower	0.9
Equalized Summer/Winter Flood Risk	-0.3
Commercial Navigation	-0.8
Tailwater Recreation	-2.0
Tailwater Habitat	-1.6
Preferred	-0.7

[1] A negative number indicates that the alternative requires less energy than the Base Case. A positive number indicates that the alternative requires more energy than the Base Case.

Water Supply Quality and Treatment

Water quality, in relationship to water supply, was analyzed for effects on water supply treatment requirements due to changes in algae concentrations, the potential for increased concentrations of soluble iron and manganese, and increased turbidity. The algal biomass concentrations in the photic zone (where light is available) were used to rate the alternatives; they represent a surrogate metric for dissolved organic matter (DOM), taste and odor impacts, and operational difficulties related to algae concentrations. Analysis of the water volume with DO less than 1 mg/L was used as a surrogate for the potential for soluble iron and manganese formation. Storm water runoff brings large amounts of sediment into the streams, rivers and reservoirs of the Tennessee River watershed. Storm events increase the cost of water treatment. However, none of the reservoir operational changes will affect the amount of sediment that enters the reservoir system. Operational changes that result in longer reservoir retention times might result in slightly more settling of suspended solids. However, experience with the water quality models used for the ROS evaluation indicated that suspended solids concentrations would vary by less than 10 mg/L among the alternatives (Shiao pers. comm.). Bohac (2003) showed that, for a change of 5 to 10 mg/L, the costs to water treatment systems in the Tennessee River watershed were insignificant. Therefore, no comparison of alternatives was made based on suspended solids.

<u>Algae</u>

Algae can cause taste and odor problems for water treatment plant operators, can contribute to the formation of DBPs, and can also contribute to operational problems such as reduced filter run times. Water quality modeling was used to investigate these potential effects by examining differences in algae concentrations between the alternatives. Reservoir maximum algae concentrations were calculated for the 8-year water quality simulation period (1987 to 1994), as shown in Table 5.5-04.

Table 5.5-04 Comparison of Maximum Algae Concentrations by Policy Alternative

Reservoir	Maximum Algae Concentration (mg/L)								Range between Alternatives (mg/L)
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred	
Cherokee	5.2	5.2	5.2	5.1	5.2	5.2	5.2	5.1	0.1
Douglas	3.5	3.8	3.8	3.4	3.5	3.8	3.8	3.4	0.4
Norris	1.3	1.3	1.4	1.5	1.3	1.5	1.4	1.4	0.2
South Holston	6.5	6.5	6.5	6.2	6.5	6.5	6.5	6.5	0.3
Watauga	3.5	3.8	4.9	5.0	3.5	4.8	4.6	5.1	1.6
Boone	6.4	6.8	6.5	6.8	6.5	6.5	6.7	6.7	0.4
Fort Patrick Henry	3.7	3.8	3.8	3.8	3.8	3.8	3.6	3.9	0.3
Melton Hill	6.0	6.0	6.0	6.3	5.9	5.8	6.2	5.7	0.6
Chickamauga	2.4	2.5	2.5	2.0	2.3	2.5	2.0	2.3	0.5
Fort Loudoun	5.1	5.2	5.2	4.7	4.6	5.0	4.9	5.1	0.6
Guntersville	8.3	8.6	8.6	8.0	8.3	8.6	8.3	7.1	1.5
Kentucky	3.4	3.4	3.4	3.4	3.4	3.5	3.4	3.2	0.3
Nickajack	2.6	2.7	2.6	2.1	2.4	2.7	2.4	2.5	0.6
Pickwick	6.8	6.5	6.6	6.5	6.7	6.4	6.5	6.3	0.5
Watts Bar	4.7	5.1	4.9	3.6	4.0	5.0	5.3	4.6	1.7
Wheeler	7.7	7.7	7.6	7.5	8.3	7.6	7.7	6.4	1.9

Even though there were slight differences between alternatives for any one reservoir, the differences in maximum concentrations were generally small on most reservoirs (Table 5.5-04). In addition, none of the alternatives exhibited a pattern of being consistently better or worse than any other alternative when all reservoirs were considered.

As discussed in Section 5.4.13, an analysis of chlorophyll-a concentrations and retention times suggested that all of the action alternatives except the Commercial Navigation Alternative could result in higher chlorophyll-a (algae) concentrations in some reservoirs.

Iron and Manganese

Reservoir water volumes with DO concentration below 1 mg/L were used as an indicator for the relative potential for soluble species of iron and manganese to form in reservoir bottoms; and they were used to rank each alternative on tributary, transitional, and mainstem reservoirs.

Based on the average rank, the Base Case and the Commercial Navigation Alternative appeared to have the lowest potential for soluble iron and manganese species formation across all reservoirs evaluated. The order of increasing potential for iron and manganese formation was the Preferred Alternative, followed by Reservoir Recreation Alternative A and the Equalized Summer/Winter Flood Risk Alternative. Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative have the highest potential for iron and manganese formation.

Because of volume differences between alternatives on tributary reservoirs, the ratios of water with DO less than 1 mg/L to total volume were investigated. It was determined that some of the effect of larger amounts of low DO water would be offset by more total water in the reservoir. As such, differences between alternatives based on ratios of low DO water to total water volume were less important than differences based only on low DO volume.

It is unclear to what degree water treatment plants could be affected by elevated concentrations of soluble iron and manganese. Many existing treatment plants have multiple-level intakes that allow iron- and manganese-rich water to be avoided. Therefore, even if some alternatives result in elevated soluble iron and manganese concentrations, treatment plants might be able to avoid potential impacts. Water treatment plant operators on South Holston, Cherokee, Douglas, Melton Hill, and Fort Loudoun Reservoirs stated that no treatment is presently required for iron and manganese. Treatment plant operators on Chickamauga, Nickajack, and Wheeler Reservoirs also confirmed that they do not now treat for iron and manganese.

The cost of chemicals to treat the differences in soluble iron and manganese that could arise if an alternative to the Base Case was implemented was estimated for Cherokee and Douglas, two reservoirs where the potential for soluble iron and manganese formation appeared to be the greatest. The additional cost for treatment was less than $5,000 per year, suggesting that any increase in soluble iron and manganese could be treated at little additional chemical cost, although some modification to process equipment might be required. However, because treatment plants presently do not routinely treat for soluble iron and manganese, initiating treatment for them would require process changes and increased operator attention. These changes might be more significant than the additional chemical costs would suggest. Implementing an alternative that would require a treatment plant to change from no treatment for soluble iron and manganese to treatment for these constituents could adversely affect some treatment plants.

Evaluation of tributary and mainstem reservoirs suggested that iron and manganese concentration differences between alternatives should be several times less on the mainstem than on the tributaries. The occurrence of low DO water in mainstem reservoirs also was cyclic over the summer, increasing in volume and then decreasing in volume only to increase again. It was also observed that the location of the water with DO below 1 mg/L typically occurred in the last few miles of the reservoir, in the forebay next to the dam. By contrast, the water with DO below 1 mg/L on tributary projects existed for most of the length of the reservoir. This also suggests that unless an intake was located in the forebay of a mainstem reservoir, water that could contain elevated iron and manganese concentrations could be avoided.

5.5.3 Base Case

Under the Base Case, the reservoirs would be operated to provide for the 2030 water demand and maintain minimum flows below reservoirs. In other words, no limitation is placed on water demand. However, there are existing intakes and there could be new intakes in tailwaters where minimum flows are provided. Because expansion of the withdrawal of the existing intakes or the additional withdrawal of the new intakes could affect the minimum flow, a case-by-case environmental analysis would be required for new intakes or expansion of existing ones. The water for future demand is available under the Base Case, but where it would be extracted from the system is an issue to be addressed on a case-by-case basis.

Elevations in reservoirs and tailwaters under the Base Case would be within the published minimum elevations for reservoirs and would not affect intake structures; pumping costs would not increase. Under the Base Case, water quality and related treatment requirements would not change.

5.5.4 All Action Alternatives

Under each action alternative, the reservoirs would also be operated to provide for the 2030 water demand and maintain minimum flows below reservoirs. As in the case of the Base Case, each action alternative places no limitation on water demand. However, where water can be extracted without substantially affecting minimum flows would remain an issue to be addressed for each alternative. Therefore, the water supply availability and the minimum flow issues would not be any different for any action alternative than they would be for the Base Case. Therefore, no specific analysis of these issues was performed, and they were not included in the following table. Table 5.5-05 shows the potential effects of the action alternatives on water supply delivery (cost) and water supply quality (treatment).

Table 5.5-05 Impacts on Water Supply by Action Alternative

Alternative	Water Supply Delivery (Cost)	Water Supply Quality (Treatment)
Reservoir Recreation A	Elevation changes under Reservoir Recreation Alternative A would not affect intake structures or require modifications to structures. Elevation changes would require less energy (1.4 million kWh/yr less) for pumping than under the Base Case.	Algae concentrations on some reservoirs could be higher than under the Base Case. Iron and manganese formations would be higher than under the Base Case.
Reservoir Recreation B	Reservoir Recreation Alternative B would not require modifications to intake structures and would require less energy for pumping (2.0 million kWh/yr less) than under the Base Case.	Algae concentration on some reservoirs under Reservoir Recreation Alternative B could be higher than under the Base Case. Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative have the highest potential for soluble iron and manganese formation.
Summer Hydropower	Elevation changes under the Summer Hydropower Alternative would result in seven reservoirs requiring modifications of their intake structures to ensure reliable supply. The cost of these modifications is estimated at $12.5 million dollars, the greatest increase in impact above the Base Case for all eight alternatives. The Summer Hydropower Alternative also has the greatest increase in energy demand for pumping (requiring 0.9 million kWh/year more) than under the Base Case.	Water quality modeling was not completed for the Summer Hydropower Alternative due to too little water in some reservoirs under dry conditions. In years for which simulations results were available, the potential for iron and manganese ranged from lowest to highest—depending on year and reservoir.
Equalized Summer/ Winter Flood Risk	Elevation changes under the Equalized Summer/Winter Flood Risk Alternative will not affect intake structures and will have lower pumping requirements (0.3 million kWh/yr) than under the Base Case.	Algae concentration on some reservoirs under the Equalized Summer/Winter Flood Risk Alternative could be higher than under the Base Case. The Equalized Summer/Winter Flood Risk Alternative has a higher potential for soluble iron and manganese formation than the Base Case and the Commercial Navigation Alternative.
Commercial Navigation	Elevations under the Commercial Navigation Alternative would require modifications to intake structures at seven reservoirs. Costs for these modifications are estimated at $3.4 million. This alternative would require less energy (0.8 million kWh/yr) for pumping than under the Base Case.	Algae concentration across the system under the Commercial Navigation Alternative would be the about the same as under the Base Case. The Commercial Navigation Alternative is similar to the Base Case in terms of potential for iron and manganese formations. The Commercial Navigation Alternative would not increase treatment costs above those for the Base Case.

Table 5.5-05 Impacts on Water Supply by Action Alternative (continued)

Alternative	Water Supply Delivery (Cost)	Water Supply Quality (Treatment)
Tailwater Recreation	Elevations under the Tailwater Recreation Alternative would require very minor modifications at three reservoirs to allow for limited temporary pumping. Estimated costs are $22,500. The Tailwater Recreation Alternative is equivalent to the Summer Hydropower Alternative, requiring less energy (2.0 million kWh/yr) for pumping than under the Base Case	Algae concentrations on some reservoirs under the Tailwater Recreation Alternative could be higher than under the Base Case. The Tailwater Recreation Alternative is similar to Reservoir Recreation Alternative B in terms of the potential for soluble iron and manganese formation.
Tailwater Habitat	Elevations under the Tailwater Habitat Alternative would require minimal temporary modifications to intake structures at two reservoirs, with an estimated cost of $21,000. Energy requirements are less (1.6 million kWh/yr) than under the Base Case.	Algae concentrations on some reservoirs under the Tailwater Habitat Alternative could be higher than under the Base Case. The Tailwater Habitat Alternative has the highest potential for soluble iron and manganese formation.
Preferred	Elevations under the Preferred Alternative would require minimal temporary modifications to intake structures on one reservoir, with an estimated cost of $26,000. Energy requirements are less (0.7 million kWh/yr) than under the Base Case.	Algae concentrations on some reservoirs under the Preferred Alternative could be higher than under the Base Case. The Preferred Alternative has slightly higher potential for soluble iron and manganese formation than the Base Case and the Commercial Navigation Alternative but less potential than Reservoir Recreation Alternative A.

Note: Water supply availability would not be affected under any action alternative and therefore was not included in the table.

5.5.5 Summary of Impacts

A summary of the alternative analysis is presented in Table 5.5-06. The alternatives were ranked from 1 to 8, with ties using the average rank. A “1” ranking is best, and an “8” ranking is worst. Algae concentrations showed little differences between alternatives. Chlorophyll-a concentrations and retention times suggested that the Base Case and the Commercial Navigation Alternative would have the lowest algae concentrations. The Base Case and the Commercial Navigation Alternative were also ranked best (lowest) in regard to iron and manganese formation. The rankings in Table 5.5-06 were based on the potential for soluble iron and manganese formation since the algae analysis did not help to distinguish between alternatives. The table also shows the sum of the intake modification costs and the present value of the difference in pumping costs, assuming a 30-year time horizon, 6-percent interest rate, and cost of power of $0.051/KWh. Because the Base Case and all the action alternatives are equal in terms of meeting the future water demand (water supply demand), this criterion was not summarized in Table 5.5-06.

Table 5.5-06 Summary of Impacts on Water Supply by Policy Alternative

Alternative	Water Supply Quality[1]	Water Supply Delivery
Base Case	No change 1.5	No change $0
Reservoir Recreation A	Slightly adverse 4.5	Slightly beneficial -$1 million
Reservoir Recreation B	Adverse 7	Slightly beneficial -$1.4 million
Summer Hydropower[2]	No change to adverse	Substantially adverse $13.1 million
Equalized Summer/Winter Flood Risk	Slightly adverse 4.5	Slightly beneficial -$0.2 million
Commercial Navigation	No change 1.5	Adverse $2.8 million
Tailwater Recreation	Adverse 7	Slightly beneficial -$1.4 million
Tailwater Habitat	Adverse 7	Slightly beneficial -$1.1 million
Preferred	No change to slightly adverse 3	Slightly beneficial -$0.5 million

1 Ranked on a scale of 1 to 8, where 1 is best and 8 is worst, with ties using the average rank of alternatives that tie. Three alternatives tied for 6th, 7th, and 8th place; therefore, each was assigned the average value of 7.

2 Water quality modeling could not be completed for the Summer Hydropower Alternative because of too little water in some reservoirs under dry conditions. In years for which simulations results were available, the potential for iron and manganese ranged from No Change to Adverse, depending on year and reservoir.

5.6 Groundwater Resources

5.6.1 Introduction

This section assesses the potential effects of future reservoir operations on groundwater resources in the Tennessee River watershed.

5.6.2 Impact Assessment Methods

Assessment of the surface water and groundwater interactions involved two phases: (1) an initial screening-level analysis to determine the zone of surface water influence on groundwater resources, and (2) a reservoir-specific analysis to determine potential effects on specific public groundwater wells situated within the zone of surface water influence identified in the screening-level analysis.

Screening-Level Analysis

A screening-level analysis was performed to determine the zone of surface water influence on groundwater resources adjacent to each TVA reservoir and tailwater. The calculation used an analytical model to represent the natural condition and assumed a sudden change in reservoir elevation that propagates through groundwater. (See Appendix D2 for additional information about the assessment of surface water and groundwater interactions.)

The furthest distance from the reservoirs where a change in reservoir elevation could be discerned in the groundwater zone was calculated. For this analysis, “no effect” represents a change in groundwater elevation less than or equal to 0.1 foot that was caused by a change in reservoir elevation. The screening-level analysis used January 1 (minimum pool) and June 1 (maximum pool) elevations and a duration of 150 days as inputs to the calculation. This range in elevation provided an upper bound for changes in groundwater levels. None of the reservoir operations policy alternatives would produce a greater change in groundwater levels than those predicted by the screening-level analysis.

Within the boundary of the screening-level analysis, the potentially affected groundwater resources were identified from the U.S. Geological Survey (USGS) database of public, commercial, agricultural, and industrial groundwater wells within the Tennessee River Valley region (Hutson et al. 2003, Bohac 2003). Any reservoir with potentially affected wells was further analyzed as described in the following sections.

In addition to the groundwater wells identified in Hutson et al. (2003) and Bohac (2003), there could be other private wells not included in these inventories that are close to Tennessee Valley reservoirs and tailwaters and could potentially be affected by changes in reservoir operations. The results of the analysis for public groundwater wells are expected to be generally representative of the effects to these private wells.

Table 5.6-01 Public Groundwater Wells within Zones of Influence of TVA Reservoirs

TVA Reservoir	Calculated Zone of Influence (feet)	Public Wells within Zone of Influence of Reservoir
Apalachia	1,050	0
Bear Creek	2,200	0
Blue Ridge	1,150	0
Boone	1,300	0
Cedar Creek	1,850	0
Chatuge	1,150	0
Cherokee	1,350	3
Chickamauga	1,140	0
Douglas	1,400	2
Fontana	1,325	0
Fort Loudoun	1,075	2
Fort Patrick Henry	1,050	0
Great Falls	1,870	0
Guntersville	1,600	0
Hiwassee	1,325	0
Kentucky	1,600	1
Little Bear Creek	1,820	0
Melton Hill	1,100	0
Nickajack	1,820	0
Normandy	1,800	0
Norris	1,350	1
Nottely	1,250	0
Ocoee #1	1,050	0
Ocoee #2	0	0
Ocoee #3	1,040	1
Pickwick	2,050	0
South Holston	1,330	0
Tellico	1,100	0
Tims Ford	1,875	1
Upper Bear Creek	2,090	0
Watauga	1,150	0
Watts Bar	1,100	2
Wheeler	1,650	0
Wilbur	1,150	0
Wilson	1,125	0

Note: The “zone of influence” is the zone of surface water influence on groundwater resources. No influence (0) is defined as changes in groundwater levels of less than 0.1 foot.

Table 5.6-01 gives the zone of groundwater influence for each TVA reservoir and the number of public wells located within this zone. For the following reservoirs, at least one public water supply well was located within the calculated zone of influence and was identified for further analysis: Cherokee, Douglas, Fort Loudoun, Kentucky, Norris, Ocoee #3, Tims Ford, and Watts Bar. Results were also used to identify wetlands potentially affected by reservoir and tailwater water level changes associated with the policy alternatives (see Section 5.8, Wetlands).

Reservoir-Specific Analysis

Reservoirs containing public wells within the zone of surface water influence on groundwater were further analyzed with respect to the reservoir operations policy alternatives. For each of the reservoir areas chosen for further analysis, the closest public well to the reservoir was designated as the most sensitive groundwater resource. The distances from these wells to the reservoirs were determined. In addition, median monthly changes in reservoir water levels were determined for all the alternatives. For all alternatives, the potential monthly change in groundwater levels at the wells closest to the reservoirs was calculated.

Any increase in groundwater levels resulting from a change in reservoir operations was considered a beneficial effect on groundwater resources. A decrease in groundwater levels of more than 3 feet resulting from a change in reservoir operations was considered an adverse effect on groundwater resources if the change occurred at or near reservoir minimum pool. This 3-foot threshold was based on the typical seasonal and annual changes in groundwater elevations attributable to non-reservoir influences and variation in groundwater use patterns.

5.6.3 Base Case

The Base Case would continue existing conditions to the year 2030. Since this alternative does not include a physical change and groundwater usage was assumed to remain fairly constant, there would be no adverse consequence to groundwater resources.

5.6.4 Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Tailwater Recreation Alternative, and Tailwater Habitat Alternative—Reservoirs

Reservoir-specific analyses indicated that Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative would most likely produce increases in water levels at public wells close to the reservoirs. The greatest increases would be at Cherokee, Douglas, and Norris Reservoirs under all four of these alternatives. The least amount of change would most likely occur at Watts Bar, Fort Loudoun, and Kentucky Reservoirs under all of these alternatives. As groundwater levels under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative would increase, impacts on groundwater resources associated with these alternatives would be slightly beneficial.

5.6.5 Summer Hydropower Alternative, Equalized Summer/Winter Flood Risk Alternative, and Commercial Navigation Alternative—Reservoirs

Reservoir operations under the Summer Hydropower Alternative, Equalized Summer/Winter Flood Risk Alternative, and Commercial Navigation Alternative potentially could decrease groundwater levels from existing conditions near some reservoirs. For these alternatives, the greatest calculated decreases in groundwater levels at nearby public wells would be at Tims Ford under the Equalized Summer/Winter Flood Risk Alternative (7 feet) and at Fort Loudoun Reservoir under the Summer Hydropower Alternative (3 feet) and the Equalized Summer/Winter Flood Risk Alternative (2 feet). The predicted decreases at Fort Loudoun are under the 3-foot threshold and would have slightly adverse effects on groundwater resources. Further analysis of Tims Ford shows groundwater levels surrounding the reservoir to be higher than any potential water levels in the reservoir. The decreases in groundwater levels calculated for Tims Ford Reservoir are, therefore, highly unlikely to occur.

5.6.6 Preferred Alternative

The monthly difference from existing conditions in groundwater levels at the wells closest to those reservoirs identified in the screening-level analysis for further evaluation was calculated for the Preferred Alternative. According to the calculations, the Preferred Alternative would most likely produce an increase or no change in groundwater levels and water levels at public wells close to the reservoirs. The greatest increases would be at Cherokee, Douglas, and Norris Reservoirs. Consequently, impacts on groundwater resources associated with the Preferred Alternative would be slightly beneficial. The increases are slightly less than those for Reservoir Recreation Alternatives A and B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative.

5.6.7 All Policy Alternatives—Tailwaters

Rivers have a much narrower zone of influence on groundwater because of the substantial difference in the volume of water in any given river reach compared to that in a reservoir (Freeze and Cherry 1979). The preceding analysis concluded that effects on groundwater resources near all reservoirs would be slightly adverse to slightly beneficial. Furthermore, all the policy alternatives would maintain minimum levels of water in tailwaters for navigation and other beneficial uses. Therefore, tailwater impacts on groundwater resources would essentially not change under any policy alternative.

5.6.8 Summary of Impacts

Table 5.6-02 provides a summary of impacts on groundwater resources by policy alternative. The Preferred Alternative, Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Commercial Navigation Alternative, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative would result in either a slightly beneficial or slightly adverse effect on public groundwater resources near TVA reservoirs, depending on the reservoir. The Summer Hydropower Alternative and Equalized Summer/Winter Flood Risk Alternative could potentially cause water levels at public wells close to Tims Ford and Fort Loudoun Reservoirs to decrease, although not substantially. Private or domestic wells not identified in Hutson et al. (2003) and Bohac (2003) that are within the zone of influence could also be adversely affected by changes in reservoir operations under all the policy alternatives. Essentially no change would occur on groundwater resources near tailwaters under any policy alternative.

Table 5.6-02 Summary of Impacts on Groundwater Resources by Policy Alternative

Alternative	All Reservoirs[1]	All Tailwaters
Reservoir Recreation A	Slightly beneficial	No change
Reservoir Recreation B	Slightly beneficial	No change
Summer Hydropower	Slightly adverse	No change
Equalized Summer/Winter Flood Risk	Slightly adverse	No change
Commercial Navigation	Slightly adverse	No change
Tailwater Recreation	Slightly beneficial	No change
Tailwater Habitat	Slightly beneficial	No change
Preferred	Slightly beneficial	No change

[1] Reservoirs that would be affected by alternatives would include Cherokee, Douglas, Fort Loudoun, Kentucky, Norris, Tims Ford, and Watts Bar. All other reservoirs would not be affected by the alternatives.

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5.7 Aquatic Resources

5.7.1 Introduction

The three main areas of concern for aquatic resources with regard to the ROS were biodiversity, sport fisheries, and commercial fisheries. The technical ability to accurately model direct impacts of environmental change on aquatic communities (e.g., numbers of species and numbers of individuals in a population) presently is limited and therefore impractical to apply across the TVA system. Instead, environmental conditions (e.g., DO, water temperature, and flow) that potentially affected aquatic communities under the various policy alternatives were modeled and used as surrogates of population and community responses. Responses of aquatic resources were discussed at a programmatic level, and anticipated change was indicated by the direction (e.g., beneficial or adverse) and magnitude (e.g., slight or substantial) of any change.

To provide a baseline for evaluation, aquatic resources responses to the policy alternatives were evaluated against the Base Case. The Base Case is described in Chapter 3, and its relationship to present operations related to aquatic resources is explained in Section 5.4, Water Quality. The estimated value of each surrogate environmental metric under the Base Case represents existing conditions that are expected to persist if no change is made to the reservoir operations policy.

Evaluation of aquatic resource issues was performed relative to waterbody type as described in this section. Surrogate measure results are presented by reservoir or tailwater. Biodiversity evaluations were made for individual reservoirs and warm-water tailwaters for fish and invertebrate communities. Biodiversity of cold-water tailwaters was not addressed because cold-water releases yield resident communities with little diversity; therefore, no alternative would change this general condition. Sport fish population conditions were assessed at reservoirs, including fish spawning conditions, and tributary tailwaters—cold-, cool-, and warm-water. Evaluation of commercial fisheries—both mussels and fishes—was conducted using metrics for mainstem reservoirs only, where most commercial activities occur.

5.7.2 Impact Assessment Methods

Based on scientifically established relationships of environmental variation and change in aquatic resources, surrogate metrics were identified to evaluate the potential change to aquatic resources under the policy alternatives (Table 5.7-01). Projected impacts on fish spawning conditions also were evaluated. Results of the evaluations of alternatives under other resource areas also were considered, including water quality analysis (see Section 5.4, Water Quality), aquatic plants (see Section 5.9, Aquatic Plants), and sediment and erosion (see Section 5.16, Shoreline Erosion).

Table 5.7-01 Environmental Factors Used to Evaluate Potential Changes among Species or Communities by Policy Alternative

Resource Issue	Category	Type	Condition Indicator	Representative or Modeled Years
General biodiversity	Reservoir	Mainstem	Dissolved oxygen (DO) water quality metrics (see Section 5.4, Water Quality)	
			Mean maximum percent of non-acceptable habitat (as percent of total daily reservoir volume)	1990,1993,1994
			Mean number of days of water volume with DO less than 1 mg/L	1990,1993,1994
		Tributary	DO water quality metrics (see Section 5.4, Water Quality)	
			Mean yearly volume of water with ammonia > 2 mg/L	1990,1993,1994
			Mean maximum percent of non-acceptable habitat (as percent of total daily reservoir volume)	1990,1993,1994
			Mean number of days of water volume with DO less than 1 mg/L	1990,1993,1994
	Tailwater	Warm-water fisheries	Mean summer (May to October) flow, DO, and temperature	1987–1994
			Mean daily range of summer (May to October) flow, DO, and temperature	1987–1994
			Mean August/September flow, DO, and temperature	1987–1994
			Mean daily range of August/September flow, DO, and temperature	1987–1994
			Hours of water temperature less than 16 ºC and 20 ºC	1987–1994
			Tailwater water quality indicators (see Section 5.4, Water Quality)	
		Cool-water fisheries	See general biodiversity, warm-water tailwater indicators (above)	
		Cold-water fisheries	See general biodiversity, warm-water flow, DO, and temperature metrics (above)	

Table 5.7-01 Environmental Factors Used to Evaluate Potential Changes among Species or Communities by Policy Alternative (continued)

Resource Issue	Category	Type	Condition Indicator	Representative or Modeled Years
Sport fisheries	Reservoir	Mainstem	Median number of weeks at summer pool elevation	1903–2001
			Median pool elevation in winter (week 2, January)	1903–2001
			Median first week stabilized at summer pool elevation	1903–2001
			See general biodiversity mainstem indicators (above)	
		Tributary	Median number of weeks at summer pool elevation	1903–2001
			Median pool elevation in winter (week 2, January)	1903–2001
			Median first week stabilized at summer pool elevation	1903–2001
			Mean volume of acceptable cool-water habitat (temperature < 24 ºC and DO >3 mg/L)	1990,1993,1994
			Mean volume of suitable cool-water habitat (temperature < 24 ºC and DO > 5 mg/L)	1990,1993,1994
			Mean volume of acceptable cool-water habitat (temperature < 20 ºC and DO > 3 mg/L)	1990,1993,1994
			Mean volume of suitable cool-water habitat (temperature < 20 ºC and DO > 5 mg/L)	1990,1993,1994
			See general biodiversity reservoir tributary indicators (above)	
	Tailwater	Warm-water fisheries	Hours of water temperature less than 16 ºC	1987–1994
			See general biodiversity metrics, warm-water tailwater indicators (above)	
		Cool-water fisheries	See general biodiversity, warm-water tailwater indicators (above)	
		Cold-water fisheries	Hours of water temperature more than 20 ºC	1987–1994
			See general biodiversity, cold-water tailwater indicators (above)	
			Tailwater water quality indicators (see Section 5.4, Water Quality)	
		Mainstem	Change in median discharge in spring (Week 13, April)	1987–1994
			Hours of no discharge from March through May	1987–1994
Commercial fisheries	Reservoir	Mainstem	See general biodiversity mainstem indicators (above)	

Reservoir Metrics

Increasing DO concentrations generally benefits aquatic life. Although very high levels of dissolved gases in water—a condition known as supersaturation—causes harm to aquatic animals, it has not been an issue for TVA reservoirs and only rarely has been an issue in tailwaters (downstream of the Kentucky Dam). Low DO concentrations not only are stressful to aquatic life; they can increase the potential for release of toxic substances (e.g., heavy metals, hydrogen sulfide, and ammonia) in the water (see Section 5.4, Water Quality). These impacts occur in reservoirs, which then can be transferred to tailwaters through discharge. Therefore, in addition to direct impacts of predicted low concentrations of DO, these estimates can be used as a surrogate measure of indirect impacts resulting from formation of toxic substances.

To evaluate changes to environmental conditions in reservoirs under the policy alternatives, the following DO and temperature metrics were used:

- Water quality metrics from Section 5.4, Water Quality:
  - Amount of water with DO < 1 milligrams per liter (mg/L)
  - Amount of water with DO < 2 mg/L
  - Amount of water with DO < 5 mg/L

Results for these metrics are presented in Section 5.4, Water Quality (Table 5.4-2). Estimates of DO < 1 mg/L were used to evaluate alternatives for the potential formation of toxic substances such as ammonia and presence of fatal concentrations of low DO. The DO < 2 mg/L metric served as an index of amount of stressful habitat, only habitable for short periods (hours or days). The final measure, DO < 5 mg/L, represented a DO concentration indicative of conditions not suitable for long-term survival and life function such as growth and feeding. Increased volumes of low DO water indicated decreasing habitat condition and increased potential of adverse impacts on aquatic biodiversity. With DO metrics, conditions representative of healthy biodiversity were also representative of conditions good for sport fish populations and commercial fisheries.

Changes in water temperature were also evaluated, especially with respect to sport fishes. Water temperature requirements for resident cold-water, cool-water, and warm-water sport fish were used to derive water temperature metrics. For cool- and cold-water species, higher temperatures decrease their potential growth or survival. For warm-water species, lower water temperatures decrease their potential growth, which indirectly lowers survival and, if temperature becomes extremely low, it may also cause direct stress or mortality. Cold-water species prefer maximum summer temperatures less than 20 ºC. Cool-water species prefer temperatures less than 24 ºC, and temperatures less than 16 ºC during the summer/fall growth period can decrease the potential productivity of warm-water communities. Most policy alternatives would influence the volume of water in tributary reservoirs that is of a suitable temperature for cold-water and cool-water fishes with an adequate concentration of DO. Because water temperature strongly influences DO and many sport fishes have combined water temperature and DO preferences that reflect this relationship, habitat conditions for tributary sport fishes were evaluated with metrics combining temperature and DO preferences.

Metrics used to evaluate environmental changes on fishes in tributary reservoirs were estimated using the water quality model (Table 5.7-01):

- Cold-water habitat

  Critical

  Mean volume-days (million m^3) with water temperature less than 20 ºC and DO > 3 mg/L for a dry, wet, and normal year.

  Preferable

  Mean volume-days (million m^3) with water temperature less than 20 ºC and DO > 5 mg/L for a dry, wet, and normal year.

- Cool-water habitat

  Critical

  Mean volume-days (million m^3) with water temperature less than 24 ºC and DO > 3 mg/L for a dry, wet, and normal year.

  Preferable

  Mean volume-days (million m^3) with water temperature less than 24 ºC and DO > 5 mg/L for a dry, wet, and normal year.

While other fishes are more tolerant of warmer water, metrics for cool-water habitat were used to serve as general indices to changes in the environment for warm-water fishes.

The hydrodynamics of reservoirs are also important to biodiversity of communities, sport fishes, and commercial fishes. Certain aspects of reservoir hydrodynamics affect water quality, as described in detail in Sections 4.4 and 5.4, Water Quality. Reservoir hydrodynamic metrics specifically used in this section included the first week of attainment of summer pool levels, elevation of winter pool levels, and the number of weeks at full pool levels. Specific to tributary reservoirs, the date of attainment of summer pool levels relates to spawning success of sport fishes. When summer pool levels have been attained earlier in the year, spring flow (and dam discharge) has been higher. Reaching summer pool levels earlier allows important shoreline areas to be flooded, providing good spawning and important nursery habitat. Due to flood risk issues, early attainment of summer pool levels is not possible; therefore, use of the median first week at summer pool is not applicable. However, as noted in Section 4.7, it is also important that tributary reservoir water levels be stabilized as much as possible during the spawning period. These stabilizations would continue under each alternative, but the stabilization would be initiated at 60 °F instead of 65 °F.

In addition, early attainment of full pool increases recolonization of formerly dewatered habitat by aquatic insect communities (fish prey). Because there is a much smaller difference between summer and winter pool levels in mainstem reservoirs (Ploskey et al. 1984), the benefit to fishes in mainstem reservoirs is considerably less and has not been included in this analysis. Attaining summer pool levels earlier in tributary reservoirs, especially in conjunction with extending the drawdown dates, increases the duration of quality habitat for young fishes, hence increasing the growing season. Irwin et al. (1997) found that increased growth of young-of-year largemouth bass *(Micropterus salmoides)* led to increased winter survival of juveniles, which ultimately improved largemouth bass catch by anglers in later years. One concern of annual extended pool levels relates to existing available habitat. The existing available habitat would decrease with years of extended pool levels as exposed reservoir bottom areas would not be dewatered for sufficient time under adequate growing conditions to redevelop the desirable vegetative growth that provides the nutrient boost and good spawning and nursery habitat.

The final measure of reservoir hydrodynamics used as a metric for aquatic communities was winter pool elevations. Raising winter pool levels reduces the area dewatered annually to increase flood storage capacity in winter, thereby increasing the amount of area inundated year-round. This would benefit both fishes and macroinvertebrate communities in tributary reservoirs, but in mainstem reservoirs the effect would be minimal. During dry years, maintaining higher winter pool levels would also increase late winter and early spring discharges (February through March 15) because less inflow would be needed to fill reservoirs to summer pool levels. Increasing discharges during this period also would benefit tailwaters by resembling pre-dam conditions of higher late winter and early spring flows, which would benefit migratory spawning fish such as sauger *(Stizostedian canadense)*, white bass *(Morone chrysops)*, paddlefish *(Polyodon spathula)*, and most suckers.

Tailwater Metrics

To evaluate aquatic resources in tailwaters, the following environmental metrics were estimated using the TVA water quality model (Table 5.7-01):

- Mean flow (cubic feet per second [cfs]) in summer (May through October);
- Mean flow (cfs) during August and September combined;
- Mean DO (mg/L) in summer (May through October);
- Mean DO (mg/L) during August and September combined;
- Mean water temperature (ºC) in summer (May through October);
- Mean water temperature (ºC) during August and September combined; and,
- The mean daily maximum change of all metrics listed above.

For cold-water tailwaters:

- Hours of water temperature greater than 20 ºC from May to October.

For cool-water/warm-water tailwaters:

- Hours of water temperature less than 16 ºC from May to October.

For tailwaters, changes to water temperature, DO, and habitat were of primary interest for evaluating proposed operations. Flow is a controlling factor of river habitat. Because flow was more easily modeled than habitat condition, it was used as a surrogate to describe changes. For all metrics, both the mean level and the range of variation were important. Hydropower operations may cause large hourly fluctuations in all three metrics, which can disrupt important behaviors such as feeding or spawning activity and cause harmful stress on organisms.

Conditions of flow, water temperature, and DO concentrations are particularly important in flowing sections during spring, summer, and autumn. Spring and summer are important because this is when most reproduction of aquatic organisms occurs—especially spring. In early spring, some fishes migrate to spawning locations, with flow and temperature being important triggers. Appropriate flow levels during spring also help transport mussel larvae, maintain buoyant fish eggs in the water column, and keep fish nests free of suffocating fine sediments. Very low flows may limit available spawning habitat for species that require naturally clean-swept substrate for successful spawning, and very high flows may limit spawning—and even destroy eggs/larvae and nests of nest-building species. In late summer, a natural period of typically low flow, habitat and water quality become critical for aquatic organisms. Low flows limit habitat diversity, which limits the number of organisms (e.g., fishes and mussels). Low flows also result in higher water temperatures and lower DO concentrations. Therefore, higher mean flow is considered to increase available habitat. Generally, a decrease in daily flow fluctuations (less extreme variation) increases the health of aquatic communities, especially those that require stable or static conditions. The number of hours of no flow from March through May for mainstem dams was evaluated as a surrogate metric for spawning success of migratory sport and commercial fishes, such as walleye *(Stizostedion vitreum)*, sauger, paddlefish, and suckers in mainstem flowing areas.

Although late summer water quality is a critical issue, conflicts exist between requirements for cold-water and warm-water communities. Temperature changes that would benefit cold-water communities decrease potential of warm-water communities, and vice versa. Cold-water river communities primarily support trout fisheries and exhibit low biodiversity, while cool-water/warm-water rivers support more types of sport fish and show higher overall biodiversity. Cool-water communities respond to temperature changes in a mixed manner because the community contains some species that prefer colder water and others that prefer warmer water. Minor water temperature changes would simply shrink locations for one group and expand those of the other group (less cold-water habitat if water temperatures rise and less warm-water habitat if water temperatures decrease). Because cool-water communities are in the middle, the length of river classified as cool-water would not change unless temperature changes are substantial.

Basic changes in DO concentrations are evaluated in Section 5.4, Water Quality. More detailed metrics describing water quality changes specific to aquatic resources are listed in Table 5.7-01, and changes in their status under the policy alternatives are summarized in Tables 5.7-02 through 5.7-09**.** Dissolved oxygen in tributary and upper mainstem dam releases would be mitigated to Lake Improvement Plan targets through the RRI Program; therefore, no changes in minimum tailwater DO conditions were anticipated or addressed in these areas.

Representative Waterbodies

Representative waterbodies were selected to typify the affected environment and assess the policy alternatives for key issues. Waterbodies were selected based on several factors, including their importance to resource areas, potential for environmental change in the waterbody, available information, and location within the TVA system. Links among EIS components were integrated when possible.

Representative waterbodies were selected as follows:

Mainstem reservoirs	Kentucky, Guntersville, and Pickwick Reservoirs
Tributary reservoirs	Tims Ford, Douglas, Norris, Nottely, Hiwassee, South Holston, Watauga, Boone, and Melton Hill Reservoirs
Cool/cold tailwaters	South Fork Holston River (one location)
Cool-to-warm tailwaters	Elk River (one location), Holston River (one location)
Warm tailwaters	French Broad River (one location), Elk River (one location), Holston River (one location)

Water Quality Models

Metrics were estimated using one of two TVA models. The TVA Water Quality Model and the reservoir hydrodynamic, or Weekly Scheduling Model, are described in Appendix C. Metric values could not be calculated for the Summer Hydropower Alternative because drier years could not be successfully calibrated and run with the Water Quality Model. Water quality reservoir metrics for this section were evaluated using years classified according to annual rainfall amounts by TVA as normal (1990), dry (1993), and wet (1994). Metrics were averaged across these representative years. Reservoir hydrodynamic metrics were calculated as the statistic (e.g., mean) condition for a given week using a policy alternative simulated for years 1903 to 2001. For tailwaters, metrics for DO, water temperature, and flow were modeled on an hourly time step for the period from 1987 to 1994.

Change in each metric was evaluated against the Base Case. Metrics were classified by the percent of change and direction of change as follows:

- ↑** ↓** +/- greater or equal to 51 percent
- ↑* ↓* +/- 26.0-50.9 percent
- ↑ ↓ +/- 11.0-25.9 percent
- **o** +/- 0.0-10.9 percent
- ↑∞ ↓∞ Values for metrics were very small, causing artificially large change, or the baseline value was zero; arrows then indicate direction of change only.

Table 5.7-02 Comparison of Reservoir Dissolved Oxygen Metrics by Policy Alternative

Alternative	Reservoir	Mean Number of Days with Water Volume Having Dissolved Oxygen Less Than 1 mg/L	Peak Daily Volume of Non-Acceptable Habitat as Percent of Total Daily Volume
Reservoir Recreation A	Boone	↑∞	↑*
	Douglas	o	o
	Guntersville	↑	↑*
	Kentucky	↓*	↑**
	Pickwick	o	o
	South Holston	o	o
	Tims Ford	o	o
Reservoir Recreation B	Boone	↑∞	↑*
	Douglas	o	o
	Guntersville	↑**	↑*
	Kentucky	↓**	↑**
	Pickwick	o	o
	South Holston	o	o
	Tims Ford	o	o

Table 5.7-02 Comparison of Reservoir Dissolved Oxygen Metrics by Policy Alternative (continued)

Alternative	Reservoir	Mean Number of Days with Water Volume Having Dissolved Oxygen Less Than 1 mg/L	Peak Daily Volume of Non-Acceptable Habitat as Percent of Total Daily Volume
Equalized Summer/Winter Flood Risk	Boone	↑∞	o
	Douglas	o	o
	Guntersville	↑*	↑*
	Kentucky	↓**	↑**
	Pickwick	o	↑
	South Holston	↓	o
	Tims Ford	o	o
Commercial Navigation	Boone	↑∞	o
	Douglas	o	o
	Guntersville	o	o
	Kentucky	↓**	↑**
	Pickwick	o	o
	South Holston	o	o
	Tims Ford	o	o
Tailwater Recreation	Boone	↑∞	↑*
	Douglas	o	o
	Guntersville	↑*	↑*
	Kentucky	↓**	↑**
	Pickwick	o	o
	South Holston	o	o
	Tims Ford	o	o
Tailwater Habitat	Boone	↑∞	↑*
	Douglas	o	o
	Guntersville	↑**	o
	Kentucky	↓*	↑**
	Pickwick	o	↑
	South Holston	↑	o
	Tims Ford	o	o

Table 5.7-02 Comparison of Reservoir Dissolved Oxygen Metrics by Policy Alternative (continued)

Alternative	Reservoir	Mean Number of Days with Water Volume Having Dissolved Oxygen Less Than 1 mg/L	Peak Daily Volume of Non-Acceptable Habitat as Percent of Total Daily Volume
Preferred	Boone	↑∞	o
	Douglas	o	o
	Guntersville	↓*	o
	Kentucky	o	o
	Pickwick	↑	o
	South Holston	o	o
	Tims Ford	o	o

Note: See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-03 Comparison of Reservoir Hydrology Metrics

Alternative	Reservoir	Median Elevation for Week 2 (January)	Median First Week of Year at Summer Pool	Weeks at Summer Pool
Reservoir Recreation A	Douglas	↑∞	o	↑∞
	Guntersville	o	o	↑∞
	Kentucky	↑∞	o	↑∞
	Norris	↑∞	↓∞	↑∞
	Pickwick	↑∞	o	↑∞
	South Holston	↑∞	↓∞	o
	Tims Ford	↑∞	o	o
Reservoir Recreation B	Douglas	↑∞	o	↑∞
	Guntersville	o	o	↑∞
	Kentucky	↑∞	o	↑∞
	Norris	↑∞	↓∞	↑∞
	Pickwick	↑∞	o	↑∞
	South Holston	↑∞	↓∞	↑∞
	Tims Ford	↓∞	o	↑∞
Equalized Summer/Winter Flood Risk	Douglas	↑∞	↑∞	o
	Guntersville	o	o	↑∞
	Kentucky	↑∞	↑∞	↑∞
	Norris	↑∞	↑∞	↑∞
	Pickwick	↑∞	↑∞	↑∞
	South Holston	↑∞	↑∞	o
	Tims Ford	↓∞	↑∞	o
Commercial Navigation	Douglas	↑∞	o	o
	Guntersville	o	o	o
	Kentucky	↑∞	o	o
	Norris	↑∞	o	o
	Pickwick	↑∞	o	o
	South Holston	↑∞	o	o
	Tims Ford	↓∞	o	o
Tailwater Recreation	Douglas	↑∞	↑∞	↑∞
	Guntersville	o	o	↑∞
	Kentucky	↑∞	o	↑∞
	Norris	↑∞	↑∞	↑∞
	Pickwick	↑∞	o	↑∞
	South Holston	↑∞	↓∞	↑∞
	Tims Ford	o	o	o

Table 5.7-03 Comparison of Reservoir Hydrology Metrics (continued)

Alternative	Reservoir	Median Elevation for Week 2 (January)	Median First Week of Year at Summer Pool	Weeks at Summer Pool
Tailwater Habitat	Douglas	↑∞	↓∞	↑∞
	Guntersville	**o**	**o**	↑∞
	Kentucky	↑∞	**o**	↑∞
	Norris	↑∞	↓∞	↑∞
	Pickwick	↑∞	**o**	↑∞
	South Holston	↑∞	↑∞	↑∞
	Tims Ford	↑∞	**o**	**o**
Preferred	Douglas	↑**	**o**	↑∞
	Guntersville	**o**	**o**	↑**
	Kentucky	**o**	**o**	↓
	Norris	↑**	↑∞	↑**
	Pickwick	**o**	**o**	↑**
	South Holston	↑*	↓∞	↑∞
	Tims Ford	**o**	**o**	**o**

Note: See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-04 Comparison of Summer Tailwater Metric Values for Tailwaters by Policy Alternative

Alternative	River Segment (Upstream Reservoir)	Mean Flow in Summer (cfs)	Mean Daily Range of Flow in Summer (cfs)	Mean Dissolved Oxygen in Summer (mg/L)	Mean Daily Range of Dissolved Oxygen in Summer (mg/L)	Mean Summer Temperature (°C)	Mean Daily Range of Summer Temperature (°C)
Reservoir Recreation A	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	o	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓	↓	o	↓	o	o
	Holston River Mile 48 (Cherokee)	↓	↓	o	o	↓	o
	South Fork Holston River Mile 43 (South Holston)	↓	o	o	o	o	o
Reservoir Recreation B	Elk River Mile 125 (Tims Ford)	o	↓	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	↓	↓	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓	↓*	o	↓	↓	o
	Holston River Mile 48 (Cherokee)	↓	↓	o	↑	↓	o
	South Fork Holston River Mile 43 (South Holston)	↓	o	o	o	o	o
Equalized Summer/ Winter Flood Risk	Elk River Mile 125 (Tims Ford)	↓	↓**	o	o	↑	↓*
	Elk River Mile 73 (Tims Ford)	↓	↓*	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	↓	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓	↓*	o	↓	o	o
	Holston River Mile 48 (Cherokee)	↓	↓	o	↑	o	o
	South Fork Holston River Mile 43 (South Holston)	o	o	o	o	o	o
Commercial Navigation	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	o	o	o	o	o
	Holston River Mile 30 (Cherokee)	o	o	o	o	o	o
	Holston River Mile 48 (Cherokee)	o	o	o	o	o	o
	South Fork Holston River Mile 43 (South Holston)	o	o	o	o	o	o

Table 5.7-04 Comparison of Summer Tailwater Metric Values for Tailwaters by Policy Alternative (continued)

Alternative	River Segment (Upstream Reservoir)	Mean Flow in Summer (cfs)	Mean Daily Range of Flow in Summer (cfs)	Mean Dissolved Oxygen in Summer (mg/L)	Mean Daily Range of Dissolved Oxygen in Summer (mg/L)	Mean Summer Temperature (°C)	Mean Daily Range of Summer Temperature (°C)
Tailwater Recreation	Elk River Mile 125 (Tims Ford)	o	↓	o	o	↓	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	↓	o
	French Broad River Mile 18 (Douglas)	↓	↓	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓	↓	o	↓	o	o
	Holston River Mile 48 (Cherokee)	↓	↓	o	↑	o	o
	South Fork Holston River Mile 43 (South Holston)	↓	↓	o	o	o	o
Tailwater Habitat	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	↓	↓**	o	↓*	o	o
	Holston River Mile 30 (Cherokee)	↓*	↓**	↑	↓**	↓	↓
	Holston River Mile 48 (Cherokee)	↓*	↓**	o	↓*	↓	↓*
	South Fork Holston River Mile 43 (South Holston)	↓	o	o	o	o	o
Preferred	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	o	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓	↓	o	o	o	o
	Holston River Mile 48 (Cherokee)	↓	↓	o	o	o	o
	South Fork Holston River Mile 43 (South Holston)	o	o	o	o	o	o

Notes: Values could not be calculated for the Summer Hydropower Alternative because severely dry years dried portions of the system, crashing the water quality model. See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-05 Comparison of August–September Tailwater Metric Values by Policy Alternative

Alternative	River Segment (Upstream Reservoir)	Mean Flow for August and September (cfs)	Mean Daily Range of Flow in August and September (cfs)	Mean Dissolved Oxygen in August and September (mg/L)	Mean Daily Range of Dissolved Oxygen in August and September (mg/L)	Mean Temperature in August and September (°C)	Mean Daily Range of Temperature in August and September (°C)
Reservoir Recreation A	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	o	o	o	o	o
	Holston River Mile 30 (Cherokee)	o	o	o	↓	↓	↑
	Holston River Mile 48 (Cherokee)	o	o	↑	o	↓	o
	South Fork Holston River Mile 43 (South Holston)	↓*	o	o	o	o	↑
Reservoir Recreation B	Elk River Mile 125 (Tims Ford)	o	↓	o	o	o	↓
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	↓	↓	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓*	↓*	↑	↓	↓	↑
	Holston River Mile 48 (Cherokee)	↓*	↓*	↑	↑	↓*	o
	South Fork Holston River Mile 43 (South Holston)	↓*	↓	o	o	o	↑
Equalized Summer/ Winter Flood Risk	Elk River Mile 125 (Tims Ford)	↑	↓*	o	o	o	↓*
	Elk River Mile 73 (Tims Ford)	o	↓	o	o	o	o
	French Broad River Mile 18 (Douglas)	↓	↓	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓*	↓*	↑	↓*	↓	↑
	Holston River Mile 48 (Cherokee)	↓*	↓*	↑	↑	↓	↑
	South Fork Holston River Mile 43 (South Holston)	↓	o	o	o	o	↑
Commercial Navigation	Elk River Mile 125 (Tims Ford)	↑**	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	↑*	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	o	o	o	o	o
	Holston River Mile 30 (Cherokee)	o	o	o	o	o	o
	Holston River Mile 48 (Cherokee)	o	o	o	o	o	o
	South Fork Holston River Mile 43 (South Holston)	o	o	o	o	o	o

Table 5.7-05 Comparison of August–September Tailwater Metric Values by Policy Alternative (continued)

Alternative	River Segment (Upstream Reservoir)	Mean Flow for August and September (cfs)	Mean Daily Range of Flow in August and September (cfs)	Mean Dissolved Oxygen in August and September (mg/L)	Mean Daily Range of Dissolved Oxygen in August and September (mg/L)	Mean Temperature in August and September (°C)	Mean Daily Range of Temperature in August and September (°C)
Tailwater Recreation	Elk River Mile 125 (Tims Ford)	o	↓	o	o	o	↓
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	↓	↓*	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓*	↓*	↑	↓	↓	↑
	Holston River Mile 48 (Cherokee)	↓*	↓*	↑	↑	↓	o
	South Fork Holston River Mile 43 (South Holston)	↓*	↓	o	↓	o	o
Tailwater Habitat	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	↓*	↓**	↑	↓*	o	o
	Holston River Mile 30 (Cherokee)	↓**	↓**	↑*	↓**	↓*	o
	Holston River Mile 48 (Cherokee)	↓**	↓**	↑	↓	↓*	↓*
	South Fork Holston River Mile 43 (South Holston)	↓*	o	o	o	o	↑
Preferred	Elk River Mile 125 (Tims Ford)	o	o	o	o	o	o
	Elk River Mile 73 (Tims Ford)	o	o	o	o	o	o
	French Broad River Mile 18 (Douglas)	o	o	o	o	o	o
	Holston River Mile 30 (Cherokee)	↓	o	o	o	↓	o
	Holston River Mile 48 (Cherokee)	↓	o	o	o	↓	o
	South Fork Holston River Mile 43 (South Holston)	↓	o	o	↓	o	o

Notes: Values could not be calculated for the Summer Hydropower Alternative because severely dry years dried portions of the system, crashing the water quality model. See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-06 Comparison of Water Temperature Metric Values for Tailwaters by Policy Alternative

Alternative	River Segment (Upstream Reservoir)	Warm Tailwaters (Summer Hours of Water Temperature Less Than 16 ºC)	Cool-to Warm-Tailwaters (Summer Hours of Water Temperature Greater Than 20 ºC)	Cool/Cold Tailwaters (Summer Hours of Water Temperature Greater Than 20 ºC)
Reservoir Recreation A	Elk River Mile 125 (Tims Ford)		o	
	Elk River Mile 73 (Tims Ford)	o		
	French Broad River Mile 18 (Douglas)	o		
	Holston River Mile 30 (Cherokee)	↑		
	Holston River Mile 48 (Cherokee)		↓*	
	South Fork Holston River Mile 43 (South Holston)			↑*
Reservoir Recreation B	Elk River Mile 125 (Tims Ford)		↑	
	Elk River Mile 73 (Tims Ford)	↑		
	French Broad River Mile 18 (Douglas)	o		
	Holston River Mile 30 (Cherokee)	↑		
	Holston River Mile 48 (Cherokee)		↓*	
	South Fork Holston River Mile 43 (South Holston)			↑**
Equalized Summer/Winter Flood Risk	Elk River Mile 125 (Tims Ford)		↑**	
	Elk River Mile 73 (Tims Ford)	↑		
	French Broad River Mile 18 (Douglas)	↓**		
	Holston River Mile 30 (Cherokee)	↓		
	Holston River Mile 48 (Cherokee)		↓*	
	South Fork Holston River Mile 43 (South Holston)			↑**
Commercial Navigation	Elk River Mile 125 (Tims Ford)		o	
	Elk River Mile 73 (Tims Ford)	o		
	French Broad River Mile 18 (Douglas)	o		
	Holston River Mile 30 (Cherokee)	o		
	Holston River Mile 48 (Cherokee)		o	
	South Fork Holston River Mile 43 (South Holston)			↑**

Table 5.7-06 Comparison of Water Temperature Metric Values for Tailwaters by Policy Alternative (continued)

Alternative	River Segment (Upstream Reservoir)	Warm Tailwaters (Summer Hours of Water Temperature Less Than 16 ºC)	Cool-to Warm-Tailwaters (Summer Hours of Water Temperature Greater Than 20 ºC)	Cool/Cold Tailwaters (Summer Hours of Water Temperature Greater Than 20 ºC)
Tailwater Recreation	Elk River Mile 125 (Tims Ford)		↑	
	Elk River Mile 73 (Tims Ford)	↑		
	French Broad River Mile 18 (Douglas)	**o**		
	Holston River Mile 30 (Cherokee)	↑		
	Holston River Mile 48 (Cherokee)		↓*	
	South Fork Holston River Mile 43 (South Holston)			↓*
Tailwater Habitat	Elk River Mile 125 (Tims Ford)		**o**	
	Elk River Mile 73 (Tims Ford)	**o**		
	French Broad River Mile 18 (Douglas)	**o**		
	Holston River Mile 30 (Cherokee)	↑**		
	Holston River Mile 48 (Cherokee)		↓**	
	South Fork Holston River Mile 43 (South Holston)			↑*
Preferred	Elk River Mile 125 (Tims Ford)		**o**	
	Elk River Mile 73 (Tims Ford)	**o**		
	French Broad River Mile 18 (Douglas)	**o**		
	Holston River Mile 30 (Cherokee)	**o**		
	Holston River Mile 48 (Cherokee)		↓	
	South Fork Holston River Mile 43 (South Holston)			↓**

Notes: Values could not be calculated for the Summer Hydropower Alternative because severely dry years dried portions of the system, crashing the water quality model.

See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-07 Comparison of Cool-Water Habitat Reservoir Metrics by Policy Alternative

Alternative	Reservoir	Mean Percent Yearly Volume of Critical Cool-Water Habitat	Mean Percent of Yearly Volume of Preferable Cool-Water Habitat
Reservoir Recreation A	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	↑	o
	Nottely	o	o
	Tims Ford	o	o
Reservoir Recreation B	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	↑	o
	Nottely	o	o
	Tims Ford	o	o
Equalized Summer/Winter Flood Risk	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	↑	o
	Nottely	o	o
	Tims Ford	o	o
Commercial Navigation	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	↑	o
	Nottely	o	o
	Tims Ford	o	o

Table 5.7-07 Comparison of Cool-Water Habitat Reservoir Metrics by Policy Alternative (continued)

Alternative	Reservoir	Mean Percent Yearly Volume of Critical Cool-Water Habitat	Mean Percent of Yearly Volume of Preferable Cool-Water Habitat
Tailwater Recreation	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	↑	o
	Nottely	o	o
	Tims Ford	o	o
Tailwater Habitat	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	↑	↑
	Nottely	o	o
	Tims Ford	o	o
Preferred	Boone	o	o
	Douglas	o	o
	Hiwassee	o	o
	Melton Hill	o	o
	Norris	o	o
	Nottely	o	o
	Tims Ford	o	o

Note: See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-08 Comparison of Cold-Water Habitat Reservoir Metrics by Policy Alternative

Alternative	Reservoir	Mean Percent of Yearly Volume of Critical Cold-Water Habitat	Mean Percent of Yearly Volume of Preferable Cold-Water Habitat
Reservoir Recreation A	South Holston	o	o
	Watauga	o	o
Reservoir Recreation B	South Holston	o	o
	Watauga	o	o
Equalized Summer/Winter Flood Risk	South Holston	o	o
	Watauga	o	o
Commercial Navigation	South Holston	o	o
	Watauga	o	o
Tailwater Recreation	South Holston	o	o
	Watauga	o	o
Tailwater Habitat	South Holston	o	o
	Watauga	o	o
Preferred	South Holston	o	o
	Watauga	o	o

Note: See explanation on page 5.7-9 for metric symbols used in the table.

Table 5.7-09 Estimated Values for Flowing Mainstem Waterbodies

Alternative	Flowing Mainstem Reach (Upstream Reservoir)	Hours of No Discharge from March through May
Reservoir Recreation A	Fort Loudoun	o
	Guntersville	o
	Pickwick	o
Reservoir Recreation B	Fort Loudoun	↓
	Guntersville	↓
	Pickwick	o
Equalized Summer/Winter Flood Risk	Fort Loudoun	↓*
	Guntersville	o
	Pickwick	o
Commercial Navigation	Fort Loudoun	o
	Guntersville	o
	Pickwick	o
Tailwater Recreation	Fort Loudoun	↓
	Guntersville	↓
	Pickwick	o
Tailwater Habitat	Fort Loudoun	↓**
	Guntersville	↓**
	Pickwick	↓**
Preferred	Fort Loudoun	↓
	Guntersville	↓
	Pickwick	↓

Note: See explanation on page 5.7-9 for metric symbols used in the table.

5.7.3 Base Case

The status of aquatic resources under the Base Case is characterized for present operations and ongoing projects in the discussions below.

General Biodiversity

Reservoirs

In reservoirs, environmental conditions under the Base Case were generally more favorable for general biodiversity than under other policy alternatives—except the Commercial Navigation Alternative, which exhibited similar conditions to the Base Case. In tributary storage reservoirs, under the Base Case, the benthic aquatic insect and mussel communities would remain strongly affected by seasonal thermal stratification and resulting low DO concentration and large water level fluctuations. Aquatic insect communities would be low in diversity and comprised of only tolerant taxa. Reservoir Fish Assemblage Index values for tributary reservoirs were not projected to change more than the standard annual variation under the Base Case.

In mainstem reservoirs, aquatic insect communities would remain fair, and the status of mussels in flowing portions would remain poor for riverine mussel species and favorable for pool-adapted species. Reservoir Fish Assemblage Index values for mainstem reservoirs were not projected to change more than the standard annual variation under the Base Case.

Sport Fisheries

Reservoirs

Sport fishes in mainstem reservoirs would remain generally good under the Base Case. Recruitment would vary with reservoir hydrology as determined by climatic conditions; wet years produce more recruitment. Because mainstem pool levels have less fluctuation than tributary storage reservoirs, inter-annual changes in sport fish populations would vary less in mainstem reservoirs than in tributary reservoirs. Sport fish populations are also highly managed by state resource agencies, and Sport Fish Index scores could vary based on changes in management objectives.

Tailwaters

Variable recruitment for sport fishes in the flowing mainstem (e.g., sauger and white bass) would continue, largely related to flow during spring—with improved conditions during years with wet March-through-May periods. Achieving target DO concentrations in tailwater releases under the RRI Program would continue to benefit tributary tailwater fisheries. Late summer water quality (temperature) would continue to stress cold-water fisheries at some sites (e.g., below Hiwassee Dam) during dry years or warm summers.

Commercial Fisheries

Reservoirs

Commercial fisheries for fish and mussels occur primarily in mainstem reservoirs. Reservoirs benefit commercial fisheries by providing increased habitat for commercial fish species that are generally adapted to pool conditions. In dry years, with reduced flow through the mainstem, low DO may adversely affect mussel fisheries, but this impact would be determined more by climatic patterns than reservoir operations. Overall, commercial species should not vary more than changes currently experienced due to variation in climatic conditions.

5.7.4 Reservoir Recreation Alternative A

General Biodiversity

Reservoirs

In tributary reservoirs, results described in Section 5.4, Water Quality, indicated that Reservoir Recreation Alternative A would increase poor water quality in reservoirs. On the worst day for water quality, this alternative would increase the volume of water with poor quality for Boone Reservoir, with no changes in other tributary reservoirs (Table 5.7-02). Pool levels in winter would be raised, reducing the amount of bottom habitat dewatered during drawdown (Table 5.7-03), which would improve some benthic habitat conditions. In mainstem reservoirs, Reservoir Recreation Alternative A would increase the potential for reduced biodiversity because it would increase the volume of DO-depleted water and the potential amount of toxic substances in the water during summer. In tributary reservoirs, there was relatively no change relative to Base Case conditions in water quality metrics related to general biodiversity. Mainstem response would be slightly adverse.

Tailwaters

Summer flow decreased, except at sites below Tims Ford (Elk River) which did not change (Table 5.7-04). Conditions of summer DO and temperature would be similar to Base Case conditions. Mean August/September DO concentrations below Douglas (French Broad River), Cherokee (Holston River), and South Holston (South Fork Holston River) Dams increased, with no change observed at other sites (Table 5.7-05). Mean temperature during late summer dropped at both sites in the Holston River, with no change in temperature estimated for other rivers. Decreases in water temperature would slightly benefit cold-water sport fishes below Cherokee Dam (Table 5.7-06) but would be slightly adverse to downstream warm-water communities (potentially decreasing biodiversity). Therefore, the overall projected impact of Reservoir Recreation Alternative A on tailwater biodiversity is no change to slightly adverse.

Water temperature criteria for all years indicated similar trends. More cold water occurred in the Holston River, less in the South Fork Holston River, and no change at other sites. Again, cold-water sport fishes may benefit at some sites under this alternative, and conditions for warm-water species in cool-water rivers would be slightly adverse.

Sport Fisheries

Reservoirs

Under Reservoir Recreation Alternative A, conditions of water quality potentially influencing sport fisheries would not change from the Base Case in tributary reservoirs (Tables 5.7-07 and 5.7-08). On the other hand, if aquatic plants become more abundant in tributary reservoirs under this alternative (as projected in Section 5.9, Aquatic Plants), resident warm-water fish and aquatic insects would slightly benefit. Because there are more warm-water than cold- or cool-water fish in most tributary reservoirs, the overall influence of Reservoir Recreation Alternative A is no change to slightly beneficial.

Water quality conditions in mainstem reservoirs would decrease slightly over the Base Case as summer stratification would be extended for approximately 30 days. The increase in the number of weeks at summer pool levels would increase the volume of water with low DO during summer, possibly adversely influencing cool-water species such as white crappie *(Pomoxis annularis)*, sauger, and striped bass *(Morone saxatilis*) (Table 5.7-03). Growth and survival of warm-water fishes (e.g., bass [*Micropterus* sp.], catfish [*Ictalurus* sp.], and sunfish [mainly *Lepomis* sp.]) in mainstem reservoirs would benefit from longer pool levels because these species are tolerant of less suitable water quality. In mainstem reservoirs, the estimated response would be no change to slightly adverse.

Tailwaters

In the mainstem, there would be no change in discharge hours from mainstem dams (Table 5.7-09) from March through May. Water temperature criteria below most reservoirs indicate no change, except at the two sites in the Holston River below Cherokee (cool-to-warm and warm), where more cold-water would be present and the number of hours with water temperatures $\geq$20 ^{o}C below South Holston Dam would increase (Table 5.7-06). Cold-water fishes would slightly benefit from increased cold-water releases, but warm-water species would incur slightly adverse conditions. Cool/cold tailwaters are projected to incur slightly adverse impacts, no change was anticipated for other warm tailwaters, and cool-to-warm tailwaters would likely have variable responses.

Commercial Fisheries

All representative mainstem reservoirs—Pickwick, Guntersville, and Kentucky—were projected to be degraded by increased volume of water with poor quality. Kentucky Reservoir would see the most change. As a result, commercial fisheries, especially for freshwater mussels, would experience adverse habitat conditions under this alternative.

5.7.5 Reservoir Recreation Alternative B

General Biodiversity

Reservoirs

In tributary reservoirs, DO metrics showed more volume of water with low DO than under Reservoir Recreation Alternative A (Section 5.4, Water Quality). This would increase the potential for slightly adverse conditions in tributary reservoirs. For mainstem reservoirs, the number of days experiencing low DO varies by reservoir. Generally, the volume of water with DO concentrations less than 2 mg/L and 5 mg/L would increase, as well as the maximum volume of water with poor water quality on the most challenging day of the year. Biodiversity could be expected to decrease slightly under these conditions.

Tailwaters

Conditions for summer tailwater metrics showed relatively little change, except below Cherokee Dam (Holston River) (Table 5.7-04). In the Holston River, mean water temperature, flow, and range of flow exhibited slight decreases. During August and September, mean flow and range of flow decreased at all sites except those below Tims Ford (Elk River), which had no change (Table 5.7-05). Mean DO increased in the Holston River, with no change in DO or water temperature projected for other tailwaters assessed. Further, water quality metrics (see Section 5.4, Water Quality) indicated no change relative to the Base Case for DO in tailwaters due to Lake Improvement Plan targets. Therefore, due to projected decreases in water temperature in warm-water tailwaters and reductions in summer flow patterns, Reservoir Recreation Alternative B is projected to result in no change or a slightly adverse impact on biodiversity.

Sport Fisheries

Reservoirs

Reservoir Recreation Alternative B would increase the weeks at full pool level and increase winter pool levels but would not change the first week when full pool level was reached. These aspects would benefit aquatic insects and shoreline spawning sport fish, such as bass, crappie, and bluegill. More days at summer pool would increase the potential for establishment of aquatic vegetation. Release of only minimum flows from June 1 to Labor Day would increase the average volume of water with low DO and low water temperature in tributary reservoirs slightly more than projected under Reservoir Recreation Alternative A. This would have minimal impact on resident warm-water fish species due to their mobility and sufficient remaining volume of water with suitable water quality. Reductions in cool-water habitat (DO concentrations) would be more important for species such as white crappie, walleye, and white and striped bass. Overall, water quality conditions preferred by sport fishes showed minimal change under this alternative in tributary reservoirs. Reduced flow from tributary reservoirs would increase the volume of water with low DO in mainstem reservoirs, thus decreasing habitat availability.

A slightly beneficial change in sport fish populations of tributary reservoirs may be anticipated due to the longer period at summer pool. Due to decreased water quality, no change to slightly adverse change would be anticipated in mainstem reservoirs.

Tailwaters

Metric changes during August and September mostly indicated no change as discussed above for tailwater biodiversity. However, specific temperature metrics for tailwater sport fishes indicated that more temperatures above 20 ºC would be experienced below Tims Ford (cool-to-warm) and South Holston (cool/cold) Dams (Table 5.7-06). The apparent conflict of metric results was due to the difference in the time frame of evaluation. Average temperatures would be cooler in the Elk River below Tims Ford during August and September. In cool-to-warm tailwaters, cold-water species would slightly benefit; but warm-water species would experience a slight adverse impact. In the South Fork Holston River, cold-water species would experience a slightly adverse impact. Warm-water species would experience some decrease in water temperature quality in downstream areas but would benefit from more stable flows while summer pool levels were maintained. Stable flows would be more important than the temperature changes for warm-water species. The hours of zero discharge from mainstem reservoirs in early spring would also decrease under this alternative, slightly benefiting sport fish spawning there. No change to slight benefits would be the impact on warm-water tailwaters.

Commercial Fisheries

Because of increased volume of water with low DO under Reservoir Recreation Alternative B, commercial fisheries—especially freshwater mussels—would experience adverse habitat conditions under this alternative. The limited ability of mussels to move out of affected areas increases their potential for decline.

5.7.6 Summer Hydropower Alternative

The Summer Hydropower Alternative would maximize summer hydropower. Water quality output for this alternative was not completed because under this alternative the model would not run for severely dry years (1986, 1987, and 1988). Therefore, outcomes for this alternative were subjective and should be accepted with caution.

General Biodiversity

Reservoirs

In mainstem reservoirs, a slight benefit may be achieved because this alternative increased mainstem flow, which would decrease the amount of water with low DO occurring during summer. For mainstem reservoirs, the number of days during summer the projected daily water volume had less than 1 and/or 2 mg/L DO decreased more than 50 percent. Increased mainstem flow would increase water levels in flowing mainstem areas, maintaining more habitats for fish, and especially aquatic insects and mussels. In tributary reservoirs, the

Summer Hydropower Alternative would decrease stratification, improving water quality, but water level fluctuation would adversely affect available shoreline habitat. Some reservoirs may reach extremely low pool levels under this alternative in very dry years. Overall, biodiversity would be adversely affected in tributary reservoirs.

Tailwaters

The Summer Hydropower Alternative would potentially extend the number of days under minimum flow targets from the Lake Improvement Plan; and unrestricted drawdown would mean more peaking flows, decreasing the stability of daily water elevations and water quality in warm-water tailwaters. The Summer Hydropower Alternative would adversely affect the potential for biodiversity.

Sport Fisheries

Reservoirs

Water quality results (Section 5.4, Water Quality) indicate that the Summer Hydropower Alternative was projected to reduce the volume of water with low concentrations of DO in some tributary reservoirs and increase it in others. Variation in suitable habitat available for cool-water and cold-water sport fish would result in variable responses by these sport fish populations in different reservoirs. The extended period of dewatering of the drawdown zone during the growing season (summer/early fall), would allow plants such as buttonbush *(Cephalanthus occidentalis)*, willows *(Salix sp.)*, and cockleburs *(Xanthium spinosum)* to thrive in the drawdown zone. This vegetation growth would enhance the potential for development of suitable habitat for spawning, a good media for aquatic insect production, and provide protection for enhanced juvenile survival and growth for warm-water species. If this habitat is not flooded for a sufficiently long period following inundation (through August), however, benefits would be generally reduced. The increased flow from tributary dams would tend to decrease the volume of water with low DO in mainstem reservoirs, which should increase the potential for better cool-water sport fish populations. Therefore, the potential for improvement for mainstem sport fish populations would slightly increase.

Tailwaters

Below mainstem dams, this alternative would not alter discharges in spring relative to the Base Case, and no change is expected for migratory fishes spawning below mainstem dams. Water temperatures from tributary reservoirs would be higher due to less cold water in storage in the late summer. Consequently, cold-water tailwater sport fishes would be adversely affected from decreasing water quality (raised water temperatures), and warm-water species would slightly benefit.

Commercial Fisheries

Increased flow through the mainstem reservoirs would improve water quality and benefit commercial fisheries.

5.7.7 Equalized Summer/Winter Flood Risk Alternative

General Biodiversity

Reservoirs

In tributary reservoirs, relatively no change in water quality condition for sport fishes was predicted (Tables 5.7-08 and 5.7-09). Mainstem DO conditions would be slightly degraded (see Section 5.4, Water Quality, and Table 5.7-02). The volume of water with critically low DO (<1 mg/L) is projected to increase considerably in Guntersville Reservoir and yet decline considerably in Kentucky Reservoir. Percent of non-acceptable habitat is projected to increase in both reservoirs. General biodiversity is expected to decrease slightly in mainstem reservoirs, with no appreciable change anticipated for tributary reservoirs.

Tailwaters

Relatively no change in late summer water temperatures is anticipated, except at sites in the Holston River, where temperature would decrease slightly. Dissolved oxygen in the Holston River below Cherokee Dam would increase slightly (Table 5.7-05). Reductions in temperature would result in a slightly adverse effect on biodiversity in the Holston River, but no change was estimated for other rivers. August/September flow under this alternative would be reduced slightly below Douglas, South Holston, and Cherokee Dams, but the daily mean range of flows, which provides more stable habitat and water quality, would be reduced— offsetting the loss of habitat from lower flows. No change in biodiversity is anticipated under this policy alternative.

Sport Fisheries

Reservoirs

Under the Equalized Summer/Winter Flood Risk Alternative summer pool levels would be achieved later in the year (Table 5.7-03) and, for most reservoirs, it would lower median summer pool levels. These aspects would result in negative impacts on shoreline species spawning and nursery habitat. Winter pool levels would be raised, except at Tims Ford, which would be lowered. Summer pool levels would be maintained longer than under the Base Case. In tributary reservoirs—except at Norris, where the mean percent of yearly volume of critical cool-water habitat would increase—relatively no change in water quality conditions for sport fishes was predicted (Table 5.7-07). Changes in pool levels under this alternative would result in a slightly adverse effect on tributary reservoir sport fisheries relative to the Base Case. As noted in Section 5.4, Water Quality, mainstem DO conditions would be degraded. Fort Loudoun Reservoir would decrease the hours of no discharge during spring, but no change was estimated for Kentucky and Pickwick Reservoirs (Table 5.7-09). This alternative would result in slightly adverse conditions for sport fishes in mainstem reservoirs.

Tailwaters

Metrics for sport fish concerns of tailwaters showed a mixed pattern of change (Tables 5.7-04 and 5.7-05). Both the cool-to-warm and warm-water tailwater sites in the Holston River below Cherokee Dam would be colder (Table 5.7-06) and with more DO, which would benefit the trout fishery immediately below the dam. Impacts on warm-water species would be slightly adverse. Estimated conditions for both the cool-to-warm and warm-water tailwater sites in the Elk River (Tims Ford) and the South Holston River cool/cold site showed a decrease in flow during August and September. No changes in summer flow or water temperature were projected. Number of hours with water temperature greater than 20 °C substantially increased in the cool/cold tailwater site below South Holston River, indicating adverse conditions. Fewer hours of water temperatures less than 16 ºC are projected to occur below Douglas Dam (French Broad River), indicating improved conditions for warm-water fish species (Table 5.7-06). However, no change was projected in summer mean water temperatures or during the August/September period (Tables 5.7-04 and 5.7-05). Under this alternative, flow from mainstem reservoirs would not change from March through May (Table 5.7-09). The response of sport fishes in warm and cool-to-warm tailwaters would be variable, with slightly adverse conditions projected for cool/cold tailwaters.

Commercial Fisheries

Mainstem reservoirs would experience an increase in yearly volumes of water with poor DO concentrations. Conditions for mussels would decrease more than those for fishes because DO is depleted in benthic areas first and, because mussels are not mobile, they cannot escape. Impacts on commercial fisheries under the Equalized Summer/Winter Flood Risk Alternative are anticipated to be slightly adverse to adverse.

5.7.8 Commercial Navigation Alternative

Estimated conditions for the Commercial Navigation Alternative were similar to those under the Base Case. See the description of conditions for the Base Case for this alternative. The only anticipated difference is the potential for a slight benefit in biodiversity of mainstem reservoirs due to projections for substantially fewer days with DO <1 mg/L in Kentucky Reservoir. However, since the peak daily volume of non-acceptable habitat in this reservoir was projected to increase substantially, the overall projected impact on mainstem reservoirs is only slightly beneficial. This also may improve slightly the potential for sport fish in mainstem reservoirs. The slight increases in winter pool elevations (Table 5.7-03) in tributary reservoirs may also slightly aid sport fish populations in these systems.

5.7.9 Tailwater Recreation Alternative

Estimated conditions for the Tailwater Recreation Alternative were similar to those for Reservoir Recreation Alternative B (described in Section 5.7.5). For details on conditions under this alternative, see Reservoir Recreation Alternative B.

5.7.10 Tailwater Habitat Alternative

General Biodiversity

Reservoirs

Increasing volumes of water with low DO were estimated for some tributary and especially for mainstem reservoirs (Table 5.7-02). These conditions would reduce suitable habitat for cool-water and cold-water fish species, aquatic insects, and mussels. Consequently, this alternative is anticipated to incur slightly adverse effects on biodiversity in both tributary and mainstem reservoirs.

Tailwaters

The Tailwater Habitat Alternative lowered mean summer and August/September flows, substantially in the Holston River (Cherokee Dam), slightly in the French Broad River (Douglas Dam) and South Fork Holston River, and not at all in the Elk River (Tims Ford Dam) (Table 5.7-05). In fact, there was no change to conditions relative to the Base Case for Elk River sites for flow, DO, or water temperature. Mean water quality conditions for the French Broad and South Fork Holston Rivers also did not change. Temperature was slightly lowered in the Holston River (Tables 5.7-04 and 5.7-05). A drop in temperature in the Holston River (cool-water) would decrease the potential biodiversity at the most downstream site, but the site nearest the dam (Cherokee) already has low diversity due to cold-water releases. Reductions in the daily mean range of DO and temperature across rivers were relatively small. Results suggest no change to slightly adverse conditions for biodiversity under this alternative.

Sport Fisheries

Reservoirs

The Tailwater Habitat Alternative would not change the date of attainment of summer pool levels (Table 5.7-03). It would increase the weeks at full pool levels and would increase winter pool levels. These changes would improve conditions for sport fishes. However, tributary reservoirs would experience a substantial increase in low DO concentrations (see Section 5.4, Water Quality), and mainstem reservoirs would similarly experience decreases in water quality metrics. Tributary reservoirs would experience a slightly adverse impact under this alternative, and mainstem reservoirs would be adversely affected based on changes to DO concentrations (Section 5.4).

Tailwaters

Reductions of water temperature below Cherokee Dam (Holston River) would provide a slight benefit to the trout fishery in the cool-to-warm section of the tailwater close to the dam (Table 5.7-06); in downstream warm-water areas, however, impacts on resident species would be slightly adverse. No change was predicted to mean condition in either the cool-to-warm or warm sections of the Elk River (Tims Ford Dam) or the French Broad River (Douglas Dam—warm tailwater) (Table 5.7-06). In the cool/cold tailwater below South Holston River, summer hours of water temperature >20 ^{o}C (unsuitable for cold-water species) would increase (Table 5.7-06), but no change in mean summer or August/September metrics was indicated (Tables 5.7-04 and 5.7-05). A large portion of the decline occurred in summer months other than August and September (July and October) but not enough to affect the full summer (May to October). Mean flow in the South Fork Holston River was reduced slightly and could decrease habitat area. Under this alternative, hours of no discharge below mainstem reservoirs would be substantially reduced (Table 5.7-09), providing a substantial benefit to sport fishes spawning below mainstem reservoirs. However, poor mainstem reservoir water quality under the Tailwater Habitat Alternative may adversely affect the same sport fishes at later life stages. Overall, metrics under this alternative indicate an adverse response from cool/cold tailwater trout populations due to increased hours with water temperatures >20 ^{o}C. A variable environmental response for sport fishes is projected in warm (no change to slightly adverse for warm-water species) and cool-to-warm (cold-water species would benefit and warm-water species would be adversely affected) tailwater types.

Commercial Fisheries

Water quality indicators for mainstem reservoirs indicated adverse changes for the commercial fisheries. The amount of low DO present in the mainstem reservoirs would increase under this alternative.

5.7.11 Preferred Alternative

General Biodiversity

Reservoirs

For tributary reservoirs, results described in Section 5.4, Water Quality, indicate that the Preferred Alternative would marginally affect water quality. This alternative would slightly increase the volume of water with DO < 1 mg/L and the volume of unacceptable habitat (DO < 2 mg/L) for Boone Reservoir, with relatively no changes in other tributary reservoirs (Table 5.7-02). Raising pool levels in winter in most tributary reservoirs (no change at Tims Ford Dam) would reduce the amount of bottom habitat dewatered during drawdown (Table 5.7-03), which would improve some benthic habitat conditions. However, low DO in summer would still affect these areas in most tributary reservoirs and would continue to restrict benthic communities. Tributary reservoir biodiversity is not anticipated to change under the Preferred Alternative.

In mainstem reservoirs, the Preferred Alternative, relative to Base Case conditions, would result in mixed impacts on the potential to reduce biodiversity, with no change in the volume of DO-depleted water in Kentucky Reservoir, a decrease in Guntersville Reservoir, and a slight increase in Pickwick Reservoir. As discussed in Section 5.4, Water Quality, Guntersville Reservoir results could have been overly influenced by the unusually dry conditions of 1988. No changes are projected for the mean peak daily volume of unacceptable habitat. Winter pool levels would not change on any of these representative mainstem reservoirs. Mainstem reservoir biodiversity impacts would be variable, with conditions in some reservoirs improving and declining in others.

Tailwaters

Summer flow would decrease at both the cool-to-warm and warm tailwater sites below Cherokee Dam. No change in flow relative to the Base Case is projected at other sites (Table 5.7-04). Conditions of summer DO and temperature would be similar to Base Case conditions. Late summer (August-September) water temperatures at both Holston River sites declined (~4 °C), which is projected to result in a slight adverse impact on these sites (Table 5.7-05). Water temperatures in other tailwaters are not projected to change. Therefore, the overall impact of the Preferred Alternative on tailwater biodiversity would be no change to slightly adverse.

Sport Fisheries

Reservoirs

Under the Preferred Alternative, conditions of water quality potentially influencing sport fisheries would not change from the Base Case in tributary reservoirs (Tables 5.7-07 and 5.7-08). On the other hand, if aquatic plants become slightly more abundant in tributary reservoirs under this alternative (as projected in Section 5.9, Aquatic Plants), resident warm-water fish and aquatic insects would slightly benefit. However, projected negative impacts on scrub/shrub plants such as buttonbush (as stated in Section 5.8, Wetlands), due to increased length of time covered by water, would result in slightly adverse impacts. Increasing the length of time at full pool under this alternative would provide additional shallow-water habitat, in the form of flooded vegetation such as grasses, during the first couple of years. This vegetation would result in additional cover, which is beneficial for survival of young fishes; however, this habitat would actually decrease with years of extended pool levels—except during dry years. Exposed reservoir bottom areas would not be dewatered for sufficient time under adequate growing conditions to redevelop the desirable vegetative growth that provides the nutrient boost and good spawning and nursery habitat. Summer pools would be extended at Douglas, Norris, and South Holston Reservoirs under this alternative, but not at Tims Ford. The volume of water with suitable cool-water habitat during summer was projected to not change in any of the representative reservoirs (Table 5.7-07). Increases in winter pool elevations (Table 5.7-03) in tributary reservoirs, except for Tims Ford, would also slightly aid sport fish populations in these systems. Overall, influence of the Preferred Alternative on tributary reservoir sport fisheries is projected to be no change to slightly beneficial.

Water quality conditions in most mainstem reservoirs would decrease slightly over Base Case conditions, as summer stratification would be extended for approximately 10 days. The number of weeks at summer pool levels would increase in Pickwick and Guntersville Reservoirs but decline slightly at Kentucky Reservoir (Table 5.7-03). Projected impacts on growth and survival of warm-water fishes (e.g., bass [*Micropterus* sp.], catfish [*Ictalurus* sp.], and sunfish [mainly *Lepomis* sp.]) in mainstem reservoirs would be variable. The increased duration at full pool would result in minimal increases in submersed aquatic vegetation (as noted in Section 5.9, Aquatic Plants). This would result in a slightly positive influence on benthic invertebrate and most fish species. Projected negative impacts on plants such as buttonbush (as stated in Section 5.8, Wetlands), due to increased length of time covered by water, would be slightly adverse in mainstem reservoirs.

<u>Tailwaters</u>

For cool/cold tailwaters, the number of summer hours with water temperatures greater than 20 °C (too warm for cold-water species) was projected to substantially decline below South Holston (South Fork Holston River Mile 43), suggesting a benefit at this location (Table 5.7-06). However, neither mean summer water temperature nor flows were projected to change relative to the Base Case at this site (Table 5.7-04). Most of the decline would occur in summer months other than August and September (June and July) but not enough to affect the full summer (May to October). During August/September, flows would slightly decrease, but water temperatures would not change from the Base Case (Table 5.7-05). Therefore, conditions for sport fish in cool/cold tailwaters are expected to be slightly beneficial.

A slight decrease in hours with water temperatures greater than 20 °C projected at the cool- to warm-water site in the Holston River below Cherokee Dam (Holston River Mile 48), with no change anticipated for the Elk River site below Tims Ford Dam (Table 5.7-06). This change would enhance the habitat for cold-water species (trout) but would negatively affect cool- and warm-water species. Mean summer water temperatures were not projected to change relative to the Base Case at either site (Table 5.7-04). During August/September, flows and water temperatures would slightly decrease at the Holston River site, but no change for either metric is projected at the Elk River site (Table 5.7-05). Conditions for cool- to warm-water tailwaters are predicted to vary, depending on the species group (cold-water species would slightly benefit, and cool- and warm-water species would experience slightly adverse conditions).

For warm tailwaters, no change in the number of summer hours (May through October) with temperatures less than 16 °C was projected for the lower Holston River, lower Elk River, or the French Broad River sites under this alternative (Table 5.7-06). Mean summer water temperatures also indicate no changes at any of these sites (Table 5.7-04). However, August/September mean water temperatures would decline at the lower Holston River site, creating slightly adverse conditions for warm-water species during this period (Table 5.7-05). Summer and August/September flows below Douglas (French Broad River Mile 18) and Tims Ford (Elk River Mile 125) Dams would not change relative to the Base Case. Flows at the lower Holston River site would decrease slightly in both summer and August/September periods (Tables 5.7-04 and 5.7-05). Mainstem reservoirs would have slightly less potential for hours of no discharge during March and April but marginally higher potential during May (Table 5.7-09). Overall, conditions for mainstem tailwater fisheries are expected to be no change to slightly beneficial. Therefore, conditions for sport fishes in warm tailwaters would be variable.

Commercial Fisheries

Based on water quality modeling, Guntersville Reservoir is projected to have fewer days with low DO (<1 mg/L) and thus improved conditions; no change at Kentucky and Douglas Reservoirs; and slight increases at Pickwick Reservoir, resulting in slightly degraded conditions under the Preferred Alternative compared to Base Case conditions (Table 5.7-02). Conditions for commercial mussels are not projected to change (the main harvest occurs in Kentucky Reservoir), while those for commercial fish are projected to vary under the Preferred Alternative.

5.7.12 Summary of Impacts

Assessment of conditions for each area of aquatic resources is summarized in Table 5.7-10. The amount of flow through the TVA system represents a driving factor on the status of aquatic organisms. In wet years, more flow through the system generally reduces the impacts of reservoir operations on aquatic organisms. In dry years, the condition of the environment is more challenging because reduced flow through the system exacerbates any adverse change induced by reservoir operations. Assessments of aquatic resources were made using the mean response of selected surrogate metrics. The response of metrics across years showed a similar pattern for the policy alternatives as the Base Case, which implies that the status of most metrics would be relatively worse in dry years and better in wet years for aquatic resources, as compared to the results stated in sections above. In many cases, however, the variations among mean metric values among policy alternatives was less than the inter-annual variation of metric values under the Base Case.

The biodiversity of mainstem reservoirs would be adversely or slightly adversely affected under all alternatives, except the Summer Hydropower Alternative and the Commercial Navigation Alternative, which would have slight benefits based on modeled changes in water quality. The Preferred Alternative would have variable results, with some reservoirs slightly benefiting from lower levels of unsuitable habitat and others experiencing slightly adverse increases in low DO conditions. Tributary reservoirs would experience no change or a slightly adverse change in metrics representing biodiversity; generally, however, no change in condition is expected because biodiversity was already affected under present operating conditions (see Section 4.7). Biodiversity in warm-water tailwaters would generally be adversely or slightly adversely affected under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Summer Hydropower Alternative, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative. No change is anticipated under the Equalized Summer/Winter Flood Risk Alternative or the Commercial Navigation Alternative. Cold-water tailwater biodiversity would not change from present conditions under any alternative. Overall, policy alternatives would result in minimal impacts on biodiversity over existing conditions.

Table 5.7-10 Summary of Impacts on Aquatic Resources by Policy Alternative

Alternative	Description of Impacts
Biodiversity – Tributary Reservoirs	
Base Case	No change – Benthic aquatic insect and mussel communities would still be affected by seasonal thermal stratification, low DO, and large water level fluctuations.
Reservoir Recreation A	No change – Benthic aquatic insect and mussel communities would still be affected by seasonal thermal stratification, low DO, and large water level fluctuations.
Reservoir Recreation B	Slightly adverse – Increased volume of water with low DO would reduce suitable habitat for cool-water species.
Summer Hydropower	Adverse – Shoreline fluctuation would adversely affect shoreline habitat.
Equalized Summer/ Winter Flood Risk	No change – Benthic aquatic insect and mussel communities would still be affected by seasonal thermal stratification, low DO, and large water level fluctuations.
Commercial Navigation	No change – Benthic aquatic insect and mussel communities would still be affected by seasonal thermal stratification, low DO, and large water level fluctuations.
Tailwater Recreation	Slightly adverse – Increased volume of water with low DO would reduce suitable habitat for cool-water species.
Tailwater Habitat	Slightly adverse – Increasing volumes of water with low DO in some reservoirs would reduce suitable habitat for cool-water and cold-water fish species, aquatic insects, and mussels.
Preferred	No change – Benthic aquatic insect and mussel communities would still be affected by seasonal thermal stratification, low DO, and large water level fluctuations.
Biodiversity – Mainstem Reservoirs	
Base Case	No change – Aquatic insect communities would remain fair; status of mussels in flowing portions would remain poor for riverine species and favorable for pool-adapted species.
Reservoir Recreation A	Slightly adverse – Increased volume of water with low DO would reduce suitable habitat.
Reservoir Recreation B	Slightly adverse – Increased volume of water with low DO would reduce suitable habitat.
Summer Hydropower	Slightly beneficial – Increased flow would decrease the amount of water with low DO during summer.
Equalized Summer/ Winter Flood Risk	No change to slightly adverse – Increase in volume of water with low DO in Guntersville Reservoir, yet considerable decrease in Kentucky Reservoir, would increase percent of non-acceptable habitat.
Commercial Navigation	Slightly beneficial – Although fewer days with DO <1 mg/L in Kentucky Reservoir, the peak volume of non-acceptable habitat in Kentucky is projected to increase substantially.

Table 5.7-10 Summary of Impacts on Aquatic Resources by Policy Alternative (continued)

Alternative	Description of Impacts
Biodiversity – Mainstem Reservoirs (continued)	
Tailwater Recreation	Slightly adverse – Increased volume of water with low DO would reduce suitable habitat.
Tailwater Habitat	Slightly adverse – Increased volume of water with low DO would reduce suitable habitat.
Preferred	Slightly adverse to slightly beneficial – Changes in DO concentrations and flows would result in some reservoirs improving (Guntersville), some staying the same (Kentucky), and some declining (Pickwick).
Biodiversity – Warm Tailwaters[2]	
Base Case	No change – Biodiversity would continue to be limited due to the restraints of a regulated system.
Reservoir Recreation A	No change to slightly adverse – Lower flow, DO concentrations, and temperature would result in slightly adverse conditions for Cherokee tailwater and no change in others.
Reservoir Recreation B	No change to slightly adverse – Decrease in water temperatures and reduced summer flow would adversely affect biodiversity, no change in water quality.
Summer Hydropower	Adverse – Decrease in the stability of daily water elevations and water quality would adversely affect biodiversity.
Equalized Summer/ Winter Flood Risk	No change – Biodiversity would continue to be limited due to the restraints of a regulated system.
Commercial Navigation	No change – Biodiversity would continue to be limited due to the restraints of a regulated system.
Tailwater Recreation	No change to slightly adverse – Decrease in water temperatures and reduced summer flow; no change in water quality.
Tailwater Habitat	No change to slightly adverse – Decrease in mean flows in Holston and French Broad, with no change in the Elk; slightly lower water temperatures in Holston; no other changes in water quality.
Preferred	No change to slightly adverse – Decreased flows and water temperatures in Holston River would adversely affect biodiversity; no change in Elk or French Broad Rivers.
Sport Fish – Tributary Reservoirs	
Base Case	No change – Conditions would continue to be stressful for cool-water species and favorable for warm-water species.
Reservoir Recreation A[2]	No change to slightly beneficial – Water quality would be similar to Base Case, but warm-water fish and aquatic insects would slightly benefit if aquatic plants become more abundant.
Reservoir Recreation B[2]	Slightly beneficial – Longer duration of high summer pool level and higher winter pool level would slightly increase aquatic habitat.

Table 5.7-10 Summary of Impacts on Aquatic Resources by Policy Alternative (continued)

Alternative	Description of Impacts
Sport Fish – Tributary Reservoirs (continued)	
Summer Hydropower	Slightly adverse to slightly beneficial – Volume of water with low DO would be reduced in some reservoirs and increased in others.
Equalized Summer/ Winter Flood Risk	Slightly adverse – Full summer pool level would be lower and achieved later in the year.
Commercial Navigation	No change to slightly beneficial – Slight increases in winter pool elevations may slightly aid sport fish populations.
Tailwater Recreation[2]	Slightly beneficial – Longer duration of high summer pool level and higher winter pool level would slightly increase aquatic habitat.
Tailwater Habitat	Slightly adverse – Low DO concentrations would increase.
Preferred	No change to slightly beneficial – Longer duration of high summer pool level would slightly increase potential for establishment of aquatic vegetation, which would increase aquatic habitat, as would increased winter pool levels.
Sport Fish – Mainstem Reservoirs	
Base Case	No change – Communities would continue to vary based on environmental conditions.
Reservoir Recreation A	No change to slightly adverse – Slight increase in volume of water with low DO during summer could adversely affect cool-water fish species; conditions for warm-water fish species would not change.
Reservoir Recreation B	No change to slightly adverse – Slight increase in volume of water with low DO in Guntersville would decrease cool-water fish habitat availability; no change in Pickwick, and slight decrease in Kentucky.
Summer Hydropower	No change to slightly beneficial – Slightly decreased volume of water with low DO would slightly increase suitable habitat.
Equalized Summer/ Winter Flood Risk	Slightly adverse – Slightly increased volume of water with low DO would slightly decrease suitable habitat.
Commercial Navigation	No change to slightly beneficial – Slightly fewer days with DO <1 mg/L.
Tailwater Recreation	No change to slightly adverse – Slight increase in volume of water with low DO in Guntersville would decrease cool-water fish habitat availability; no change in Pickwick, and slight decrease in Kentucky.
Tailwater Habitat	Adverse – Lower DO would result in less available habitat.
Preferred	Slightly adverse – Slightly increased volume of water with low DO would slightly decrease suitable habitat.
Sport Fish – Warm Tailwaters	
Base Case	No change – Communities would continue to vary based on environmental conditions.
Reservoir Recreation A	No change – Communities would continue to vary based on environmental conditions.

Table 5.7-10 Summary of Impacts on Aquatic Resources by Policy Alternative (continued)

Alternative	Description of Impacts
Sport Fish – Warm Tailwaters (continued)	
Reservoir Recreation B	No change to slightly beneficial – Decrease in hours of zero discharge from mainstem reservoirs in early spring would slightly enhance spawning conditions for migratory spawners.
Summer Hydropower	Slightly beneficial – Temperatures higher in tributary tailwaters due to less cold water storage in late summer would result in slightly adverse impact on cold-water fish species and slight benefit to warm-water species.
Equalized Summer/ Winter Flood Risk	Slightly adverse to slightly beneficial – Flows and temperatures would vary among reservoirs, benefiting cold-water fish species and resulting in slightly adverse impact on warm-water species.
Commercial Navigation	No change – Communities would continue to vary based on environmental conditions.
Tailwater Recreation	No change to slightly beneficial – Decrease in hours of zero discharge from mainstem reservoirs in early spring would slightly enhance spawning conditions for migratory spawners.
Tailwater Habitat	Slightly adverse to slightly beneficial – Decrease in water temperature would benefit cold-water fish species and result in slightly adverse impact on warm-water species.
Preferred	Slightly adverse to slightly beneficial – Slight decreases in water temperatures and flows below Cherokee Dam would result in slightly adverse impact on warm-water habitat; reduced hours of zero discharge from mainstem reservoirs in early spring would slightly enhance spawning conditions for migratory spawners.
Sport Fish – Cool-to-Warm Tailwaters	
Base Case	No change – Improvements would continue due to Reservoir Release Improvement (RRI) initiatives; warm-water species would continue to be limited.
Reservoir Recreation A	Slightly adverse to slightly beneficial – Fewer hours with water temperatures exceeding 20 °C would benefit cold-water fish species but would adversely affect warm-water species.
Reservoir Recreation B	Slightly adverse to slightly beneficial – Fewer hours with water temperatures exceeding 20 °C would benefit cold-water fish species but would adversely affect warm-water species.
Summer Hydropower	Slightly beneficial – Temperatures higher in tributary tailwaters due to less cold water storage in late summer would result in slightly adverse impact on cold-water fish species and slight benefit to warm-water species.
Equalized Summer/ Winter Flood Risk	Slightly adverse to slightly beneficial – Fewer hours with water temperatures exceeding 20 °C would benefit cold-water fish species but would adversely affect warm-water species.
Commercial Navigation	No change – Improvements would continue due to RRI initiatives; warm-water species would continue to be limited.

Table 5.7-10 Summary of Impacts on Aquatic Resources by Policy Alternative (continued)

Alternative	Description of Impacts
Sport Fish – Cool-to-Warm Tailwaters (continued)	
Tailwater Recreation	Slightly adverse to slightly beneficial – Fewer hours with water temperatures exceeding 20 °C would benefit cold-water fish species but would adversely affect warm-water species.
Tailwater Habitat	Slightly adverse to slightly beneficial – Decrease in water temperature would benefit cold-water fish species and result in slightly adverse impact on warm-water species.
Preferred	Slightly adverse to slightly beneficial – Fewer hours with water temperatures exceeding 20 °C would benefit cold-water fish species but would adversely affect warm-water species.
Sport Fish – Cool/Cold Tailwaters	
Base Case	No change – Improvements would continue due to RRI initiatives.
Reservoir Recreation A	Slightly adverse – Slightly increased number of hours with water temperatures exceeding 20 °C would be slightly adverse for trout.
Reservoir Recreation B	Slightly adverse – Slightly increased number of hours with water temperatures exceeding 20 °C would be slightly adverse for trout.
Summer Hydropower	Adverse – Increased hours with temperatures greater than 20 °C would be undesirable for trout.
Equalized Summer/ Winter Flood Risk	Slightly adverse – Slightly increased number of hours with water temperatures exceeding 20 °C would be slightly adverse for trout.
Commercial Navigation	No change – Improvements would continue due to RRI initiatives.
Tailwater Recreation	Slightly adverse – Slightly increased number of hours with water temperatures exceeding 20 °C would be slightly adverse for trout.
Tailwater Habitat	Adverse – Increased hours with temperatures greater than 20 °C would be undesirable for trout.
Preferred	Slightly beneficial – Decrease in number of hours with water temperatures greater than 20 °C would be slightly beneficial for trout.
Commercial Fisheries – Reservoirs	
Base Case	No change – Communities would continue to vary based on environmental conditions.
Reservoir Recreation A	Adverse – Volume of water with poor water quality would increase due to delayed summer drawdown.
Reservoir Recreation B	Adverse – Volume of water with poor water quality would increase due to delayed summer drawdown.
Summer Hydropower	Beneficial – Increase of flow through mainstem reservoirs would increase the water quality.
Equalized Summer/ Winter Flood Risk	Slightly adverse to adverse – Yearly volumes of water with poor DO conditions would increase.

Table 5.7-10 Summary of Impacts on Aquatic Resources by Policy Alternative (continued)

Alternative	Description of Impacts
Commercial Fish – Reservoirs (continued)	
Commercial Navigation	No change – Communities would continue to vary based on environmental conditions.
Tailwater Recreation	Adverse – Volume of water with poor water quality would increase due to delayed summer drawdown.
Tailwater Habitat	Adverse – Volume of water with low DO would increase in mainstem reservoirs.
Preferred	Slightly adverse to slightly beneficial – Number of days with DO <1 mg/L would decrease in Guntersville, increase in Pickwick, and not change in Kentucky and Douglas Reservoirs.

1 Cold-water tailwaters are not included because resident communities are minimal due to the cold-water releases, and no alternative would change this general condition.

2 Slight increase in volume of water with low DO during summer/fall would result in slightly adverse conditions for reservoir cold-water and cool-water species.

For sport fish concerns, there was no expected change or slight improvement in tributary reservoirs under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Commercial Navigation Alternative, the Tailwater Recreation Alternative, and the Preferred Alternative. Under the Summer Hydropower Alternative, results for tributary reservoirs would be more variable, depending on species, and slightly adverse under the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative. Mainstem reservoirs would experience slightly adverse impacts on sport fish under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, and the Preferred Alternative. Slightly beneficial results are anticipated under the Summer Hydropower Alternative and the Commercial Navigation Alternative, and adverse impacts are projected under the Tailwater Habitat Alternative. Overall, response of sport fish in tributary and mainstem reservoirs differs, and results depend more on water temperature preference in tributary reservoirs and DO requirements in mainstem reservoirs. Variable results were achieved when metrics indicated change, but changes were not consistent across all reservoir waterbodies assessed.

Metrics for warm-water tailwaters indicated that no change in status is anticipated under Reservoir Recreation Alternative A and the Commercial Navigation Alternative. No change to slightly beneficial results may occur under Reservoir Recreation Alternative B and the Tailwater Recreation Alternative, with variable results under the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative. The Summer Hydropower Alternative would adversely affect warm-water sport fish. Cool/cold tailwaters would experience no change or slight benefits under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Commercial Navigation Alternative, the Tailwater Recreation Alternative, and the Preferred Alternative from decreasing water temperatures in cool-water waterbodies during late summer. Impacts under the Tailwater Habitat Alternative would be variable, as metric responses were mixed across waterbodies. Under the Summer Hydropower and Tailwater Habitat Alternatives, impacts on cold-water tailwaters would be adverse, and slightly adverse under the Equalized Summer/Winter Flood Risk Alternative. In cool-to-warm tailwaters, the Commercial Navigation Alternative is projected to result in no change in sport fisheries, while Reservoir Recreation Alternative B, the Summer Hydropower Alternative, and the Tailwater Recreation Alternative would result in no change to a slightly beneficial change in status. Reservoir Recreation Alternative A, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative would cause variable results as cold-water species (trout) slightly benefit from cooler water temperatures in the late summer that would cause slightly adverse conditions for warm-water species.

Commercial fisheries would experience no change under the Commercial Navigation Alternative. Adverse or slightly adverse conditions may be achieved under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative from water quality changes in mainstem reservoirs, particularly Kentucky Reservoir. Under the Summer Hydropower Alternative, commercial fisheries would benefit from increased mainstem flow and improved summer water quality. Under the Preferred Alternative, conditions for commercial mussels are not projected to change, while those for commercial fish are projected to vary. Some areas are projected to experience slight improvements to water quality (DO concentrations), and others slight declines.

In conclusion, no policy alternative represents a clear benefit to aquatic resources. Metrics indicated that the Commercial Navigation Alternative would cause little change from the Base Case, with possibly some benefits. Biodiversity would generally not benefit under any alternative. Sport fish would experience the most potential benefits under Reservoir Recreation Alternative B and the Tailwater Recreation Alternative. The Preferred Alternative projects some benefits to tributary reservoir and cool/cold tailwater sport fish. Variable results are anticipated for mainstem reservoir biodiversity, warm and cool-to-warm tailwaters, and commercial fishing. Commercial fisheries would generally experience adverse impacts under most alternatives due to decreased water quality (DO concentrations) and spring flows in mainstem reservoirs. Generally, impacts on commercial fisheries would be concentrated on mussels, as commercial fish species are mobile while mussels cannot behaviorally escape decreasing water quality conditions. Under the Preferred Alternative, no change is projected for commercial mussels. Commercial fish species in some areas would slightly benefit; in other areas, habitat conditions (DO concentrations) would decline slightly.

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5.8 Wetlands

5.8.1 Introduction

This section evaluates impacts on wetland locations, types, and functions for the Base Case and the policy alternatives. Because the individual alternatives would not affect all reservoirs in the same way, each policy alternative would not affect all wetlands associated with the reservoir system. Over time, changes in the timing and duration of surface water and soil saturation could change the locations, types, and functions—and as a result, the extents and distributions—of wetlands and the social, environmental, and economic values they provide.

Changes in wetland extent, distribution, and habitat connectivity would occur as conditions become wetter or drier. These changes include both short-term changes (changes that may occur within a decade or two) and long-term changes (changes that may continue over many decades or even centuries). Where increasing duration of water is an effect, there may be no place for wetlands to shift or expand into due to shoreline development or topography. In these areas, certain types of wetlands may be lost permanently.

Wetland vegetation types are generally adapted to particular water regimes; either too much or too little water can adversely affect all types of wetland vegetation. For example, flats and aquatic beds would be affected by changes in the timing and duration of exposure to water. Increased periods of exposure may reduce the extent of aquatic bed vegetation. Decreased periods of exposure may reduce the period of time available for the annual plant species that colonize flats (non-persistent emergents) to complete their lifecycles and set seed for subsequent generations.

The woody vegetation of forested and scrub/shrub wetlands is particularly sensitive to increased duration of water, which may result in loss of existing shrubs and trees, or slow attrition when seeds are prevented from germinating and establishing within the community to replace older individuals that have died. Some of these woody wetland vegetation types (particularly buttonbush scrub/shrub wetlands) may not be able to shift into new locations because current management regimes and climatic conditions are no longer favorable for their establishment. On the other hand, reduction in the level and duration of water may allow wetland vegetation to be invaded by upland or non-native species, changing vegetation composition and function.

The effects on water regimes were considered separately from the effects on wetland vegetation types, because the effects in many cases are different. Increased availability of water was assumed to enhance all wetland water regimes, and decreasing availability of water was assumed to diminish all wetland water regimes.

5.8.2 Impact Assessment Methods

Potentially affected wetlands were identified based on their occurrence within a projected groundwater area of influence. The groundwater area of influence was projected based on geologic modeling of the distance at which reservoir water levels cease to affect groundwater levels in each physiographic region in the study area (see Section 5.6 [Groundwater Resources] and Appendices D2 and D4a). In karst areas (limestone geology), this groundwater area of influence may fail to include a small number (statistically insignificant) of wetlands associated with affected springs and seeps that occur at a great distance from the reservoirs and tailwaters.

In general, the policy alternatives would affect mainstem and tributary systems differently. Different types of wetlands would be affected differently under each policy alternative, and these different types of wetlands are not distributed evenly among the individual reservoirs and tailwaters. For the purpose of comparison, reservoirs and tailwaters were assessed individually; and changes in mainstem reservoirs, tributary reservoirs, mainstem tailwaters, and tributary tailwaters, were compared separately.

Existing research and data did not permit quantification of potential changes in wetland extents (size and location) that might occur during the study period. Therefore, levels of impact were assessed according to the number of existing acres of wetlands that would be enhanced in function versus the number of acres that would be diminished in function. This method of assessment measures changes that would occur in the immediate future (in 1 to 5 years). The effects of the alternatives were compared by using the acreages of the affected types of wetlands weighted with a measure of the magnitude of the change caused by each alternative, and with the direction of the change (positive, zero, or negative impact) based on the alternative and the type of wetland.

For each alternative, mean changes in summer pool levels (duration and maximum elevation) and winter pool (maximum elevation) levels were compared with conditions under the Base Case to determine the magnitude of change each alternative would cause on water availability in wetlands. Changes in mainstem and tributary reservoirs were assessed separately. This magnitude of change was used to assess the degree to which proposed changes might affect wetland types and wetland functions. Changes in filling dates to reach summer pool were also evaluated. The Base Case was assigned a magnitude of zero for comparison.

For tailwaters, data generated by the water quality model was used to determine the magnitude of change each alternative would cause on water availability in wetlands. Relevant data from this analysis included minimum surface water elevations that are expected to occur during 90 percent of the year in tailwaters below dams. Mainstem and tributary tailwaters were evaluated separately because this modeling indicated that proposed changes in tailwaters would vary considerably between these two groups.

5.8.3 Base Case

Under the Base Case, wetlands would continue to follow existing trends. Overall, there would be minor but steady changes in wetland extents and distributions, shifts in wetland types, and a slow decline in wetland functions.

Wetland Location. Minor but steady declines in the extents and distributions of wetlands would continue, as discussed in Section 4.8. This decline in wetland extents and distributions also would result in a decrease in habitat connectivity.

Wetland Type. Wetland vegetation types are expected to follow existing trends. In general, acreage of scrub/shrub wetlands would increase, and the habitat quality and acreage of persistent emergent and forested wetlands would decline. National trend data for aquatic beds and flats are not available; however, TVA data show cyclical fluctuations in aquatic beds (see Section 4.9, Aquatic Plants) with large increases in coverage since the early 1960s following the introduction and establishment of Eurasian watermilfoil and more recently other invasive species such as hydrilla.

All wetland water regimes, shoreline wetlands, and surface-isolated wetlands are expected to follow existing trends. More than 22,000 acres of wetlands with controlled water levels on several reservoirs are expected to follow existing trends influenced by routine reservoir fluctuations (Table 4.8-02).

Wetland Function. Loss or degradation of wetland extents, distributions, and types would result in a general decline in all wetland functions. This would adversely affect wetland functions related to water quality, floodwater and stormwater storage, shoreline/bank stabilization and erosion control, carbon storage, wetland-upland community interspersion, and public use.

5.8.4 Reservoir Recreation Alternative A and Tailwater Habitat Alternative

Reservoir Recreation Alternative A would generally increase the availability of water by 4 to 7 weeks during the growing season, relative to the Base Case. This could cause slight shifts in the extents and distributions of wetlands and wetland types. The changes in the timing of the presence of water would adversely affect flats, scrub/shrub, and some forested wetlands. There would be a slight decrease in wetland functions. The Tailwater Habitat Alternative would result in some effects similar to those described for Reservoir Recreation Alternative A, especially on mainstem reservoirs. However, changes in water availability and wetland types would be more pronounced on tributaries under the Tailwater Habitat Alternative, where the duration of summer pool levels on affected reservoirs would increase up to 24 weeks longer than conditions under the Base Case and up to 16 weeks longer than under Reservoir Recreation Alternative A (see Appendix D4b for additional details).

Wetland Location. Over time, changes in the timing and duration of surface water and soil saturation under Reservoir Recreation Alternative A and the Tailwater Habitat Alternative would lead to slight increases in the extents and distributions of wetlands. Similar increases in wetland habitat connectivity would occur.

Wetland Type. Under Reservoir Recreation Alternative A, the extended duration of summer pool levels would positively affect aquatic bed and emergent wetlands, because more water would be available during the growing season to wetlands on affected mainstem and tributary reservoirs and tailwaters. Aquatic beds may experience some decline in deeper water zones, but this loss may be offset by expansion of submersed aquatic plants into the drawdown zone. The additional time that water is present in the wetland during the growing season would negatively affect flats, scrub/shrub, and some forested wetlands. Some already stressed forested wetlands would be stressed beyond existing conditions. Overall, Reservoir Recreation Alternative A would result in a negative effect on wetland vegetation types. The types of impacts resulting from the Tailwater Habitat Alternative would generally be the same as those for Reservoir Recreation Alternative A, but the magnitude of adverse impacts would be greater compared to those under Reservoir Recreation Alternative A.

The extended duration of summer pool levels on affected mainstem and tributary reservoirs and tailwaters would increase availability of water in all wetland water regimes, shoreline wetlands, and surface-isolated wetlands in the groundwater influence zone.

The increase in winter pool elevations could interfere with controlled wetlands on Wheeler and Douglas Reservoirs. Increases in winter pool elevations could interfere with dewatering efforts in managed wetlands on affected reservoirs. Late-season flooding on these reservoirs could also jeopardize crops planted for wildlife. Adverse impacts could increase costs to invested agencies, including maintenance and replacement costs of associated infrastructure (such as access roads, signage, levees, pumps, and monitoring equipment) (see Section 4.8.3 for more details).

Wetland Function. Systemwide, Reservoir Recreation Alternative A and the Tailwater Habitat Alternative would result in a net moderate decrease in wetland functions related to floodwater and stormwater storage and water quality because of changes in wetland extents, distributions, and types. A moderate increase in wetland functions related to shoreline/bank stabilization and erosion control, carbon storage, wetland-upland community interspersion, and all other general functions provided by all wetland types may result from changes in wetland extents, distributions, and types.

5.8.5 Reservoir Recreation Alternative B and Tailwater Recreation Alternative

Reservoir Recreation Alternative B and the Tailwater Recreation Alternative would cause a major increase in the availability of water from 9 to 11 weeks during the growing season; this could cause moderate shifts in the extents and distributions of wetlands and wetland types (Appendix D4b). The changes in the timing of the presence of water would adversely affect flats, scrub/shrub, and forested wetlands. Changes would occur faster than wetland plant communities could adapt. There would be an overall decrease in wetland functions.

Wetland Location. Over time, changes in the timing and duration of surface water and soil saturation could lead to minor increases in the extents and distributions of wetlands. Similar increases in habitat connectivity would occur.

Wetland Type. Under Reservoir Recreation Alternative B and the Tailwater Recreation Alternative, the extended duration of summer pool levels would positively affect aquatic bed and emergent wetlands because more water would be available during the growing season to wetlands on affected mainstem and tributary reservoirs and tailwaters. The additional time that water is present in the wetland during the growing season would negatively affect flats, scrub/shrub, and forested wetlands. Many affected scrub/shrub and forested wetlands would die back faster than they would expand into new suitable habitat. In areas where expansion could occur, scrub/shrub communities might develop within 5 to 10 years; forests would require a period of decades to reach maturity. Overall, Reservoir Recreation Alternative B and the Tailwater Recreation Alternative would negatively affect wetland vegetation types.

The extended duration of summer pool levels on affected mainstem and tributary reservoirs and tailwaters would increase availability of water in all wetland water regimes, shoreline wetlands, and surface-isolated wetlands in the groundwater influence zone.

The increase in winter pool elevations could interfere with those wetlands with controlled water levels on Kentucky, Wheeler, and Douglas Reservoirs.

Wetland Function. Systemwide, Reservoir Recreation Alternative B and the Tailwater Recreation Alternative would result in a net moderate decrease in wetland functions related to floodwater and stormwater storage and water quality due to changes in wetland extents, distributions, and types. A moderate increase in wetland functions related to shoreline/bank stabilization and erosion control, carbon storage, wetland-upland community interspersion, and all other general functions provided by all wetland types may result from changes in wetland extents, distributions, and types.

5.8.6 Summer Hydropower Alternative

The Summer Hydropower Alternative would decrease the mean summer pool duration on reservoirs for about 10 weeks (range -4 to -25 weeks), thus reducing the availability of water in wetlands during the growing season (Appendix D4b). This would result in major shifts or losses in wetland extents and distributions, degradation of most vegetated wetlands, and major loss of wetland functions. Changes would occur faster than wetland plant communities could adapt. Overall, the Summer Hydropower Alternative would result in the most adverse effects on wetlands of all of the alternatives.

Wetland Location. Over time, changes in the timing and duration of surface water and soil saturation would lead to substantial decreases in the extents and distributions of wetlands. Similar decreases in habitat connectivity also would occur.

Wetland Type. The reduction in summer pool levels would adversely affect aquatic beds and persistent emergent, scrub/shrub, and forested wetlands of all affected reservoirs and tailwaters. Overall, the Summer Hydropower Alternative would adversely affect wetland vegetation types.

The reduction in water availability during spring and summer would potentially positively affect flats because they would be exposed earlier in the year. However, too much exposure of flats could dry them out so that insufficient moisture remains for germination of seeds of nonpersistent emergent plants. On mainstem and tributary reservoirs, the decreased water availability would negatively affect aquatic bed, emergent, and forested wetlands, because there would not be enough water during the growing season to support these wetland plants. Potential effects on scrub/shrub wetlands could be either positive or negative depending on drawdown rates and summer pool management in reservoirs. If drawdown rates proceed slowly, these vegetation types may expand into the drawdown zone. If drawdown rates increase too quickly or erratically, these important wetlands could lose their most important source of water and dry up before they could migrate into other suitable habitat.

The earlier drawdown and shorter summer pool duration on affected mainstem and tributary reservoirs would decrease availability of water in all wetland water regimes, shoreline wetlands, and surface-isolated wetlands in the groundwater influence zone. The increase in winter pool elevations could interfere with wetlands with controlled water levels on Douglas Reservoir.

Wetland Function. Systemwide, the Summer Hydropower Alternative would result in a substantial increase in summer floodwater and stormwater storage function of wetlands, because less water would be stored in affected reservoirs during summer months. A major decrease in wetland functions related to water quality, shoreline/bank stabilization and erosion control, carbon storage, wetland-upland community interspersion, and other general functions provided by all wetland types may result from changes in wetland extents, distributions, and types.

5.8.7 Equalized Summer/Winter Flood Risk Alternative

The Equalized Summer/Winter Flood Risk Alternative would change the mean summer pool duration by -11 to +8 weeks on affected reservoirs compared to the Base Case. On mainstem reservoirs, summer filling dates would be delayed from 4 to 7 weeks. On tributary reservoirs, summer pool elevations would change from -21 to +3 feet relative to the Base Case (Appendix D4b). These changes in water availability would greatly alter the timing and availability of water during the growing season for most wetlands. This would result in damage to scrub/shrub and forested wetlands, particularly on tributary reservoirs where these wetland types are already limited in abundance and extent. Changes would occur faster than wetland plant communities could adapt.

Wetland Location. Over time, changes in the timing and duration of surface water and soil saturation would lead to major decreases in the extents and distributions of wetlands. Similar decreases in habitat connectivity would occur.

Wetland Type. By delaying summer pool filling dates on both mainstem and tributary reservoirs and having lower summer pool elevations on tributary reservoirs, aquatic beds, scrub/shrub, and forested wetlands on all affected reservoirs and tailwaters would be adversely affected.

The impact analysis methodology shows potential enhancement to flats in mainstem reservoirs and tailwaters and tributary reservoirs under the Equalized Summer/Winter Flood Risk Alternative. In general, lower summer water levels, especially on tributary reservoirs, would expose flats more during the year; but there is valid concern that too much summer drying would deplete the soil moisture necessary for seed germination and growth of non-persistent emergent plants. Higher winter pool elevations would drown out plants that were able to begin establishing themselves on exposed flats. The increased exposure of flats might also increase the opportunity for upland or invasive plants to colonize exposed flats. Because of these factors, the overall effect for flats would be adverse, and the overall effect for aquatic beds would be variable on tributary reservoirs under the Equalized Summer/Winter Flood Risk Alternative.

Impacts on scrub/shrub and forested wetlands would be especially harmful on tributary reservoirs where these vegetation types are somewhat uncommon. The decrease in summer pool elevations on tributary reservoirs would isolate these wetlands from their most important source of water, resulting in a net loss of these wetlands on affected reservoirs. Changes in water regimes would occur faster than these wetland types could adapt to new conditions.

The reduction in water availability during spring and early summer would negatively affect aquatic bed, flats, emergent, scrub/shrub, and forested wetlands because there would not be enough water during the growing season to support these wetland plants. Overall, effects of the Equalized Summer/Winter Flood Risk Alternative would result in negative system-wide impacts on wetland vegetation types.

On affected mainstem and tributary reservoirs and tailwaters, the reduced availability of water in all wetland water regimes would adversely affect shoreline wetlands and surface-isolated wetlands in the groundwater influence zone. The increase in winter pool elevations on Wheeler and Douglas Reservoirs could interfere with wetlands having controlled water levels on these reservoirs.

Wetland Function. Loss or degradation of wetland extents, distributions, and types would result in a major decrease in all wetland functions. This would adversely affect wetland functions related to water quality, floodwater and stormwater storage, shoreline/bank stabilization and erosion control, carbon storage, wetland-upland community interspersion, and public use.

5.8.8 Commercial Navigation Alternative

The Commercial Navigation Alternative would increase winter pool levels up to 2 feet over Base Case conditions on seven mainstem reservoirs (Appendix D4b). This increase would cause minor changes in water availability. Effects on wetland extents, distributions, types, and functions would be minor. The increase in winter pool levels on affected reservoirs would primarily reduce exposure of flats during winter months. Higher winter pools would also have slightly adverse effects on scrub/shrub and forested wetland types. The Commercial Navigation Alternative would not affect flood and stormwater storage, carbon storage, wetland-upland community interspersion, and all other general wetland functions

5.8.9 Preferred Alternative

The Preferred Alternative would extend the duration of summer pool on most reservoirs and delay spring fill dates on three mainstem reservoirs (Chickamauga, Watts Bar, and Fort Loudoun). The Preferred Alternative would generally increase the availability of water by 4 to 9 weeks during the growing season on affected reservoirs. This could cause slight shifts in the extents and distributions of wetlands and wetland types. Changes in the timing of the presence of water would adversely affect vegetated flats, scrub/shrub, and certain forested wetlands. There would be a slight decrease in wetland functions. The Preferred Alternative would result in effects that are similar to but less than those described for Reservoir Recreation Alternative A and the Tailwater Habitat Alternative (see Appendix D4b for additional details).

Wetland Location. Over time, changes in the timing and duration of surface water and soil saturation under the Preferred Alternative could lead to slight increases in the extents and distributions of wetlands. There could be some opportunities for new wetlands to develop as a result of the extension of summer pools. These opportunities for increases would be limited, because the capillary fringe would not extend much beyond its current extent. Other limiting factors for new wetland formation are the availability of suitable soils, topography, and suitable landforms. Any increase in extent of wetlands could lead to similar increases in wetland habitat connectivity.

Wetland Type. The additional time that water is present in wetlands during the growing season would adversely affect flats, scrub/shrub, and many forested wetlands and would positively affect aquatic bed and persistent emergent wetlands. Many flats, especially those supporting nonpersistent emergent wetlands, would be limited in their exposure and development. Many nonpersistent emergent communities could revert to unvegetated flats, because they could not complete their growth cycles and produce viable seed. Eventually these nonpersistent wetland communities could die off and be replaced by upland species or exotic, invasive pest plants.

Scrub/shrub and forested wetlands that are currently under extreme environmental stress (e.g., buttonbush swamps) would not respond well to prolonged flooding. Many scrub/shrub communities could die off and be replaced by aquatic beds in the drawdown zone and emergent communities in drier habitat.

Increased availability of water during the growing season could stress trees in temporarily and seasonally flooded or saturated forested wetlands to the point that they begin to die. Dominated tree species in these wetland types are not adapted to prolonged flooding or soil saturation. Many temporarily and seasonally flooded or saturated forested wetlands could convert to scrub/shrub and emergent communities in the ROS planning period to year 2030. Eventually, more water-tolerant tree species may colonize these wetter sites, but new forested wetlands would require many decades to develop and mature.

Changes in aquatic beds would likely be positive because of longer summer pools, but the health and vigor of aquatic beds depend on many environmental factors in addition to water levels (see Section 5.9, Aquatic Plants). Persistent emergent wetlands would likely adapt well to the extension of summer pool conditions due to their ability to withstand prolonged flooding and/or soil saturation and adaptations that allow them to reproduce vegetatively as well as by seed dispersal.

Over time, the Preferred Alternative could produce some major shifts in distribution of wetland types. Negative effects on flats, scrub/shrub, and forested wetlands would persist. Overall, the Preferred Alternative would result in a negative effect on wetland vegetation types. Effects would be negative on vegetation types of mainstem reservoirs, mainstem tailwaters, and tributary reservoirs, and neutral on tributary tailwaters.

Because winter pool levels would not change relative to the Base Case, wetlands with artificially controlled water levels would not be affected by the Preferred Alternative.

Wetland Function. Systemwide, the Preferred Alternative would result in a net moderate decrease in wetland functions related to floodwater and stormwater storage and water quality due to changes in wetland extents, distributions, and types. A moderate increase in wetland functions related to shoreline/bank stabilization and erosion control, carbon storage, wetland-upland community interspersion, and all other general functions provided by all wetland types may result from changes in wetland extents, distributions, and types.

5.8.10 Summary of Impacts

The largest impacts of the proposed alternatives are the potential effects on wetland extents and wetland vegetation types (Table 5.8-01). These changes in wetland extents and types would result in corresponding changes in wetland functions and the social, environmental, and economic values they provide. Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative would increase the availability of water to wetlands. The changes in the availability of water to wetlands would improve opportunities for some new wetlands to develop in suitable habitat. However, the same changes that would encourage new wetland formation would adversely affect existing wetland vegetation types, in particular flats, scrub/shrub, and forested wetlands. Wetland vegetation types dominated by woody plants (scrub/shrub and forested wetlands) would require decades to recover from these changes. Forested wetlands would be particularly slow to recover, because trees require decades to become established and reach maturity.

The Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative would result in negative impacts on both wetland extents and types. Both of these alternatives would result in an overall decrease in availability of water to wetlands during the growing season. Under the Equalized Summer/Winter Flood Risk Alternative, the decrease in summer pool elevations on tributary reservoirs would isolate these wetlands from their most prevalent source of water. This hydrologic isolation would effectively eliminate scrub/shrub and forested wetlands from tributary reservoirs. Both the Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative would adversely affect scrub/shrub and forested wetland communities on tributary reservoirs.

The Base Case and the Commercial Navigation Alternative would result in the least adverse impacts on wetlands on both mainstem and tributary reservoirs and tailwaters.

Overall, Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Summer Hydropower Alternative, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative would result in negative effects on wetlands. The Summer Hydropower Alternative would result in the most adverse impacts compared to the other alternatives. The Base Case and the Commercial Navigation Alternative would result in the greatest possible net positive impacts on wetlands.

Table 5.8-01 Summary of Impacts on Wetland Resources by Policy Alternative

Alternative	Description of Impacts
Base Case	No change – Wetlands would continue to follow existing trends. There would be minor but steady changes in wetland extents and distributions, shifts in wetland types, and a slow decline in wetland functions overall.
Reservoir Recreation A	Slightly adverse – The availability of water would generally increase during the growing season. This would cause slight shifts in the extents and distributions of wetlands and wetland types. The changes in the timing of the presence of water would adversely affect flats, scrub/shrub and forested wetlands. However, there would be positive effects on aquatic bed and persistent emergent wetlands. There would be a slight decrease in wetland functions overall.
Reservoir Recreation B	Adverse – The major increase in the availability of water during the growing season would cause moderate shifts in the extents and distributions of wetlands and wetland types. The changes in the timing of the presence of water would adversely affect flats, scrub/shrub and forested wetlands. Changes would occur faster than wetland plant communities could adapt However, there would be positive effects on aquatic bed wetlands. There would be a moderate decrease in wetland functions overall.
Summer Hydropower	Substantially adverse – The availability of water would be greatly decreased in wetlands during the growing season. This would result in major shifts or losses in wetland extents and distributions and the degradation of most vegetated wetlands, resulting in a major loss in wetland functions.
Equalized Summer/Winter Flood Risk	Substantially adverse – The timing and availability of water would be reduced in wetlands during the growing season for most wetlands. This would result in adverse effects on flats, scrub/shrub and forested wetlands, particularly on reservoirs where they are already limited in abundance. Changes would occur faster than wetland plant communities could adapt. There would be a major decrease in wetland functions overall.
Commercial Navigation	No change – There would be minor changes in water availability. Effects on wetland extents, distributions, types, and functions would be similar to the Base Case. The Commercial Navigation Alternative would affect wetlands at the least number of reservoirs.
Tailwater Recreation	Adverse – There would be a major increase in the availability of water during the growing season that would cause moderate shifts in the extents and distributions of wetlands and wetland types. Changes in the timing of the presence of water would adversely affect flats, scrub/shrub and forested wetlands. Changes would occur faster than wetland plant communities could adapt. However, there would be positive effects on aquatic bed wetlands. There would be a moderate decrease in wetland functions overall.
Tailwater Habitat	Slightly adverse – The availability of water would generally increase during the growing season. This would cause slight shifts in the extents and distributions of wetlands and wetland types. The changes in the timing of the presence of water would adversely affect flats, scrub/shrub and forested wetlands. However, there would be positive effects on aquatic bed and persistent emergent wetlands. There would be a slight decrease in wetland functions overall.
Preferred	Slightly adverse – The availability of water would generally increase during the growing season. This would cause slight shifts in the extents and distributions of wetlands and wetland types. The changes in the timing of the presence of water would adversely affect flats, scrub/shrub and forested wetlands. However, there would be positive effects on aquatic bed wetlands. There would be a slight decrease in wetland functions overall.

5.9 Aquatic Plants

5.9.1 Introduction

Changes in water elevation or duration have the potential to affect the following factors related to aquatic plants: area of total plant coverage, area of invasive species coverage, and composition of plant communities. However, the effects of environmental factors beyond human control and prediction, such as weather and the hydrologic cycle, are overriding factors in determining increases or decreases in coverage of aquatic plants and invasive aquatic plants. These factors cannot be managed and would transcend most changes in water management or drawdown regime. Thus, while the following discussion of reservoir operations policy alternatives is based on qualitative metrics, these estimates must be viewed in the context of natural event cycles.

The primary qualitative metric used for impact comparison was a change in coverage (in acres), although community composition changes are also discussed. A change in coverage includes either an increase or a decrease in the vegetated acres. Change can be seen as adverse or beneficial, depending on the reader's perspective. For example, increases in plant coverage are generally considered beneficial by bass anglers and fisheries and wildlife managers. These same increases may be viewed as undesirable by shoreline property owners and recreational boaters. Consequently, the impacts discussed below are not described as adverse or beneficial. Due to their dominance, any increase or decrease in aquatic plant coverage discussed below was assumed to be mostly a change in invasive species coverage.

5.9.2 Impact Assessment Methods

The policy alternatives were divided into groups based on similar changes in water elevations and durations. Table 5.9-01 (see Section 5.9.10) lists generalized operational changes in the reservoirs (for example, higher winter pool elevations and more rapid water drawdown), and their potential effects on the aquatic plants in the mainstem and tributary reservoirs. However, a majority of these impacts, particularly those on the mainstem reservoirs, would be overridden by the natural hydrologic and climatic variability in the system. Some of the impacts anticipated on the tributary reservoirs may fall outside the range of natural variability; nevertheless, they still would be relatively small scale.

Both storage and run-of-river reservoirs have been included in the analyses below. Because of operational differences, the potential for impacts on aquatic plants on storage reservoirs would be greater than on run-of-river reservoirs. Impacts occurring on storage reservoirs could result from changes in water elevations and durations. Run-of-river reservoirs would not undergo substantial changes in water elevations or durations. On these reservoirs, therefore, aquatic plant and aquatic invasive plant coverage would continue to increase or decrease based primarily on the natural fluctuation associated with hydrologic and climatic events and hydrogeneration schedules.

All impacts caused by the proposed alternatives and discussed below are ranked "low" in terms of substantially affecting the Tennessee River watershed because all impacts would be overridden by the natural variability in the system or the small scale of any measurable impact.

Substantial increases in algal biomass have the potential to decrease the amount of light available for aquatic plant growth. As discussed in detail in Section 5.4, Water Quality, regression analysis for chlorophyll-a concentrations indicated that the proposed alternatives are not anticipated to substantially alter the algal biomass of either the mainstem or tributary reservoirs. Changes in algal biomass that can be attributed to the proposed alternatives are anticipated to be less than 10 percent, which is within the range of the present natural variation of the system. Chlorophyll-a concentration in samples collected in 2002, a year when flows approximated those of several of the alternatives, indicated higher levels of chlorophyll-a than predicted by the regression analysis for several mainstem reservoirs. Coverage of aquatic macrophytes slightly increased or remained stable in all mainstem reservoirs in 2002 (Table 4.9-02); indicating no clear short-term inverse relationship between chlorophyll-a concentrations and aquatic macrophyte coverage. As discussed in Section 4.9.3, data were not available for trends in coverage of riverine plants of the Tennessee Valley. Although some of the alternatives may substantially change the velocity and duration of water flow, which could lead to scouring of habitat areas, community species shift, or reductions of light due to increased sediment load, these changes could not be measured with available information and were not included in the alternatives analyses below.

Impacts for each of the policy alternatives on overall populations of most emergent, invasive, or nuisance species listed in Table 4.9-01 are expected to be similar to changes in emergent wetlands discussed in Section 5.8, Wetlands. An exception is American lotus, where changes are likely to be more similar to those of submersed and floating-leaved aquatic plants. Historically, many of the emergent, invasive plants (e.g., purple loosestrife, common reed, and reed canary grass) in Table 4.9-01 have not been a widespread nuisance on TVA reservoirs. However, emergent invasive plants could become more abundant in situations where propagule sources (e.g., seeds, rhizomes, and fragments) are readily available and in additional areas of suitable habitat that become available for colonization. Invasive emergent species with existing large, established populations—such as alligatorweed, Uruguayan waterprimrose, water smartweed, and giant cutgrass—would likely have the highest potential for expansion, especially on mainstem reservoirs.

Few changes in invasive and nuisance emergent plant populations are expected for the Commercial Navigation Alternative compared to the Base Case. Several of the alternatives (e.g., Reservoir Recreation Alternative A, the Tailwater Habitat Alternative, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Preferred Alternative; and the Equalized Summer/Winter Flood Risk Alternative on mainstem reservoirs) may allow expansion of emergent wetlands (see Section 5.8) and would maintain and possibly enhance habitat for the expansion of invasives. These same policy alternatives that positively affect emergent communities would adversely affect shrub/scrub and forested wetlands by increasing the duration of surface water and soil saturation. This could provide additional opportunities for expansion of invasive emergents into "open" habitats caused by the decline of these wetland types. The remaining alternatives (the Summer Hydropower Alternative and Equalized Summer/Winter Flood Risk Alternative on tributary reservoirs) that negatively affect emergent wetlands by decreasing the duration of surface water and soil saturation could reduce populations of emergent and nuisance invasive plants. However, some emergent invasive species (e.g., purple loosestrife, common reed, reed canary grass, and alligatorweed) that sometimes colonize drier sites might expand into the upper drawdown zone under the Summer Hydropower Alternative on both mainstem and tributary reservoirs as the water recedes. In the short term, these same species might also colonize the habitat opened by the lower summer pool elevations on tributary reservoirs und the Equalized Summer/Winter Flood Risk Alternative. In the long term, these species would likely be replaced by terrestrial plants that would colonize this zone.

5.9.3 Base Case

The Base Case would continue existing water drawdown regimes. As shown in Figure 4.9-01, plant coverage has widely fluctuated naturally under existing operations. Under the Base Case, therefore, aquatic plant and aquatic invasive plant coverage on all mainstem and tributary reservoirs would continue to increase or decrease based primarily on the natural fluctuation associated with hydrologic and climatic events.

5.9.4 Commercial Navigation Alternative

The Commercial Navigation Alternative is similar to the Base Case but differs by raising winter pool levels where possible on the mainstem storage reservoirs. Aquatic plant and aquatic invasive plant coverage on mainstem and tributary storage reservoirs would continue to increase or decrease based primarily on the natural fluctuation associated with hydrologic and climatic events. Higher winter levels on mainstem storage reservoirs could favor the establishment and expansion of species such as Eurasian watermilfoil and hydrilla into areas of the drawdown zone that are presently colonized primarily by spinyleaf naiad and other annuals.

5.9.5 Reservoir Recreation Alternative A and Tailwater Habitat Alternative

Under Reservoir Recreation Alternative A and the Tailwater Habitat Alternative, summer or near-summer pool elevations would be held for a longer duration and winter pool elevations would be raised where possible. On the tributary storage reservoirs, summer pool levels under the Tailwater Habitat Alternative would be held longer than those under Reservoir Recreation Alternative A. Little change in plant coverage is expected on mainstem storage reservoirs for either alternative. Coverage of Eurasian watermilfoil and hydrilla colonies could decrease slightly on the deep-water side of the colonies due to a reduction in light penetration. Aquatic plants in the drawdown zone could slightly increase due to longer summer pools. Higher winter water levels on the mainstem storage reservoirs could favor the establishment and expansion of species such as Eurasian watermilfoil and hydrilla into some areas of the drawdown zone that are presently colonized primarily by spinyleaf naiad and other annuals. Because of longer summer pool levels, aquatic plant coverage could slightly increase in tributary storage reservoirs in flatter areas with suitable substrate, especially if the increase in winter water elevation is sufficient to dampen the drawdown amplitude to less than 10 feet. Under the Tailwater Habitat Alternative, the potential for slightly larger increases in plant coverage on tributary storage reservoirs could occur because of summer pool levels extending longer into fall. Invasive aquatic plants such as spinyleaf naiad and other annuals could colonize these areas.

5.9.6 Reservoir Recreation Alternative B and Tailwater Recreation Alternative

Reservoir Recreation Alternative B and the Tailwater Recreation Alternative would fill storage reservoirs to summer pool elevations and hold the water at these elevations until Labor Day—later in the year than existing operating guidelines but not as late as under the Tailwater Habitat Alternative. Winter water elevations would be increased, where possible. Little change in plant coverage on mainstem storage reservoirs is anticipated. Coverage of Eurasian watermilfoil and hydrilla colonies could decrease slightly on the deep-water side of the colonies due to a reduction in light penetration. Aquatic plants in the draw down zone could slightly increase due to longer summer pools. Higher winter water levels on mainstem storage reservoirs could favor the establishment and expansion of species such as Eurasian watermilfoil and hydrilla into some areas of the drawdown zone that are presently colonized primarily by spinyleaf naiad and other annuals. A slight increase in coverage could occur on tributary storage reservoirs with a large drawdown (over 10 feet). On a few tributary storage reservoirs (for example, the Chatuge and South Holston), where the amplitude of drawdown is reduced to less than 10 feet, slightly larger increases in coverage could occur where suitable substrate exists. Invasive aquatic annuals such as spinyleaf naiad could have the highest potential for establishment.

5.9.7 Summer Hydropower Alternative

Under the Summer Hydropower Alternative, drawdown would begin in June to increase power production. On mainstem storage reservoirs, the potential exists for substantial decreases (estimated at 10 to 40 percent reduction) in total plant coverage (primarily spinyleaf naiad and other annuals) growing in the upper portion of the drawdown zone. Decreases in total coverage would be greater in reservoirs such as Chickamauga with a large drawdown (about 7 feet) and less in reservoirs like Guntersville with a small drawdown (2 feet). A slight expansion of Eurasian watermilfoil and hydrilla into deeper areas could occur because of increased light penetration (due to less water to filter light through). In most tributary storage reservoirs where higher winter water levels would occur, a slight decrease in overall coverage is anticipated because water levels would not be elevated long enough during summer for annual plants to complete their seed cycle.

5.9.8 Equalized Summer/Winter Flood Risk Alternative

The Equalized Summer/Winter Flood Risk Alternative would result in lower summer pool water elevations and higher winter pool elevations on the tributary storage reservoirs, and later-filling, longer summer pool water elevations that are reduced quickly on the mainstem storage reservoirs (similar to Reservoir Recreation Alternative B but with a faster drawdown). This modification may result in a wide variety of effects, depending on how much the water levels vary from the existing regime. A slight decrease in plant coverage on mainstem reservoirs is anticipated. Coverage of Eurasian watermilfoil and hydrilla colonies could decrease slightly on the deepwater side of the colonies due to a reduction in light penetration. Aquatic plants in the drawdown could decrease slightly due to the delayed fill, although extended pool to later in the growing season could offset some of the decrease. Decreases under the Equalized Summer/Winter Flood Risk Alternative likely would be greater than under the remaining alternatives, except for the Summer Hydropower Alternative. Lower summer water elevations on tributary storage reservoirs could slightly decrease existing small populations of plants by dewatering the upper contours. The longer summer pool levels and decreased drawdown could slightly increase submersed and floating-leaved plants in flatter areas with suitable substrate, particularly in some reservoirs (for example, Chatuge) where the drawdown is less than 10 feet.

5.9.9 Preferred Alternative

The Preferred Alternative would result in a delayed fill in Chickamauga and upstream mainstem reservoirs, and extended summer pool elevations on several mainstem reservoirs. Summer pool levels would extend to Labor Day on tributary reservoirs, and winter water levels would be raised where possible. Little change in plant coverage on mainstem reservoirs is anticipated. In reservoirs with extended summer pool elevation, coverage of Eurasian watermilfoil and hydrilla colonies could decrease slightly on the deep-water side of the colonies due to a reduction in light penetration. Aquatic plants in the upper portion of drawdown zone could decrease slightly in reservoirs with delayed fill. This decrease could be offset by the extended summer pool levels.

The extended summer pool elevations and decreased drawdown in tributary reservoirs could slightly increase submersed and floating-leaved plants in flatter areas with suitable substrate, particularly in some reservoirs (for example, Chatuge) where the drawdown is reduced to less than 10 feet. Invasive aquatic annuals such as spinyleaf naiad could have the highest potential for establishment.

5.9.10 Summary of Impacts

Table 5.9-01 describes impact analysis considerations related to aquatic and invasive aquatic plants by operating option. Table 5.9-02 provides a summary of impacts on aquatic plants in mainstem and tributary reservoirs by policy alternative. Except for the Summer Hydropower Alternative, the policy alternatives would not cause aquatic plant and aquatic invasive plant coverage to change substantially from the Base Case on all the mainstem reservoirs and a majority of the tributary reservoirs. Potential coverage changes on mainstem reservoirs for alternatives other than the Summer Hydropower Alternative would be slight, and during most years natural environmental factors, such as weather and the hydrologic cycle, would override the effects of these alternatives in determining aquatic plant and invasive aquatic plant growth or decline. An exception is the Equalized Summer/Winter Flood Risk Alternative, where a slight decrease in coverage might occur during some years. Some of the impacts anticipated on the tributary reservoirs may fall outside the range of natural variability during some years; nevertheless, they still would be relatively small scale.

Table 5.9-01 Impact Analysis Considerations Related to Aquatic Plants by Operating Characteristic

Operating Characteristic	Impacts on Aquatic Plants in Mainstem Reservoirs	Impacts on Aquatic Plants in Tributary Reservoirs
Summer pool elevations held past present drawdown date	Because these plants have already completed their life cycle, little increase or decrease in coverage is expected; slight decrease or no expansion of Eurasian watermilfoil and hydrilla into deeper contours because of light limitations; slight increase in drawdown zone coverage due to longer growing season, and possibly more Eurasian watermilfoil/hydrilla in drawdown zone during summer.	Not many exist here; potential slight increase in coverage in flatter areas where habitat and substrate exist—primarily the annual/naiad mix, which can complete seed production before dewatering.
Higher winter pool elevations	In some mainstem reservoirs, potential to increase coverage of Eurasian watermilfoil and hydrilla because not dewatered; reducing area of drawdown zone would result in decreased coverage of annual/naiad mix.	Decreased amplitude of fluctuation to 10 feet or less in higher winter pool levels would increase potential for plants to colonize suitable habitat areas, which could increase coverage.
Lower summer pool elevations	Potential to decrease coverage in upper contours by reducing inundated habitat; increased light levels would allow expansion of Eurasian watermilfoil and hydrilla into deeper contours.	Not many exist here; reducing inundated habitat in upper portion of drawdown zone may result in slight decreases in the few existing populations.
Faster drawdowns, dewatering earlier in year	Shorter growing season could decrease coverage, especially in drawdown zone; annual species such as naiads and pondweeds may not be able to complete their seed cycles; may see species shift to perennial species with growth from underground propagules or to species that can complete their life cycles; possible expansion of hydrilla and Eurasian watermilfoil due to increased light penetration.	Not many exist here; decrease in the few existing populations and decrease in potential for establishment of additional populations.

Note: This table is applicable to storage reservoirs; run-of-river reservoirs would not experience large water elevation fluctuations under the policy alternatives.

Table 5.9-02 Summary of Impacts on Aquatic and Invasive Aquatic Plants by Policy Alternative

Alternative	Description of Impacts
Base Case	Aquatic and invasive aquatic plant coverage on mainstem and tributary reservoirs would continue to increase or decrease based primarily on natural fluctuation associated with hydrologic and climatic events.
Reservoir Recreation A	Little change in plant coverage is expected on mainstem reservoirs; a species shift could occur between increasing and decreasing communities of invasive plant species. Due to longer summer pool levels, aquatic plant coverage could increase slightly in some tributary reservoirs, especially if increase in winter water elevation is sufficient to reduce the drawdown to less than 10 feet.
Reservoir Recreation B	Little change in plant coverage on mainstem reservoirs is anticipated; however, a species shift could occur between increasing and decreasing communities of invasive species. A slight increase in coverage could occur on tributary reservoirs with a large drawdown (over 10 feet). On tributary reservoirs (for example, Chatuge and South Holston), where the drawdown is reduced to less than 10 feet, larger increases in coverage could occur.
Summer Hydropower	On mainstem reservoirs, there is potential for large reductions in plants growing in upper portion of drawdown zone. A slight expansion of Eurasian watermilfoil and hydrilla into deeper areas could occur because of increased light penetration. In most tributary reservoirs where higher winter water levels would occur, a slight decrease in overall coverage is anticipated because water levels would not be elevated long enough during summer for annual plants to complete their seed cycle.
Equalized Summer/Winter Flood Risk	This alternative may result in a wide variety of effects, depending on how much water levels vary from current regime. A slight decrease in plant coverage on mainstem reservoirs is anticipated during some years. Lower summer water elevations on tributary reservoirs could decrease existing populations of plants; however, longer summer pool levels and decreased amplitude of drawdown could increase submersed and floating-leaved plants—particularly in some reservoirs (for example, Chatuge) where the drawdown is less than 10 feet.
Commercial Navigation	Coverage on the mainstem and tributary reservoirs would continue to increase or decrease based primarily on natural fluctuation associated with hydrologic and climatic events. Higher winter water levels on mainstem reservoirs could favor establishment and expansion of perennial invasive species into some areas of drawdown zone currently colonized by annuals.
Tailwater Recreation	Little change in plant coverage on mainstem reservoirs is anticipated; however a species shift could occur between increasing and decreasing communities of invasive species. A slight increase in coverage could occur on tributary reservoirs with a large drawdown (over 10 feet). On tributary reservoirs (for example, Chatuge and South Holston), where drawdown is reduced to less than 10 feet, larger increases in coverage could occur.

Table 5.9-02 Summary of Impacts on Aquatic and Invasive Aquatic Plants by Policy Alternative (continued)

Alternative	Description of Impacts
Tailwater Habitat	Little change in plant coverage is expected on mainstem reservoirs; however, a species shift could occur between increasing and decreasing communities of invasive species. Due to summer pool levels extending later into fall, potential for increases in plant coverage on tributary reservoirs could be greater than under Reservoir Recreation Alternative A, especially if increase in winter water elevation is sufficient to reduce the drawdown to less than 10 feet.
Preferred	Little change in plant coverage is expected on mainstem reservoirs; however, a species shift could occur between increasing and decreasing communities of invasive species. A slight increase in coverage could occur in some tributary reservoirs, with the highest potential in reservoirs (for example, Chatuge) where the increase in winter elevation is sufficient to reduce the drawdown to less than 10 feet.

Note: Most anglers and waterfowl hunters would consider increases in aquatic plants to be beneficial, while most recreational boaters and shoreline property owners would consider such increases adverse.

5.10 Terrestrial Ecology

5.10.1 Introduction

Much of the terrestrial plant and animal life occurring in the vicinity of TVA reservoirs has adjusted to the established dynamic conditions associated with management of the many reservoirs and stream reaches. Changes in reservoir operations would change the seasonal timing and duration of water levels. The following discussion describes potential impacts of such changes on the upland and lowland plant communities, including those that are globally imperiled, and the associated wildlife communities described in Section 4.10.

Changes in the seasonal timing and duration of water levels could affect the species composition of plant and animal communities in the study area by changes to the structure of riparian habitats and the resulting gain or loss of specific community types. Factors such as increased shoreline erosion, residential development, and the spread of invasive species could substantially affect the distribution and quality of terrestrial habitats throughout the water control system.

5.10.2 Impact Assessment Methods

Data on the terrestrial ecology of the study area were gathered from field interviews with subject matter experts, published reports, TVA land use plans, environmental impact studies, and biological data collection centers. These data were used to identify plant and animal communities that could be affected by changes in reservoir operations.

Impacts on the terrestrial ecology of the study area were analyzed by summarizing effects described in various sections within this EIS. Results of analyses for wetlands and aquatic plants were used to identify potential effects on terrestrial resources. Analyses for other resource areas, such as invasive species, shoreline erosion, and land use were also used to identify potential effects on terrestrial plant and animal communities. The effects identified in these chapters were summarized for each alternative. This analysis used a qualitative approach to analyze the effects of each alternative on the terrestrial plant and animal resources in the study area.

Using the Base Case as a reference benchmark, the alternatives were grouped according to their similarities of impact on terrestrial ecology. Although the effects from potential changes in reservoir operations would vary widely, this analysis attempted to capture effects of the greatest magnitude on the resource.

The analysis of impacts in this section pertains only to mainstem storage and tributary storage reservoirs. Run-of-river reservoirs were initially investigated for elevation changes associated with each policy alternative. Because pool elevations for these reservoirs would not change under any of the alternatives, terrestrial ecology would not be affected around these reservoirs.

5.10.3 Base Case

Lowland Plant Communities

Most lowland terrestrial plant communities have adjusted to current operating conditions. Some communities, such as stands of water tupelo (*Nyssa aquatica*) on Guntersville and Wheeler Reservoirs and buttonbush (*Cephalanthus occidentalis*) on Kentucky Reservoir, are notable exceptions. Several stands of these species show signs of stress from prolonged periods of inundation under existing water regimes.

The Base Case would continue to provide lower winter pool elevations than any of the policy alternatives and thus would allow more opportunity for seed germination and establishment of vegetation in scrub/shrub and flats. As described in the SMI EIS, a long-term reduction in native shoreline plant communities would occur.

In areas where currents are sufficiently strong, headwater erosion of islands and toe accretion of deposits would continue under the Base Case, with consequent potential minor losses of bottomland hardwood or upland forest communities and some globally rare wetland communities. Slight increases in flats and scrub/shrub communities are expected under the Base Case.

Upland Plant Communities

Under the Base Case, continued rates of erosion would lead to additional loss of upland habitat adjacent to mainstem and tributary reservoirs (see Section 5.16, Shoreline Erosion). Existing successional patterns in upland communities would continue except where disrupted by shoreline development.

Wildlife Communities

Under the Base Case, most TVA reservoirs would continue to be operated at levels that are favorable to gulls, shorebirds, waterfowl, and other reservoir-dependent wildlife. Species associated with upland and lowland habitats would continue to derive benefits from the river system, and no adverse impacts on terrestrial wildlife are expected. The continuation of existing operations would result in limited effects on waterfowl and other migratory birds, as they have adapted to present conditions.

5.10.4 Commercial Navigation Alternative

The effects of the Commercial Navigation Alternative on lowland and upland terrestrial communities are expected to be similar to those described for the Base Case. Most plant communities would persist with little change. Impacts on vegetation under the Commercial Navigation Alternative would be minor.

Under the Commercial Navigation Alternative, higher winter pools would affect lowland wildlife species primarily through the net reduction of flats and changes in shallow-water habitats. Overall, available flats would be reduced as they are flooded by higher reservoir levels, resulting in a decrease in foraging areas for waterfowl (primarily geese) and roosting areas for gulls and other species. Areas inundated during winter would increase, shifting shallow-water foraging habitat for waterfowl and wading birds to higher elevations.

5.10.5 Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Tailwater Recreation Alternative, and Tailwater Habitat Alternative

Lowland Plant Communities

Under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative, summer pool levels would be extended to or later than Labor Day, and winter pool levels would be raised by 2 feet. The prolonged periods of inundation under these alternatives would stress species in the bottomland hardwood, scrub/shrub, and flats communities. Over time, large acreages of scrub/shrub community would likely convert to aquatic beds or marshes dominated by wetland emergent species. Species least tolerant to prolonged flooding would be adversely affected within a few years, particularly those in presently stressed bottomland hardwoods and scrub/shrub communities (Hall and Smith 1955).

Annual plant species that make up the flora of flats communities require sufficient exposure to air in order to germinate and grow to reproductive condition (Webb 1988, Gunn 2003). Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative would considerably decrease the areas occupied by annually vegetated flats communities, especially on Kentucky, Barkley, Pickwick, and Douglas Reservoirs.

The composition of globally imperiled communities would change to favor species that are more tolerant of prolonged flooding. The magnitude of the impact cannot be evaluated because the regional extent of various imperiled communities is unknown. Overall, impacts on lowland plant communities are expected to be detrimental in localized areas under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative.

Upland Plant Communities

Extending summer pool levels and raising winter pool levels would maintain existing groundwater levels adjacent to waterbodies, with minimal short-term and long-term effects on the terrestrial ecology of the region over the next 30 years. Saturation of surface soils would result in a minor loss of upland plant species and replacement by species more tolerant to flooding. Overall, impacts on upland terrestrial communities are expected to be minimal under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative.

Wildlife Communities

A variety of changes to wetland habitats are possible under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative (see Sections 5.8.4 and 5.8.5 in Wetlands). Effects on wildlife communities resulting from higher winter pools would be the same as those described for the Commercial Navigation Alternative. Extended summer pools would affect wildlife primarily by extending the period that summer flats and pools, aquatic beds, and wetlands are inundated. Extended pool levels under these alternatives would delay exposure of flats habitats, resulting in adverse impacts on shorebirds and teal as they migrate through the area (see Table 5.10-01). Eventually flats would develop later in fall but might not have adequate exposure time to allow vegetation to become established. This could result in adverse impacts to waterfowl (primarily geese) that forage on these areas in early winter months.

Table 5.10-01 Dates That Shorebird Habitat (Flats) Would Be Exposed during Summer Drawdown by Policy Alternative

Alternative	Reservoir (elevation [feet])				
	Kentucky (356.6)	Pickwick (411.5)	Wheeler (554)	Chickamauga (679)	Douglas (987)
Base Case	08/25	09/10	09/01	10/20	08/10
Reservoir Recreation A	10/07	11/01	10/07	11/05	09/05
Reservoir Recreation B	11/15	11/05	10/20	11/05	09/25
Summer Hydropower	07/25	07/25	07/25	07/25	07/25
Equalized Summer/Winter Flood Risk	09/15	10/15	10/15	10/15	NA
Commercial Navigation	08/25	09/10	09/01	10/20	08/10
Tailwater Recreation	11/25	11/05	10/20	11/05	09/25
Tailwater Habitat	10/05	11/01	10/05	11/05	11/01
Preferred	08/25	10/15	10/05	10/20	08/20

Notes: Dates were derived from the Weekly Scheduling Model for each alternative.

NA = Not applicable; summer pool levels are not projected to reach this elevation during years with normal levels of rainfall.

Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative could result in increases in aquatic vegetation, a food base for some waterfowl and aquatic turtles, on the tributary reservoirs. The increased vegetative biomass is likely to result in an increase in aerial aquatic insects that provide food for wildlife foraging on and adjacent to the river system.

Under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative, upland and some lowland species of wildlife would continue to derive benefits from the river system. Changes in operations under these alternatives would result in limited effects on semi-aquatic mammals and non-game wildlife, as they would adapt to changing conditions. Due to the anticipated decrease in flats habitats, shorebirds and early fall migrant waterfowl would be adversely affected during fall migration periods under these alternatives.

5.10.6 Summer Hydropower Alternative

Lowland Plant Communities

The Summer Hydropower Alternative has the potential to greatly expand or shrink the extent of the flats community, depending on how reservoirs are managed. Prolonged exposure and resultant drying of flats would reduce their extent, while slow drawdown at the appropriate time would allow extensive germination of seeds and establishment of associated plant communities. The Summer Hydropower Alternative could greatly reduce the extent of the scrub/shrub community (because of the severely reduced period of summer pool levels) and could initiate widespread changes in the composition of species found in bottomland hardwood forests.

Under the Summer Hydropower Alternative, delaying summer pool levels and shortening the duration of summer pool levels would allow upland species to displace existing bottomland hardwoods—resulting in adverse impacts on this community type. Impacts on scrub/shrub communities would be similar, although the shortened duration of summer pool levels might allow expansion of this community into new locations over the long term. The shortened duration of summer pool levels would result in loss of water from some globally imperiled plant communities listed in Table 4.10-01 (those with species more tolerant to flooding), triggering consequent changes in species composition and loss of community character.

Upland Plant Communities

The short duration of summer pool levels under the Summer Hydropower Alternative would not promote development of adjacent wetlands. Therefore, impacts on upland terrestrial communities are expected to be minimal under this alternative.

Wildlife Communities

Effects on terrestrial ecology resulting from higher winter pool levels under the Summer Hydropower Alternative are the same as those described for the Commercial Navigation

Alternative. Effects on wildlife under the Summer Hydropower Alternative would vary by reservoir. Shorter summer pool levels would affect wildlife primarily through changes in the availability of flats, aquatic beds, and wetlands. Early migrant shorebirds could benefit from the increase in the amount of exposed flats; however, flats may dry before shorebirds arrive, allowing vegetation to become established on these areas. While this could be detrimental to shorebirds, wintering waterfowl could benefit as these vegetated flats become flooded in winter. Decreases in aquatic beds may result in a reduction of food available to waterfowl and other species that feed in or adjacent to the river system. Overall, the Summer Hydropower Alternative would result in a negative change in wetland community types due to the loss of habitat for the variety of lowland, non-game animals that rely on these communities—including numerous Neotropical songbirds and semi-aquatic mammals.

Because of the instability of reservoir levels and the projected negative changes in wetland communities, the Summer Hydropower Alternative would also result in localized adverse impacts on wildlife that depend on lowland communities.

5.10.7 Equalized Summer/Winter Flood Risk Alternative

Lowland Plant Communities

Under the Equalized Summer/Winter Flood Risk Alternative, higher winter pool levels and lower summer pool levels may stress bottomland hardwood species (which are least tolerant of flooding from winter water levels). Some new species may move into bottomland hardwood forests under the Equalized Summer/Winter Flood Risk Alternative. The same rationale applies to imperiled communities. The management regime would likely eliminate some existing scrub/shrub communities but might allow for its reestablishment in different places. Development of nonpersistent vegetation on flats is likely to be severely restricted or eliminated as lower summer pool levels and higher winter pool levels would narrow the drawdown zone where this vegetation currently exists. Overall, selection of the Equalized Summer/Winter Flood Risk Alternative would result in adverse impacts on lowland plant communities, especially flats communities on tributary reservoirs.

Upland Plant Communities

The Equalized Summer/Winter Flood Risk Alternative is not expected to result in impacts on upland plant communities, because this alternative would not promote development of adjacent wetlands.

Wildlife Communities

Under the Equalized Summer/Winter Flood Risk Alternative, terrestrial ecology effects resulting from higher winter pool levels would be similar to those described for the Commercial Navigation Alternative. Lower summer pool levels would affect wildlife primarily through changes in wetlands and the ability to flood crops in dewatering units. Adequate water may not be available in the emergent and scrub/shrub wetland habitats to provide foraging and cover for waterfowl, such as wood ducks. Resident geese are very adaptable and would probably eventually start nesting in the drawdown zone. The persistence of aquatic beds would benefit the species that depend on these habitats. Raising summer pool levels later could alleviate spring crop flooding on mainstem waterfowl impoundments (see Section 4.14 [Managed Areas and Ecologically Significant Sites]).

Under the Equalized Summer/Winter Flood Risk Alternative, upland and lowland species of wildlife would continue to derive benefits from the river system. Changes in operations would result in limited effects on waterfowl, semi-aquatic mammals, and non-game wildlife, as they would adapt to changing conditions. The projected negative effects on flats habitat could adversely affect shorebirds during fall migration periods.

5.10.8 Preferred Alternative

Lowland Plant Communities

Under the Preferred Alternative, summer pool levels could be extended to Labor Day on 10 tributary and five mainstem reservoirs. The impacts on the lowland plant communities would be similar to those described for Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternatives—but to a lesser degree (see Table 5.10-01). Impacts on the lowland communities on Kentucky and Barkley Reservoirs would be similar to those under the Base Case; operations on these reservoirs would not be modified under the Preferred Alternative.

Upland Plant Communities

Impacts on the upland plant communities are expected to be similar to those described for Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative. Impacts on these resources are expected to be minimal under the Preferred Alternative.

Wildlife Communities

Raising winter pool levels on Wheeler and tributary reservoirs would result in effects similar to those described for the Commercial Navigation Alternative; however, impacts are expected to be of lesser magnitude. Extending summer pool levels on selected mainstem and tributary reservoirs under the Preferred Alternative would result in effects on terrestrial wildlife similar to those described for Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative. The delayed exposure of flats on Wheeler, Pickwick and, to a lesser extent, Douglas during late summer would adversely affect waterfowl and shorebirds (see Table 5.10-01). Under the Preferred Alternative, these resources would not be affected on Kentucky and Barkley Reservoirs because these reservoirs would continue to be operated as they are under the Base Case. System-wide adverse changes to bottomland hardwood forests, scrub/shrub wetlands, and flats communities (see Section 5.8, Wetlands) would result in changes in the distribution, abundance, and diversity of wildlife species that use these areas.

5.10.9 Summary of Impacts

The Base Case would result in fewer impacts on plant and wildlife resources than any of the action alternatives. Each policy alternative is expected to result in shifts in community types that will benefit some plant and animal species and adversely affect others. Table 5.10-02 identifies the impacts expected under each policy alternative on the issues of concern related to terrestrial ecology. Alternatives that would result in loss or change in species composition of wetland habitat types or communities would also result in the greatest potential impacts.

Except for the Summer Hydropower Alternative, changes in operations under all remaining policy alternatives would result in limited effects on semi-aquatic mammals and many non-game wildlife species, as they would adapt to changing conditions. Under several of the policy alternatives, shorebirds and waterfowl potentially would be adversely affected during fall migration periods, due to the decrease in the availability of flats along the reservoirs. Likewise, these same alternatives are expected to result in a loss of bottomland hardwood, flats, and scrub/shrub communities and changes in the composition of species in imperiled plant communities. Such changes in wetland communities are likely to result in shifts in species and numbers of local waterfowl.

Compared to the other policy alternatives, the Preferred Alternative and the Commercial Navigation Alternative are expected to result in a lower level of impacts on plant and animal populations; however, these impacts would be greater than those under the Base Case. Due to the instability of reservoir levels and the projected negative changes in wetland communities, the Summer Hydropower Alternative would result in the greatest impacts on the terrestrial ecology of the region.

Table 5.10-02 Summary of Impacts on Terrestrial Ecology by Policy Alternative

Alternative	Description of Impacts
Base Case	No change – Wildlife population trends would continue to mirror national trends; some bottomland hardwood communities would continue to be stressed.
Reservoir Recreation A	Adverse – Aquatic beds would persist longer, benefiting a wide variety of wildlife. Reduction of flats during late summer would affect migrating shorebirds and waterfowl. Some bottomland hardwood and scrub/shrub communities would be lost; and the composition of species in imperiled plant communities would change.
Reservoir Recreation B	Adverse – Aquatic beds would persist longer, benefiting a wide variety of wildlife. Reduction of flats during late summer would affect migrating shorebirds and some waterfowl. Some bottomland hardwood and scrub/shrub communities would be lost; and the composition of species in imperiled plant communities would change.
Summer Hydropower	Substantially adverse – Wetland habitats would be more adversely affected than under other alternatives. Reduction of flats and aquatic beds would adversely affect many dependent species of wildlife. Distribution and extent of scrub/shrub, bottomland hardwood, and imperiled plant communities potentially could be altered.
Equalized Summer/Winter Flood Risk	Adverse – Aquatic beds would persist longer, benefiting a wide variety of wildlife. Reduction of flats during late summer would affect migrating shorebirds and some waterfowl. Loss of scrub/shrub communities and changes in bottomland hardwood and imperiled plant communities would result.
Commercial Navigation	Slightly adverse – Minor benefits to some wetland types and associated wildlife. Decrease in flats on mainstem reservoirs would affect migrating shorebirds and some waterfowl; some bottomland hardwood communities would continue to be stressed.
Tailwater Recreation	Adverse – Aquatic beds would persist longer, benefiting a wide variety of wildlife. Reduction of flats during late summer would affect migrating shorebirds and some waterfowl. Loss of bottomland hardwood and scrub/shrub communities and species shifts in imperiled plant communities would occur.
Tailwater Habitat	Adverse – Aquatic beds would persist longer, benefiting a wide variety of wildlife. Reduction of flats during late summer would affect migrating shorebirds and some waterfowl. Loss of some bottomland hardwood and scrub/shrub communities and species shifts in imperiled plant communities would result.
Preferred	Slightly adverse – Aquatic beds would persist longer, benefiting a wide variety of wildlife. Reduction of flats during late summer would adversely affect migrating shorebirds and some waterfowl on select mainstem and tributary reservoirs. Loss of some bottomland hardwood and scrub/shrub communities and species shifts in imperiled plant communities would result.

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5.11 Invasive Plants and Animals

5.11.1 Introduction

Changes in reservoir operations have the potential to affect habitat suitability for invasive terrestrial and aquatic animals and terrestrial plants. Changes in habitat suitability would affect species abundance or their ability to colonize new areas.

5.11.2 Impact Assessment Methods

To determine impacts on invasive species, each policy alternative was evaluated to determine whether revised operation of the water control system would produce consistent support for conditions critical to the life history of the identified species. When changes in operations would consistently produce more favorable conditions, an increase in the abundance of invasive species was assumed. Factors considered in the analysis included:

- Increased development of open spaces;
- Changes to water quality;
- Increased reservoir elevations over longer duration; and,
- Changes to reservoir and tailwater flows.

Proposed changes to the reservoir operations policy under each alternative were evaluated for these four factors to determine how the alternatives would affect the population abundance and spread of invasive terrestrial and aquatic plants and animals.

5.11.3 Base Case

Invasive Terrestrial Animals and Plants

Under the Base Case, suitable habitat for invasive terrestrial animals and their populations is expected to continue to increase due to reasonably foreseeable actions in the Valley. Similarly, invasive terrestrial plant populations are expected to continue to increase as native habitats are altered to accommodate population growth and subsequent development pressures. This alternative is therefore not expected to directly affect the present or future rate of the establishment or spread of invasive terrestrial animals or plants.

Invasive Aquatic Animals

The Base Case would not affect habitat suitability for common carp, grass carp, or rusty crayfish; because these species tolerate a wide range of environmental conditions, their populations are expected to continue to increase. The feeding habits of the three species adversely affect the habitats and populations of other more desirable fish species. Alewives and blueback herring, on the other hand, prefer cool, well-oxygenated water, which may become limited in certain reservoirs during late summer under the Base Case. Asiatic clam densities fluctuate from year to year but would likely remain high, and zebra mussel populations would likely continue to increase and expand.

5.11.4 Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Equalized Summer/Winter Flood Risk Alternative, and Tailwater Recreation Alternative

Invasive Terrestrial Animals and Plants

Under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, and the Tailwater Recreation Alternative, summer pool elevations would be extended and winter pool elevations would be altered, depending on the climate. These alternatives are not expected to modify habitat suitability for most invasive terrestrial animals or most invasive terrestrial plants. Their present rate of establishment or spread is not expected to be affected by extending the summer reservoir elevations and decreasing the length of time that the flats are exposed, because these species do not depend on the flats. Changes in winter elevations are not anticipated to influence invasive plants or animals beyond expectations for the Base Case.

Invasive Aquatic Animals

Habitat suitability for common carp, grass carp, and rusty crayfish would be unaffected by all policy alternatives. Because these species tolerate a wide range of environmental conditions, their populations are expected to continue to increase. Alewives and blueback herring prefer cool, well-oxygenated water, which may restrict their expansion downstream regardless of the selected alternative. As under the Base Case, densities of Asiatic clam would likely remain high, and zebra mussel populations would likely continue to increase and expand regardless of the selected alternative.

5.11.5 Summer Hydropower Alternative

Invasive Terrestrial Animals and Plants

Under the Summer Hydropower Alternative, drawdown would begin in June to increase power production. This modification would change the length of time that the flats are exposed and the extent of their exposure. Exposure of the flats for longer periods of time could result in the establishment of invasive plant species such as common privet and Japanese knotweed, increasing their distribution. Invasive terrestrial animals do not rely on flats or summer water levels; therefore, this alternative is not expected to affect their rate of establishment or spread. Raising water levels would cause invasive terrestrial plants that presently inhabit the shoreline to move inland; therefore, their population levels would be maintained.

Invasive Aquatic Animals

Habitat suitability for alewives, blueback herring, common carp, grass carp, rusty crayfish, Asiatic clams, and zebra mussels would be unaffected by all policy alternatives (see Section 5.11.4).

5.11.6 Commercial Navigation Alternative

Invasive Terrestrial Animals and Plants

Under the Commercial Navigation Alternative, winter reservoir elevations would be raised in the mainstem reservoirs. Increased winter reservoir elevations could reduce the spread of some invasive terrestrial plant species along mainstem reservoirs and cause other species (such as Japanese knotweed and common privet) to move inland as water levels are extended, which would maintain present population levels of these species.

Invasive Aquatic Animals

Habitat suitability for alewives, blueback herring, common carp, grass carp, rusty crayfish, Asiatic clams, and zebra mussels would be unaffected by all policy alternatives (see Section 5.11.4).

5.11.7 Tailwater Habitat Alternative

Invasive Terrestrial Animals and Plants

The Tailwater Habitat Alternative involves fill dates and drawdown levels that differ from present operations for some reservoirs, depending on annual precipitation patterns. Reservoir levels generally would be higher than those under the Base Case. The spread of some invasive terrestrial plant species could be reduced but, if winter levels exceed maximum summer elevations (Great Falls), suitable habitat may be created for the inland expansion of common privet and Japanese knotweed—as well as other invasive plants.

Invasive Aquatic Animals

Habitat suitability for alewives, blueback herring, common carp, grass carp, rusty crayfish, Asiatic clams, and zebra mussels would be unaffected by all policy alternatives (see Section 5.11.4).

5.11.8 Preferred Alternative

Invasive Terrestrial Animals and Plants

Under the Preferred Alternative, summer pool elevations would be extended and winter pool elevations would be altered. These changes are not anticipated to affect the current rate of most invasive terrestrial plant, terrestrial animal, or aquatic animal establishment or spread. As described in Reservoir Recreation A Alternative, a slight reduction in the spread of some invasive terrestrial plant species could result due to increased winter reservoir elevations. Invasive terrestrial animal species are expected to respond to this alternative as under the Base Case.

Invasive Aquatic Animals

Habitat suitability for alewives, blueback herring, common carp, grass carp, rusty crayfish, Asiatic clams, and zebra mussels would be unaffected by all policy alternatives (see Section 5.11.4).

5.11.9 Summary of Impacts

Table 5.11-01 provides a summary of impacts on invasive terrestrial and aquatic animals and terrestrial plants by policy alternative.

Habitat suitability for most invasive terrestrial animals would be unaffected by all policy alternatives because the species tolerate a wide range of environmental conditions. Their present trends relative to rate of establishment or spread would override the effects of any of the alternatives. Similarly, population abundance and spread of invasive terrestrial plants would be unaffected by any of the alternatives, except for the Summer Hydropower Alternative, where exposure of the flats for longer periods of time could result in the establishment of certain invasive plant species, thus increasing their distribution.

Habitat suitability for alewives, blueback herring, common carp, grass carp, and rusty crayfish would be unaffected by all policy alternatives. Because these species tolerate a wide range of environmental conditions, their populations are expected to continue to increase. Alewives prefer cool, well-oxygenated water, which may restrict their expansion downstream regardless of the alternative selected. Asiatic clam densities likely would remain high, and zebra mussel populations likely would continue to increase and expand regardless of the alternative selected.

Of all alternatives evaluated, only the Summer Hydropower Alternative is expected to increase the abundance of invasive terrestrial plants or animals or invasive aquatic animals (Table 5.11-01). However, because natural variability would likely result in potential impacts as great, or greater than, the impacts associated with this alternative, a measurable increase in impacts would not be expected.

Table 5.11-01 Summary of Impacts on Invasive Terrestrial and Aquatic Animals and Terrestrial Plants by Policy Alternative

Alternative	Description of Impacts
Base Case	No change – Habitat suitability and populations of terrestrial animals and plants would continue to increase. Populations of common carp, grass carp, rusty crayfish, and zebra mussel would continue to increase. Asiatic clam densities would remain high. Alewife populations would remain the same. Blueback herring would continue downstream habitation of cool-water environments below Hiwassee Reservoir.
Reservoir Recreation A	No change – Habitat suitability of terrestrial animals and plants, and their present rate of establishment or spread would not change due to extending summer reservoir elevations. Impacts on aquatic animals would be the same as those for the Base Case.
Reservoir Recreation B	No change – Impacts would be the same as those for the Base Case.
Summer Hydropower	Slightly adverse – Distributions of some invasive plant species would increase; distributions of terrestrial animals would not change. Impacts on aquatic animals would be the same as those for the Base Case.
Equalized Summer/ Winter Flood Risk	No change – Impacts would be the same as those for the Base Case.
Commercial Navigation	No change – Impacts would be the same as those for the Base Case.
Tailwater Recreation	No change – Impacts would be the same as those for the Base Case.
Tailwater Habitat	No change – Impacts would be the same as those for the Base Case.
Preferred	No change – Impacts would be the same as those for the Base Case.

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5.12 Vector Control

5.12.1 Introduction

As described in Section 4.12, changes in reservoir operations policy may affect the breeding success of mosquitoes in both permanent and temporary pools (floodwaters) created within water control system reservoirs. Of principal importance are changes in water elevations and their persistence or duration on the landscape. The following analysis assumed that the water management techniques to control mosquitoes (see Section 4.12.2, Regulatory Programs and TVA Management Activities) would remain in place under all the reservoir operations policy alternatives.

5.12.2 Impact Assessment Methods

To estimate the potential increase in mosquito populations and the associated increased risk of disease, projected water elevation forecasts prepared with the Weekly Scheduling Model were reviewed for each alternative. These forecasts were compared to the outputs for existing operations under the Base Case. Water elevations held higher or longer were the criteria for determining that higher mosquito populations and the associated risk of disease would result.

Policy alternatives that would increase water elevations or extend the area and duration of inundation may increase mosquito breeding habitat and populations, depending on temperature and rainfall during the mosquito season (March through October). The effects of these modifications depend primarily on weather (temperature and rainfall) and the resulting water levels. During a dry year, there would be little to no effect on the mosquito populations. An extension of summer pool would also increase the potential for floodwater mosquitoes if a major rain event occurred. Since the water is already high, the floodplain would drain less efficiently.

Representative tributary reservoirs were chosen for analysis because of their mosquito history; the selected tributary reservoirs historically had more mosquito activity than other tributary reservoirs. All of the mainstem reservoirs were evaluated except Nickajack Reservoir; Nickajack Reservoir is a run-of-river reservoir for which no water elevation modeling data were available. Changes in levels that result from the alternatives are expected to be minimal.

The potential of a policy alternative to increase mosquito breeding habitat and populations was considered an adverse impact relative to the Base Case. The potential of a policy alternative to decrease mosquito breeding habitat and populations was considered a beneficial impact relative to the Base Case.

5.12.3 Base Case

The Base Case would continue TVA's present operations schedule and would not affect existing mosquito breeding habitat or population abundance for permanent pool or floodwater mosquitoes. Although many unknowns or poorly understood influences are associated with mosquito-vectored diseases; the Base Case is not anticipated to affect the present rates or trends for disease occurrence.

5.12.4 Summer Hydropower Alternative

The Summer Hydropower Alternative would reduce the water elevations and duration of inundation, and thus the mosquito breeding habitat in both mainstem and tributary reservoirs. Depending on weather—which could dominate the effect of reduced water elevations for a particular year or for a period of years—this alternative would result in diminished mosquito populations for both permanent pool and floodwater species. The associated risk of mosquito-vectored diseases would also be reduced under the Summer Hydropower Alternative.

5.12.5 Commercial Navigation Alternative

The Commercial Navigation Alternative would result in very little or no change from existing operations. Depending on weather—which could dominate the effect of proposed modifications for a particular year or for a period of years—this alternative would not substantially affect mosquito population abundance. The associated risk of mosquito-vectored diseases is also not anticipated to change under the Commercial Navigation Alternative.

5.12.6 Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Equalized Summer/Winter Flood Risk Alternative, Tailwater Recreation Alternative, and Tailwater Habitat Alternative

Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative to some degree would increase the water elevations or duration of inundation in mainstem and tributary reservoirs. These alternatives would result in an increase in mosquito breeding habitat and populations for both permanent pool and floodwater species, and an increased risk of mosquito-vectored diseases. The individual effects of these alternatives would differ slightly. Due to the complexity of the natural system and the dominating effects of weather, these differences cannot be described in a meaningful way. Potential effects associated with Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative would be greater on tributary reservoirs because the operations changes for tributary reservoirs under these alternatives would deviate more from existing operations (the Base Case). Historically, water levels in tributary reservoirs have fluctuated more than those in mainstem reservoirs. Some of the alternatives would no longer allow the amount of historical fluctuation in tributary reservoirs, thus resulting in more substantial changes for tributary reservoirs than for mainstem reservoirs.

5.12.7 Preferred Alternative

The Preferred Alternative would increase the water elevations and/or duration of inundation in some mainstem and some tributary reservoirs. Mosquito populations on Kentucky Reservoir would not change from the Base Case. The delayed fill on Chickamauga, Watts Bar, and Fort Loudoun Reservoirs could decrease mosquito populations in April and May. Extension of summer pools on Chickamauga, Guntersville, Wheeler, and Pickwick Reservoirs could result in an increase in mosquito breeding habitat and populations for both permanent pool and floodwater species. An increased risk of mosquito-borne diseases in late summer would result. Potential effects associated with the Preferred Alternative would vary on tributary reservoirs. Historically, water levels in tributary reservoirs have fluctuated more than those in mainstem reservoirs. Mosquito populations could increase on Norris and Fontana Reservoirs, and the mosquito season could be extended on these reservoirs. Water levels of these tributaries would be higher and longer than in the past. During the first few years, this increase in mosquitoes could be worse because the vegetation along the shore line would be inundated, creating more mosquito habitat. This effect should lessen over the years, as this vegetation begins to die because of the inundation.

5.12.8 Summary of Impacts

Tables 5.12-01 and 5.12-02 provide a summary of impacts on mosquito population abundance by policy alternative. Alternatives that would increase water elevations or extend the area and duration of inundation may increase mosquito breeding habitat and populations, depending on temperature and rainfall during the mosquito season (March through October). The effects of these modifications depend primarily on weather (temperature and rainfall) and the resulting water levels.

The Base Case and the Commercial Navigation Alternative are not anticipated to affect present rates or trends for mosquito population abundance or disease occurrence. Depending on weather, which could dominate the effect of reduced water elevations in a particular year or for a period of years, the Summer Hydropower Alternative would result in diminished mosquito populations for both permanent pool and floodwater species, and a corresponding reduced risk of mosquito-borne diseases.

Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative would result in an increase in mosquito breeding habitat and populations for both permanent pool and floodwater species, and an increased risk of mosquito-vectored diseases. The individual effects of these alternatives probably would differ slightly but cannot be described in a meaningful way because of the complexity of the natural system and the dominating effects of weather. Potential effects associated with Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative would be greater on tributary reservoirs because the operations changes for tributary reservoirs would deviate more from existing operations on those reservoirs.

In general, the Preferred Alternative would increase mosquito populations and extend the mosquito season for both permanent pool and floodwater species on some mainstem and tributary reservoirs. The effects would vary by reservoir. An increase in mosquito populations or an extension of the mosquito season would increase the risk of mosquito-vectored diseases.

Table 5.12-01 Summary of Impacts on Mosquito Population Abundance at Selected Reservoirs by Policy Alternative

Reservoir	Alternative							
	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs								
Fort Loudoun	No change	No change	Decrease	No change	No change	No change	No change	Decrease
Watts Bar	No change	Increase	Decrease	No change	No change	Increase	No change	Decrease
Chickamauga	Increase	Increase	Decrease	Increase	No change	Increase	Increase	Increase
Guntersville	Increase	Increase	Decrease	Increase	No change	Increase	Increase	Increase
Wheeler	Increase	Increase	Decrease	Increase	No change	Increase	Increase	Increase
Wilson	No change	No change	Decrease	Increase	No change	No change	No change	No change
Pickwick	Increase	Increase	Decrease	Increase	No change	Increase	Increase	Increase
Kentucky[1]	Increase	Increase	Decrease	Increase	No change	Increase	Increase	No change
Tributary Reservoirs								
Cherokee	Increase	Increase	No change	Increase	No change	Increase	Increase	No change
Douglas	Increase	Increase	Decrease	Decrease	Increase	Increase	Increase	No change
Hiwasee	Increase	Increase	Decrease	Increase	No change	Increase	Increase	No change
South Holston	Increase	Increase	No change	Increase	No change	Increase	Increase	Increase
Fontana	Increase	Increase	Decrease	Decrease	No change	Increase	Increase	Increase
Tims Ford	No change	Increase	Decrease	Decrease	No change	Increase	No change	No change
Norris	Increase	Increase	Decrease	Increase	No change	Increase	Increase	Increase

Notes:

"Decrease," "increase," and "no change" indicate the effect of a particular alternative on mosquito breeding habitat and the consequent effect on mosquito population abundance and the associated risk of disease.

The selected tributary reservoirs were chosen for analysis because of their mosquito and aquatic plant history.

[1] The effects of increasing the water level on Kentucky Reservoir are amplified because TVA does not fluctuate water levels to control mosquito populations on that reservoir.

Table 5.12-02 Summary of Impacts on Vector Control by Policy Alternative

Alternative	Description of Impacts
Base Case	No change to the number of days mosquito breeding habitat would be present.
Reservoir Recreation A	Adverse – Extending summer pools would extend the number of days mosquito breeding habitat would be present.
Reservoir Recreation B	Adverse – Extending summer pools would extend the number of days mosquito breeding habitat would be present.
Summer Hydropower	Beneficial – Drop in elevations earlier would provide less mosquito breeding habitat.
Equalized Summer/Winter Flood Risk	Slightly adverse – The equalization of flood risk would slightly increase the number of days mosquito breeding habitat would be present.
Commercial Navigation	No change to the number of days mosquito breeding habitat would be present.
Tailwater Recreation	Adverse – Extending summer pools would extend the number of days mosquito breeding habitat would be present.
Tailwater Habitat	Adverse – Extending summer pools would extend the number of days mosquito breeding habitat would be present.
Preferred	Adverse – Extending summer pools would extend the number of days mosquito breeding habitat would be present.

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5.13 Threatened and Endangered Species

5.13.1 Introduction

The information about endangered, threatened, and other types of protected species presented in Section 4.13 and Appendix D6a indicates that 526 protected species are known from within the 1-mile buffers around the reservoir and stream waterbodies covered by the scope of the ROS evaluation. Of that total, 172 species are known from within the 200-foot buffers around the waterbodies. The remainder of the discussion presented in Section 4.13 provides two general conclusions about the occurrence of protected species as they relate to the evaluation of the policy alternatives. Most protected species known from within or immediately adjacent to the waterbodies where ROS activities could occur typically exist in aquatic habitats along the least-modified stream reaches (warm tributary tailwaters, flowing mainstem reaches, some pooled mainstem reaches, and cool-to-warm tributary tailwaters). Relatively few protected species exist in or adjacent to any tributary reservoir, in any cool/cold tributary tailwaters, or in the drier terrestrial habitats that exist within 200 feet of any waterbody. These observations indicate that warm tributary tailwaters, flowing mainstem reaches, some pooled mainstem reaches, and cool-to-warm tributary tailwaters are the waterbody categories where most of the direct effects of the policy alternatives on protected species could occur. The information presented in Section 4.13 also suggests that at least a few of the 526 protected species known from the ROS waterbody areas can occur in just about any habitat present within 1 mile around almost any reservoir or tailwater included in this evaluation. This observation indicates that the evaluation of indirect and cumulative effects associated with the policy alternatives should consider all of the protected species known from the 1-mile buffers around the potentially affected waterbodies. These conclusions form the basis for the evaluation of threatened and endangered species described in this section.

The information presented in the following discussion is a general summary of the evaluation that has been conducted with regard to threatened and endangered species. Details of the evaluation concerning protected species living in flowing-water habitats are presented in Appendix D6b. Results of the species-specific evaluation concerning federal-protected animals and plants are presented in the USFWS Biological Opinion (Appendix G).

5.13.2 Impact Assessment Methods

Direct Effects

The information presented in Section 4.13 indicates that 172 protected species are known from within the 200-foot buffers around the ROS waterbodies—the area where any direct effects of the policy alternatives would be most likely to occur. Information about the typical habitats and known occurrences of these species was used to associate them into clusters that would be affected in similar ways by various operational changes. The seven evaluation clusters are identified in Table 5.13-01, along with the numbers of species in each major taxonomic group that were assigned to them. The species included in each cluster are identified in the following paragraphs. In addition, the “Direct Effects Analysis” column in Appendix D6a presents the evaluation cluster in which each species is addressed.

Excluded Areas

Information presented in Section 3.4.1 indicates that none of the alternatives would include changes in the operations policy at Normandy Dam in the Duck River watershed or at any of the four dams in the Bear Creek watershed (Bear Creek, Upper Bear Creek, Little Bear Creek, and Cedar Creek Dams). Therefore, the following evaluation excludes any discussion about the 23 protected species that occur only within the 200-foot buffers around the 13 waterbodies in the Duck River and Bear Creek watersheds. Each of these excluded species is identified in the “Direct Effects Analysis” column in Appendix D6a. Any potential for the various alternatives to affect these species is discussed below under Indirect Effects.

Flowing-Water Habitats

The largest cluster of protected species identified in Table 5.13-01 consists of 58 species that typically occur in flowing-water habitats, including at least some parts of the impounded mainstem Tennessee and Cumberland Rivers. Nearly all of these species are mollusks and fish; however, the flowing-water habitats cluster also includes two turtles and a large, completely aquatic, salamander (the hellbender). All of these species are typically found in habitats out in the river or stream, where the water is obviously moving.

Holding water in reservoirs can modify habitat conditions important to flowing-water species because temperature and DO concentrations stratify in reservoirs during late spring, summer, and early fall, and those changes affect the water released from the dams. As described in Section 3.3, the various types of changes that could be made in the reservoir operations policy focus on when reservoir elevations would be raised or lowered, and when and how much water would be released from the dams. TVA aquatic biologists used these basic concepts to help identify specific evaluation measures (metrics) that would indicate any differences in direct effects between the Base Case and each policy alternative. The metrics were designed to focus on specific locations and specific times of the year that are important to the reproduction and survival of species living in flowing-water habitats. Metrics were developed for each of the four waterbody categories in which direct effects of the alternatives could affect protected species populations (warm tributary tailwaters, flowing mainstem reaches, pooled mainstem reaches, and cool-to-warm tributary tailwaters). These metrics are listed in Table 5.13-02. Details about why each metric is pertinent to specific waterbody types and the results of the comparisons between various alternatives and the Base Case are presented in Appendix D6b.

Table 5.13-01 Number of Protected Species Included in Each Part of the Direct Effects Evaluation

Direct Effects Analysis Category	Numbers of Species within Major Taxonomic Groups								Category Totals
	Plants	Mollusks	Arthropods	Fish	Amphibians	Reptiles	Birds	Mammals	
Excluded areas	8	5	0	11	0	0	0	0	23
Flowing-water habitats	0	44	0	11	1	2	0	0	58
Shoreline and lowland habitats	29	0	0	2	1	1	4	0	37
Upland habitats	30	0	0	0	0	0	1	0	31
Apalachia Bypass reach	4	3	0	1	0	0	0	0	8
Wide-ranging species	0	0	0	0	0	0	3	4	7
Reservoir inflow areas	1	1	0	2	0	0	0	0	4
Cave aquifers	0	0	1	2	0	0	0	0	3
Group totals	**72**	**53**	**1**	**29**	**2**	**3**	**8**	**4**	**172**

Note: The part of this evaluation in which each individual protected species is addressed is indicated in the “Direct Effects Evaluation” column in Appendix D6a.

Table 5.13-02 Flowing-Water Habitat Evaluation Metrics

Metric No.[1]	Waterbody Category and Metric Description
Pooled Mainstem Waterbodies	
1	The total volume of water in a reservoir with dissolved oxygen (DO) < 2 mg/L during the year
Flowing Mainstem Waterbodies	
2	The amount of time when the water downstream from a dam would contain DO < 2 mg/L during the summer period (July through October)
3	The minimum water level that would be achieved 90 percent of the time during the year at a given point downstream from a dam
Warm Tributary Tailwaters (4–9) and Cool-to-Warm Tributary Tailwaters (10–15)	
4 & 10	The minimum water level achieved 90 percent of the time during the year at the selected sites
5 & 11	The difference between the 90- and 10-percent instantaneous flow rates at the selected sites during the second and third weeks in June
6 & 12	The average water temperature at the selected sites during the second and third weeks in June
7 & 13	The difference between the 90- and 10-percent instantaneous water temperatures at the selected sites during the second and third weeks in June
8 & 14	The average water temperature at the selected sites during the third and fourth weeks in August
9 & 15	The difference between the 90- and 10-percent instantaneous water temperatures at the selected sites during the third and fourth weeks in August

[1] These metrics are specific evaluation measures developed by TVA aquatic biologists to compare the effects of the policy alternatives at specific locations and during specific times of the year that are important to the reproduction and survival of species living in flowing-water habitats.

Results of the three metric comparisons concerning the effects of the policy alternatives on protected species living in mainstem reservoirs and tailwaters (pooled mainstem reaches and flowing mainstem reaches, respectively) are summarized in Table 5.13-03. Most of the policy alternatives would produce substantially higher minimum water elevations (substantially more potential habitat for protected aquatic species) downstream from the mainstem dams (Metric # 3). The exceptions to this pattern are the Equalized Summer/Winter Flood Risk Alternative and the Preferred Alternative, both of which would typically produce minimum water elevations similar to those produced under the Base Case. Few of the policy alternatives would produce any differences in the number of hours with DO < 2 mg/L released from the mainstem dams (Metric # 2). The major exception to this pattern was the expectation of more hours of low DO discharges (substantially adverse habitat conditions) downstream from Watts Bar Dam under the Preferred Alternative; however, TVA has committed to providing a minimum of 4 mg/L DO in the discharge from this dam.

Table 5.13-03 Summary of Direct Effects on Threatened and Endangered Species for Mainstem Reservoirs and Tailwaters

Metric No.	Affected Waterbody	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower[1]	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs									
1	Kentucky	N	N		N	N	N	SA	N
1	Guntersville	N	N		N	N	N	N	N
1	Chickamauga	N	N		N	N	N	SA	N
Mainstem Tailwaters									
2	Pickwick discharge	N	SA		N	N	N	N	N
2	Wilson discharge	N	N		N	N	N	SA	N
2	Guntersville discharge	SA	N		N	N	N	N	N
2	Watts Bar discharge	N	N		N	N	N	N	SSA
3	Pickwick—RM 190	SB	SSB		N	SSB	SSB	SSB	N
3	Wilson—RM 256	SSB	SSB		N	SSB	SSB	SSB	N
3	Guntersville—RM 349	SB	SB		N	N	SB	SB	N
3	Watts Bar—RM 530	SSB	SSB		SA	SB	SSB	SSB	N

Notes:

RM = River mile.

Evaluation abbreviations:

A = Adverse changes with regard to protected aquatic species.
B = Beneficial changes with regard to protected aquatic species.
N = Not statistically different from the Base Case.
S = Slightly (80 – 95 percent confidence level).
SS = Substantially (95 percent confidence level or higher).

[1] No statistical analysis data are available for this alternative.

Other exceptions were more hours of low DO discharges (slightly adverse conditions) downstream from Guntersville Dam under Reservoir Recreation Alternative A, downstream from Pickwick Dam under Reservoir Recreation Alternative B, and downstream from Wilson Dam under the Tailwater Habitat Alternative. Only the Tailwater Habitat Alternative would result in more water volume with DO < 2 mg/L in at least some of the downstream reservoirs (Metric # 1); that alternative yielded indications of more water with low DO (slightly adverse habitat conditions) in Kentucky and Chickamauga Reservoirs.

Overall, only the Tailwater Habitat Alternative would result in decreased DO concentrations in mainstem reservoirs (slightly adverse habitat conditions) in comparison to what would occur under the Base Case, and only the Equalized Summer/Winter Flood Risk Alternative and the Preferred Alternative would result in minimum water levels as low as what would occur under the Base Case. All of the other alternatives would yield higher minimum water levels (providing slightly or substantially more habitat for protected aquatic species). The Preferred Alternative could result in more hours of low DO water downstream from Watts Bar Dam (substantially adverse habitat conditions); however, TVA would ensure that the discharge from Watts Bar Dam continued to meet its existing 4 mg/L DO target.

Table 5.13-04 summarizes the results of the 12 metric comparisons concerning the effects of the policy alternatives on protected species living in warm and cool-to-warm tributary tailwaters. With regard to the minimum water level metrics (Metrics # 4 and # 10), only the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would produce effects different from what would occur under the Base Case. The Equalized Summer/Winter Flood Risk Alternative would result in higher minimum water levels (slightly more minimum wetted area) at the (warm) French Broad River site. The Tailwater Habitat Alternative would result in higher minimum water levels at the site on the French Broad River (slightly beneficial habitat conditions) and at both sites on the Holston River (substantially beneficial conditions).

With regard to the mid-June flow range metrics (Metrics # 5 and # 11), only the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would produce effects different from what would occur under the Base Case. The Equalized Summer/Winter Flood Risk Alternative would produce less variation in mid-June flow ranges at both sites on the Holston River (substantially beneficial habitat conditions for protected species) and at the cool-to-warm site on the Elk River (slightly beneficial conditions for protected species). The Tailwater Habitat Alternative would produce less variation in flow ranges (substantially beneficial conditions) at the sites on the Holston, French Broad, and Hiwassee Rivers but would not result in flow ranges any different from those under the Base Case at either site on the Elk River.

The four average temperature metrics (Metrics # 6 and # 12 concerning mid-June and Metrics # 8 and # 14 concerning late August) tend to follow consistent patterns—at least on the individual rivers. All of the policy alternatives would produce higher (substantially beneficial) average temperatures than under the Base Case at the Hiwassee River site during both time periods. All of the policy alternatives except the Commercial Navigation Alternative would produce lower (substantially adverse) average temperatures than under the Base Case at both Holston River sites in late August (Metric # 14). The Equalized Summer/Winter Flood Risk Alternative would produce higher (substantially beneficial conditions) average temperatures at the cool-to-warm site on the Elk River during both time periods, higher (slightly beneficial) average temperatures at the warm site on the Elk River in mid-June, and higher (substantially beneficial) average temperatures at both Holston River sites in mid-June.

Table 5.13-04 Summary of Direct Effects Metrics Related to Protected Species for Warm and Cool-to-Warm Tributary Tailwaters

Metric	Location	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower[1]	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred	Metric	Location	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower[1]	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Warm Tributary Tailwaters										**Cool-to-Warm Tributary Tailwaters**									
4	Holston RM 30	N	N		N	N	N	SSB	N	10	Holston RM 48	N	N		N	N	N	SSB	N
4	Fr. Broad RM 18	N	N		SB	N	N	SB	N	10	Hiwassee RM 48	N	N		N	N	N	N	N
4	Elk RM 73	N	N		N	N	N	N	N	10	Elk RM 125	N	N		N	N	N	N	N
5	Holston RM 30	N	N		SSB	N	N	SSB	N	11	Holston RM 48	N	N		SSB	N	N	SSB	N
5	Fr. Broad RM 18	N	N		N	N	N	SSB	N	11	Hiwassee RM 48	N	N		N	N	N	SSB	N
5	Elk RM 73	N	N		N	N	N	N	N	11	Elk RM 125	N	N		SB	N	N	N	N
6	Holston RM 30	N	N		SSB	SB	N	N	N	12	Holston RM 48	N	N		SSB	N	N	N	N
6	Fr. Broad RM 18	N	N		SSB	N	N	N	N	12	Hiwassee RM 48	SSB	SSB		SSB	SSB	SSB	SSB	SSB
6	Elk RM 73	N	N		SB	N	N	N	N	12	Elk RM 125	N	N		SSB	N	N	N	N
7	Holston RM 30	N	N		N	N	N	SB	N	13	Holston RM 48	N	N		SSA	N	N	N	N
7	Fr. Broad RM 18	N	N		SSA	N	N	N	N	13	Hiwassee RM 48	N	N		N	N	N	SB	N
7	Elk RM 73	N	N		N	N	N	N	N	13	Elk RM 125	N	N		SSB	N	N	N	N

Table 5.13-04 Summary of Direct Effects Metrics Related to Protected Species for Warm and Cool-to-Warm Tributary Tailwaters (continued)

Metric	Location	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower[1]	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Warm Tributary Tailwaters (continued)									
8	Holston RM 30	SSA	SSA		SSA	N	SSA	SSA	SSA
8	Fr. Broad RM 18	N	N		SSB	N	N	N	N
8	Elk RM 73	N	N		N	N	N	N	N
9	Holston RM 30	N	N		N	N	N	SSB	N
9	Fr. Broad RM 18	N	N		SB	N	N	N	N
9	Elk RM 73	N	N		N	N	N	N	N

Metric	Location	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower[1]	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Cool-to-Warm Tributary Tailwaters (continued)									
14	Holston RM 48	SSA	SSA		SSA	N	SSA	SSA	SSA
14	Hiwassee RM 48	SSB	SSB		SSB	SSB	SSB	SSB	SSB
14	Elk RM 125	N	SB		SB	N	SB	N	N
15	Holston RM 48	SB	SSB		SB	N	SSB	SSB	N
15	Hiwassee RM 48	N	N		N	N	N	N	N
15	Elk RM 125	N	SSB		SSB	N	SSB	N	N

Notes:

Fr = French.
RM = River mile.

Evaluation abbreviations:

A = Adverse changes with regard to protected aquatic species.
B = Beneficial changes with regard to protected aquatic species.
N = Not statistically different from the Base Case.
S = Slightly (80 – 95 percent confidence level).
SS = Substantially (95 percent confidence level or higher).

1 No statistical analysis data are available for this alternative.

Concerning the four temperature range metrics, the policy alternatives would produce very few differences from the ranges under the Base Case at the warm tailwater sites during either mid-June (Metric # 7) or late August (Metric # 9). Two of the exceptions to this pattern would occur under the Tailwater Habitat Alternative, which would produce less temperature variation at the warm reach site on the Holston River during both mid-June (slightly beneficial habitat conditions) and in late August (substantially beneficial conditions). The other exceptions would occur at the French Broad River site under the Equalized Summer/Winter Flood Risk Alternative, which would produce more temperature variation (substantially adverse conditions) in mid-June and less variation (slightly beneficial conditions) in late August than would occur under the Base Case.

In the cool-to-warm tailwater reaches, the effects of the alternatives on the temperature range metrics would differ, depending on which month was being examined. During mid-June (Metric # 13), the Tailwater Habitat Alternative would produce less variation (slightly beneficial conditions) at the Hiwassee River site. Also during mid-June, the Equalized Summer/Winter Flood Risk Alternative would produce more temperature variation (substantially adverse habitat conditions) at the Holston River site and less temperature variation (substantially beneficial conditions) at the Elk River site. During late August (Metric # 15), none of the alternatives would produce temperature variations different from the Base Case at the Hiwassee River site. At the Elk River site, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, and the Tailwater Recreation Alternative would produce less temperature variation (substantially beneficial conditions) during this period. At the Holston River site, five of the alternatives would produce less temperature variation during late August (slightly beneficial habitat conditions under Reservoir Recreation Alternative A and the Equalized Summer/Winter Flood Risk Alternative; substantially beneficial conditions under Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Preferred Alternative).

The Summer Hydropower Alternative is not included in the metric evaluation of the flowing-water habitats because the Water Quality model could not provide output data for low-flow years (such as 1987 to 1989) when that alternative would result in discharging virtually all of the water in several tributary reservoirs. The general impressions about the effects of the Summer Hydropower Alternative on protected aquatic species that can be derived from its description (see Section 3.3.4) suggest that summer flow and, probably, water temperatures in the tributary tailwaters would be more variable than under the Base Case (less natural conditions for protected aquatic species). In mainstem reservoirs and tailwaters during the summer months, the Summer Hydropower Alternative probably would provide higher flows and, possibly, higher DO concentrations (more natural conditions for protected aquatic species) than would occur under the Base Case.

Shoreline and Lowland Habitats

The shoreline and lowland habitats that exist along the margins of the reservoirs and regulated stream reaches included in the ROS study area are inhabited by many types of animals and plants, some of that are protected at the federal or state level. The cluster of species covered by this part of the protected species evaluation includes a total of 39 species: 30 plants, five birds, two fish, an amphibian, and a reptile. Each of these species is identified in the "Direct Effects Analysis" column in Appendix D6a. Some of these species spend their entire lives submersed in springs, ponds, or other bodies of water (such as largeleaf pondweed and spring pygmy sunfish) but most of the others live in and around wetland habitats at the edges of the waterbodies. Changes in summer and winter pool levels, and when the reservoirs would be filled and drawn down under the various policy alternatives, could substantially affect the protected species living in these shoreline and lowland habitats. The general aspects of those effects are discussed in Section 5.8 (Wetlands) and Section 5.10 (Terrestrial Ecology). The following paragraphs focus on the ways various policy alternatives could affect the protected species living in these habitats.

Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative would involve holding reservoir pool levels higher until, or later than, Labor Day. Under these alternatives, large areas on the mainstem reservoirs now occupied by scrub/shrub or bottomland hardwood communities would become aquatic beds; however, the Preferred Alternative would not involve any pool level changes or impacts on shoreline habitats on Kentucky Reservoir. Protected plants and animals now living in scrub/shrub or bottomland hardwood communities (such as lamance iris and green treefrog) would be adversely affected by the loss of suitable habitat. Other protected species (such as the great egret and wood stork) might benefit from the additional foraging habitat; however, they also might lose present roosting and potential nesting sites. Spring and seep habitats harboring protected aquatic species adjacent to the full-pool reservoirs would not be adversely affected and might increase in size as the scrub/shrub habitats declined. Overall, these alternatives would adversely affect protected species living in shoreline and lowland habitats, primarily because of the unreplaced loss of the scrub/shrub habitats.

Under the Summer Hydropower Alternative, reservoir pool levels would be held at high levels for much shorter time periods during the year than would occur under the Base Case. Under the Summer Hydropower Alternative, large areas of mainstem and tributary reservoirs now occupied by various types of wetland habitats would lose water more quickly during the growing season, and upland species would encroach on those habitats. Protected species that require wetland habitat conditions (such as sweetflag) would be adversely affected. This alternative also would result in adverse impacts on protected species living in shoreline and lowland habitats, again because of habitat loss.

The changes in reservoir pool levels that would occur under the Equalized Summer/Winter Flood Risk Alternative would result in continual changes in reservoir pool elevations. These pool level changes would occur throughout the growing season and would essentially prevent the establishment of stable wetland communities (see Section 5.8, Wetlands). As with the previous two sets of alternatives, protected species that require relatively stable wetland habitat conditions would be adversely affected by the Equalized Summer/Winter Flood Risk Alternative, although, once again, different operations policy would be responsible.

The Commercial Navigation Alternative would involve only minor modifications in pool levels during summer. During winter, the higher mainstem pool levels would serve to stabilize some wetland habitats, perhaps as slightly different communities than presently exist. Higher winter mainstem pool levels also could result in less foraging habitat for protected shorebirds such as the piping plover. Overall, this alternative probably would result in slightly beneficial impacts on protected shoreline and lowland species when compared to the Base Case.

Upland Habitats

The upland habitats cluster of protected species includes 30 plants (identified in the "Direct Effects Analysis" column in Appendix D6a) and one bird (Swainson's warbler). All of these species have been encountered within the 200-foot buffers around one or more ROS waterbodies; however, they typically occur in drier upland habitats that are not influenced by manipulation of the reservoirs or tailwaters. As indicated for all upland plant and animal communities (see Section 5.10, Terrestrial Ecology), these protected species would not be affected (directly or indirectly) by any of the policy alternatives. None of the alternatives would include raising summer pool levels any higher than under the Base Case; none of the alternatives would involve changes in the loss of land by wave action, erosion, or mass wasting (see Section 5.16, Shoreline Erosion); and none of the alternatives would result in changes in the locations or rates of conversion of open land to residential or commercial developments (see Section 5.15, Land Use).

Apalachia Bypass Reach

The eight protected species included in the Apalachia Bypass Reach cluster consist of four plants, two freshwater mussels, an aquatic snail, and a fish. These species are being evaluated together mostly because one of the habitats in which they all occur would be affected by a flow modification that is proposed as part of each of the policy alternatives.

During all times of the year, except when spilling is required from Apalachia Dam, nearly all of the flow at this dam is diverted through a tunnel to the powerhouse. The river channel in this bypassed stream reach receives leakage flow from the dam and unregulated inflow from several small tributary streams. Terrestrial vegetation along the bypass reach includes some species adapted to life in and along the river channel, along with trees and other woody vegetation that can survive infrequent but substantial flooding and scouring. These eight protected species include two plants (Ruth's golden aster and gibbous panic-grass) that are only found in rock crevices along scoured streambeds; two aquatic or semi-aquatic plants (creekgrass and a pondweed) that occur in the water; and three mollusks and a fish (knotty elimia snail, Cumberland bean, tan riffleshell mussels, and tangerine darter) that occur on, in, or not far from the stream bottom.

TVA may augment minimum flow in the 13-mile reach of the Hiwassee River between Apalachia Dam and the Apalachia Powerhouse to enhance the diversity of aquatic species in that waterbody. The present concept is to release a continuous flow of approximately 25 cfs from Apalachia Dam into the bypass reach between June 1 and November 1. The additional flow would be intended to increase the wetted area down the length of the bypass channel and provide additional flow and habitat stability for native aquatic species. This modification in the flow pattern downstream from Apalachia Dam is included in each of the policy alternatives (see Section 3.4.1).

The additional minimum flow would increase the amount of, and improve the quality of, the habitats for the protected mollusks and fish, and, potentially, for other protected aquatic species that exist or could be introduced into this part of the Hiwassee River. With regard to the plants, however, the infrequent but substantial spilling events control whether these protected species can continue to survive along this river channel. Previous observations have suggested that submersal for more than 10 consecutive days during the growing season (March through September) probably would have adverse effects on at least some of these plant species. Analysis of the actual flow data; however, indicates that spills exceeding 10 days duration have occurred routinely during the 60-year period since Apalachia Dam was built. Adoption of the proposed additional flow down this bypass channel would not result in more days of spilling or longer duration spills than would occur under the Base Case. These results indicate that the proposed change would not likely result in adverse effects on the protected plants or animals in this area.

Wide-Ranging Species

This cluster of six species includes two birds (peregrine falcon and bald eagle) and four mammals (eastern big-eared bat, gray bat, eastern small-footed bat, and Indiana bat). All six of these species have specific breeding, feeding, and roosting requirements; however, they all also range over wide areas on a daily or a seasonal basis, typically including some time over or along reservoirs and larger streams. Peregrine falcons and eastern small-footed bats would continue to forage, roost, and reproduce unaffected by the types or extent of changes involved in the policy alternatives.

Bald eagles and gray bats could be benefited by Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Commercial Navigation Alternative, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative to the extent that each alternative would increase the size of reservoir pools and increase the numbers of food items (mostly fish and waterfowl for the eagles and adult aquatic insects for gray bats). The Summer Hydropower Alternative could have the opposite effect on these species because it would decrease the size of mainstem reservoir pools and might decrease the number of food items for these species. Results of the Aquatic Resources evaluation indicate that Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative would likely result in degraded biodiversity but increases in the number of warm-water fishes (see Section 5.7, Aquatic Resources). That evaluation also indicated that the Commercial Navigation Alternative would result in similar effects on aquatic life to what would occur under the Base Case.

In contrast, eastern big-eared bats and Indiana bats could be adversely affected by Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Commercial Navigation

Alternative, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative to the extent that each alternative would increase the size of reservoir pools and decrease the number of suitable roosting trees in forested wetlands (see Section 5.8 [Wetlands] and Section 5.10 [Terrestrial Ecology]). Under any of these alternatives, both of these species would be able to find other suitable roosting trees in adjacent areas and would be able to adapt to the habitat changes without any long-term adverse effects.

Reservoir Inflow-Related Areas

This evaluation cluster includes only four species; however, these species represent a variety of relationships that may be pertinent across many parts of the river systems. One of these species, Cumberland rosemary, lives on seasonally inundated banks and bars along swift Cumberland Plateau streams—including a site on the Emory River just upstream from the full pool level on Watts Bar Reservoir. The second species, the Appalachian elktoe, is known from unimpounded stream reaches just upstream from Fontana and Calderwood Reservoirs. The third, bluemask darter, occurs in unimpounded stream reaches just upstream from Great Falls Reservoir. And the fourth, sicklefin redhorse (a fish), is known from impounded and unimpounded reaches upstream from Mission and Fontana Reservoirs. In all four of these cases (and, potentially at least, in several others), the flowing-water habitats in which these species occur extend downstream to the limits of or, occasionally, into the impoundments. The present status of these species (and, in effect, the Base Case) includes the fact that the impoundments were built and the habitats within those reservoirs may not be suitable for the protected species. Each of the policy alternatives calls for the reservoirs to be filled to present summer pool levels at some point during the year, and none of the policy alternatives includes raising summer pool levels any higher than they would be under the Base Case. Those facts support the conclusion that none of the policy alternatives would result in additional impacts on protected aquatic species living upstream from the affected reservoirs. The same facts also support the conclusion that none of the policy alternatives would likely provide any long-term benefits to upstream populations of protected aquatic species because any flowing-water habitat restored by lowering a reservoir pool during part of the year would be re-impounded at other times during the year.

Cave Aquifers

Three protected species are known from pools or flowing water in caves within the 200-foot buffer areas around the ROS waterbodies. These three protected aquatic cave species are an un-described cave shrimp, the Alabama cavefish, and the southern cavefish. In each of the locations where these species occur adjacent to ROS waterbodies, the underground aquifer systems exist at a higher elevation than the full pool level of the adjacent reservoir or regulated stream reach and do not appear to fluctuate when the reservoir pool levels are changed. Given that none of the policy alternatives would include raising pool levels higher than the elevations already reached under the Base Case, none of the policy alternatives would directly affect these protected cave aquatic species.

Indirect Effects

As indicated in Section 4.13, Table 4.13-02, and the introduction to this section, at least a few of the 526 protected species know from within the 1-mile buffers around the ROS waterbodies could occur in virtually any habitat present in those corridors. On that basis, the possibility exists that one or more of the policy alternatives could result in secondary or indirect effects on some protected species even though the operational changes at the dams associated with the alternatives would not directly affects those species.

While secondary and indirect effects on protected species might occur under some of the policy alternatives, information presented in other sections of this EIS indicates that no indirect effects on these species would occur. As indicated for all the terrestrial plant and animal communities (see Section 5.10, Terrestrial Ecology), none of the alternatives would include raising summer pool levels any higher than would occur under the Base Case; none of the alternatives would involve more than minor changes in the loss of land by wave action, erosion, or mass wasting (see Section 5.16, Shoreline Erosion); and none of the alternatives would result in changes in the locations or rates of conversion of open land to residential developments (see Section 5.15, Land Use). If none of the alternatives would affect the locations or rates of residential shoreline development, they also would not lead to any indirect effects on waterbodies included in this evaluation or any stream segments further upstream from the tributary reservoirs.

5.13.3 Base Case

Under the Base Case, existing trends would continue with regard to the status of endangered, threatened, and other protected species in the ROS study area. As indicated in Section 4.13, 526 of the species that occur in the TVA region have been provided additional protection by the federal and state governments because their original habitats had been severely degraded by human development of the land and the water. The variety of monitoring, habitat improvement, and enhancement activities that have been started in recent years are likely to continue and perhaps would be expanded. Laws and regulations would continue to provide some level of protection for these species. Future trends for the protected species in the ROS study area are likely to include a few successes, more failures, and many unknowns. The following summaries indicate the likely trends for the seven clusters of protected species discussed in Section 5.13.2 under the Base Case.

Flowing-Water Habitats. As indicated in Section 4.7, Aquatic Resources, the flowing-water habitats in the tributary tailwaters are beginning to show signs of improvement following the addition of minimum flows and DO augmentations identified in the Lake Improvement Plan. Except for the expanding snail darter populations in the tailwaters downstream from Cherokee and Douglas Dams, monitoring data do not yet indicate that protected aquatic species are responding to these improvements. Some protected species are being reintroduced into the tributary and mainstem tailwaters on the assumption that they should survive and reproduce there. Populations of most protected freshwater mussel species living in mainstem waterbodies do not include many young individuals and appear to be declining toward extirpation in those habitats.

Shoreline and Lowland Habitats. Information presented in Section 4.8 (Wetlands) and Section 4.10 (Terrestrial Ecology) indicates that most shoreline and lowland plant and animal communities appear to have adapted to the present operations policy; however, the spread of invasive wetland species and continuing pressure to develop shoreline property are reducing the size and number of these habitats. Unrelated to the TVA reservoir operations policy, the continuation of existing trends along shorelines and other lowland habitats would include the gradual loss of suitable habitat and populations of protected species that occur in those areas.

Upland Habitats. Protected species living in upland areas around the reservoirs and regulated streams are not directly affected by the present operations policy. Given the presence of the reservoirs, the continuation of existing trends would include the gradual loss of natural upland habitats to invasive species and development. More than likely, some protected upland species would benefit from ongoing and future enhancement activities; however, many others would continue to remain unknown to the general public and could be adversely affected by increasing development pressures.

Other Protected Species. Under the Base Case, the other clusters of protected species discussed in Section 5.13.2 also would continue to follow existing trends. Most of the wide-ranging birds and bats would continue to expand in numbers and distribution as ongoing management activities fulfill their goals, while the Indiana bat would continue to decline. Protected species living in caves or free-flowing stream reaches upstream from impoundments would not be affected by the reservoir operations policy but could be affected by localized pollution events or development pressures.

5.13.4 Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and Tailwater Recreation Alternative

Under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and the Tailwater Recreation Alternative, summer pool levels would be extended on most tributary reservoirs to Labor Day but would vary from each other in the amounts and the timing of releases from the dams. Concerning protected species, the variety of monitoring, habitat improvement, and enhancement activities that have been started in recent years are likely to continue and perhaps would be expanded. Laws and regulations would continue to provide some level of protection for these species, and future trends for the protected species in the ROS study area would likely be similar to the patterns described for the Base Case. The following summaries indicate how impacts on habitat clusters of protected species under these alternatives would differ from those described in the Base Case.

Flowing-Water Habitats. Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and the Tailwater Recreation Alternative would result in relatively few changes in the habitats of protected aquatic species in the regulated river system. In tributary tailwaters, Reservoir Recreation Alternative A and the Tailwater Recreation Alternative would result in more natural summer water temperatures in some cool-to-warm waterbodies than the Base Case, while all three of these alternatives would result in less natural water temperatures in others. In the Tennessee River mainstem, all three alternatives would result in higher minimum water levels in tailwaters, which could provide some additional habitat for protected aquatic species. Reservoir Recreation Alternative A also might result in less DO than the Base Case in the releases from some mainstem dams.

Shoreline and Lowland Habitats. The longer duration of summer pool levels on tributary reservoirs that would occur under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and the Tailwater Recreation Alternative would result in losses of scrub/shrub habitats along the margins of those waterbodies. Protected species that depend on scrub/shrub habitats would be adversely affected by these changes.

Upland Habitats. Like the Base Case, Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and the Tailwater Recreation Alternative would not affect protected species living in upland habitats.

Other Protected Species. Under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and the Tailwater Recreation Alternative, the longer duration of summer pool levels could benefit populations of bald eagles and gray bats foraging over the affected reservoirs. Under these alternatives, impacts on other wide-ranging protected species, protected species occurring upstream from impoundments or living in caves, or protected species living in the Hiwassee River between Apalachia Dam and the Apalachia Powerhouse would not differ from what would occur under the Base Case.

5.13.5 Equalized Summer/Winter Flood Risk Alternative and Tailwater Habitat Alternative

Although the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative have different purposes, both would involve operating the dams based on the amount of runoff coming into the river system. Under these alternatives, reservoir pool levels and flows in the tailwaters would vary in response to how much water was flowing down the rivers. Laws and regulations would continue to provide some level of protection for protected species in the ROS study area, and future trends for those species would likely be somewhat similar to the patterns described for the Base Case. The variety of monitoring, habitat improvement, and enhancement activities that have been started in recent years also would be likely to continue and perhaps would be expanded within the context of either of these alternatives.

Flowing-Water Habitats. Both the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would tend to provide more natural flow and temperature regimes in mainstem tailwaters than the Base Case; however, the Tailwater Habitat Alternative also could provide more stressful DO conditions in mainstem waterbodies. In the tributary tailwaters, these alternatives would lead to more natural summer flow and water temperature conditions.

Shoreline and Lowland Habitats. The Equalized Summer/Winter Flood Risk Alternative would lead to adverse changes in the habitats of shoreline and wetland protected species because reservoir pool levels would be continually changing throughout the year. The Tailwater Habitat Alternative would lead to adverse changes in the habitats of some shoreline and wetland protected species because tributary reservoir pool levels would remain higher during parts of the year than they would under the Base Case.

Upland Habitats. The Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would not affect protected species living in upland habitats.

Other Protected Species. Under the Tailwater Habitat Alternative, the longer duration of summer pool levels on tributary reservoirs could benefit populations of bald eagles and gray bats foraging over those areas. Impacts under the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would not differ from those described under the Base Case for other wide-ranging protected species, protected species occurring upstream from impoundments or living in caves, or protected species living in the Hiwassee River between Apalachia Dam and the Apalachia Powerhouse.

5.13.6 Commercial Navigation Alternative

The operational changes included in the Commercial Navigation Alternative would focus on improving the reliability of the mainstem Tennessee River for commercial navigation. Impacts on protected species related to the changes in winter pool levels and minimum flows downstream from the mainstem dams associated with this alternative would be similar to those described for the Base Case. The variety of monitoring, habitat improvement, and enhancement activities that have been started in recent years would likely continue and perhaps would be expanded under this alternative. Laws and regulations would continue to provide some level of protection for these species, and the future trends for the protected species in the ROS study area would remain unchanged from what would occur under the Base Case.

Flowing-Water Habitats. Impacts on the habitats of protected aquatic species under the Commercial Navigation Alternative would be similar to those described for the Base Case. In tributary tailwaters, the only differences in impacts from those described for the Base Case would be a few more examples of more natural average summer water temperatures. In mainstem habitats, the only differences would be increases in minimum water elevations. None of the flowing-water metrics indicated more adverse impacts than would occur under the Base Case.

Shoreline and Lowland Habitats. The higher winter pool levels and only minor modifications in summer pool levels on mainstem reservoirs that would occur under the Commercial Navigation Alternative would slightly benefit protected species living in shoreline and wetland habitats.

Upland Habitats. The Commercial Navigation Alternative would not affect protected species living in upland habitats.

Other Protected Species. The relative stability in mainstem pool levels provided by the Commercial Navigation Alternative would result in potential benefits to bald eagles and gray bats. This alternative would not have effects any different from the Base Case on other wide-ranging protected species, protected species occurring upstream from impoundments or living in caves, or protected species living in the Hiwassee River between Apalachia Dam and the Apalachia Powerhouse.

5.13.7 Summer Hydropower Alternative

Operation of the reservoir system under the Summer Hydropower Alternative would focus on maximizing power production at the dams. Daily and seasonal changes in dam operations would result in a variety of differences from the Base Case. Although monitoring activities on the river system would likely continue, some habitat improvement and enhancement activities that have been started in recent years might not be continued because of the decrease in tailwater habitat stability. Laws and regulations would continue to provide some level of protection for endangered and threatened species; future trends for the protected species in the ROS study area would be the same as described for the Base Case.

Flowing-Water Habitats. As indicated in Section 5.13.2, the Summer Hydropower Alternative could not be included in the metric evaluation because no water quality modeling data were available. General impressions about the effects of the Summer Hydropower Alternative on protected aquatic species that can be derived from its description suggest that summer flow and probably water temperatures in the tributary tailwaters would be more variable than would occur under the Base Case (less natural conditions for protected aquatic species). In mainstem reservoirs and tailwaters during summer, the Summer Hydropower Alternative probably would provide higher flows and possibly higher DO concentrations (more natural conditions for protected aquatic species) than the Base Case.

Shoreline and Lowland Habitats. The early lowering of summer reservoir pool levels under the Summer Hydropower Alternative would reduce the amount of wetland habitats and would result in adverse changes for protected species that occur in those areas.

Upland Habitats. The Summer Hydropower Alternative would not affect protected species living in upland habitats.

Other Protected Species. The early lowering of summer reservoir pool levels under the Summer Hydropower Alternative would reduce the size of mainstem reservoir pools, which could lead to decreases in the numbers of prey species for bald eagles and gray bats. Impacts under the Summer Hydropower Alternative would not differ from those described under the Base Case for wide-ranging protected species, protected species occurring upstream from impoundments or living in caves, or protected species living in the Hiwassee River between Apalachia Dam and the Apalachia Powerhouse.

5.13.8 Preferred Alternative

Under the Preferred Alternative, tributary reservoir drawdown would be restricted from June 1 through Labor Day, summer operating zones would be maintained through Labor Day at four additional mainstem projects, and higher winter pool operating ranges would be established at 10 tributary reservoirs. Base Case minimum flows and the DO targets adopted following completion of the Lake Improvement Plan would continue to be met and, subject to flood control operations or extreme drought conditions, scheduled releases would be provided at five additional tributary projects to increase tailwater recreational opportunities. No changes in operations policy would occur on Kentucky Reservoir under the Preferred Alternative.

Concerning protected species, the variety of monitoring, habitat improvement, and enhancement activities that have been started in recent years are likely to continue and perhaps would be expanded. Laws and regulations would continue to provide some level of protection for these species, and future trends for the protected species in the ROS study area would likely be similar to the patterns described for the Base Case.

Flowing-Water Habitats. The Preferred Alternative would result in relatively few changes in the habitats of protected aquatic species in the regulated river system. In tributary tailwaters, this alternative would result in more natural summer water temperatures in some cool-to-warm waterbodies and less natural water temperatures in others than would occur under the Base Case. In the Tennessee River mainstem, adoption of the Preferred Alternative would not degrade present habitat quality downstream from the dams; however, additional effort would be required to continue to provide a minimum of 4 mg/L DO downstream from Watts Bar Dam.

Shoreline and Lowland Habitats. The longer duration of summer pool levels on tributary and some mainstem reservoirs that would occur under the Preferred Alternative would result in losses of scrub/shrub habitats along the margins of those waterbodies. Protected species that depend on scrub/shrub habitats would be adversely affected by these changes. These effects would not occur on Kentucky Reservoir because no changes in operations policy would occur in that reservoir under the Preferred Alternative.

Upland Habitats. Like the Base Case, the Preferred Alternative would not affect protected species living in upland habitats.

Other Protected Species. Under the Preferred Alternative, the longer duration of summer pool levels could benefit populations of bald eagles and gray bats foraging over the affected reservoirs. Under this alternative, impacts on other wide-ranging protected species, protected species occurring upstream from impoundments or living in caves, or protected species living in the Hiwassee River between Apalachia Dam and the Apalachia Powerhouse would not differ from what would occur under the Base Case.

5.13.9 Summary of Impacts

Table 5.13-05 provides a summary of the results of the analysis of impacts on threatened, endangered, and other protected species.

In general, these results indicate that the Commercial Navigation Alternative would not result in any adverse effects on protected species and would provide beneficial effects on summer water temperatures for protected species in comparison to the Base Case. The Preferred Alternative would also provide beneficial effects on summer water temperatures for protected aquatic species in some tailwaters but would result in adverse summer temperature effects in other tailwaters. Both the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would lead to some adverse effects on scrub/shrub habitats along reservoir shorelines but would also provide beneficial temperature effects for protected species in tributary tailwaters. The Tailwater Recreation Alternative, Reservoir Recreation Alternative A, and Reservoir Recreation Alternative B would result in some adverse effects on scrub/shrub habitats along reservoir shorelines and some adverse summer temperature effects on protected aquatic species in tributary tailwaters. The Summer Hydropower Alternative probably would result in adverse effects on summer water temperature ranges in tailwaters and on scrub/shrub habitats along reservoir shorelines.

Table 5.13-05 Summary of Impacts on Endangered, Threatened, and Other Protected Species by Policy Alternative

Alternative	Evaluation Cluster							
	Flowing-Water Mainstem Reservoirs and Tailwaters	Flowing-Water Tributary Reservoirs and Tailwaters	Shorelines and Lowland Habitats	Uplands Habitats	Apalachia Bypass Reach	Wide-Ranging Species	Reservoir Inflow Areas	Cave Aquifers
Base Case	No change – Continuation of existing trends could lead to eventual loss of some mussel species from these habitats.	No change – Continuation of existing trends would include increasing diversity and reintroductions of protected species in these tailwaters.	No change – Continuation of existing trends would include the gradual loss of habitats and species populations.	No change – Existing trends would continue.	No change – Existing trends would continue.	No change – Existing trends would continue.	No change – Existing trends would continue.	No change – Existing trends would continue.
Reservoir Recreation A	Slightly beneficial – Higher minimum water levels on tailwaters; less DO in releases from some dams.	Variable – Less natural water temperatures in some tailwaters, more natural in others; less late summer temperature variation in some tailwaters.	Slightly adverse – Unreplaced loss of scrub/shrub habitats due to higher summer pool levels.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Slightly beneficial – Potential benefits to eagles and gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.
Reservoir Recreation B	Slightly beneficial – Higher minimum water levels on tailwaters; less DO in releases from some dams.	Variable – Less natural water temperatures in some tailwaters, more natural in others; less late summer temperature variation in some tailwaters.	Slightly adverse – Unreplaced loss of scrub/shrub habitats due to higher summer pool levels.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Slightly beneficial – Potential benefits to eagles and gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.

Table 5.13-05 Summary of Impacts on Endangered, Threatened, and Other Protected Species by Policy Alternative (continued)

Alternative	Evaluation Cluster							
	Flowing-Water Mainstem Reservoirs and Tailwaters	Flowing-Water Tributary Reservoirs and Tailwaters	Shorelines and Lowland Habitats	Uplands Habitats	Apalachia Bypass Reach	Wide-Ranging Species	Reservoir Inflow Areas	Cave Aquifers
Summer Hydropower	Beneficial – Probably higher flows and DO concentrations.	Adverse – Probably more variable summer flows and water temperatures.	Adverse – Unreplaced loss of wetland habitats due to shorter duration of summer pool levels.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Adverse – Potential adverse effects to gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.
Equalized Summer/ Winter Flood Risk	No change – Lower tailwater level at one site.	Beneficial – Less variation in June flow rates and less summer temperature variation in some tailwaters; more natural summer water temperatures in most tailwaters.	Adverse – Unreplaced loss of wetland habitats due to frequent changes in pool levels.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	No change – Existing trends would continue.	No change – Existing trends would continue.	No change – Existing trends would continue.
Commercial Navigation	Beneficial – Higher minimum water levels on most tailwaters.	Slightly beneficial – Very similar to Base Case; more natural summer water temperature in some tailwaters.	Slightly beneficial – Increased stability of slightly modified wetlands.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Slightly beneficial – Potential benefits to eagles and gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.

Table 5.13-05 Summary of Impacts on Endangered, Threatened, and Other Protected Species by Policy Alternative (continued)

Alternative	Evaluation Cluster							
	Flowing-Water Mainstem Reservoirs and Tailwaters	Flowing-Water Tributary Reservoirs and Tailwaters	Shorelines and Lowland Habitats	Uplands Habitats	Apalachia Bypass Reach	Wide-Ranging Species	Reservoir Inflow Areas	Cave Aquifers
Tailwater Recreation	Beneficial – Higher minimum water levels on tailwaters.	Variable – Less natural water temperatures in some tailwaters, more natural in others; less late summer temperature variation in some tailwaters.	Slightly adverse – Unreplaced loss of scrub/shrub habitats due to higher summer pool levels.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Slightly beneficial – Potential benefits to eagles and gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.
Tailwater Habitat	Variable – Higher minimum water levels on tailwaters; larger volume of low DO water; longer time of low DO discharges at one dam.	Beneficial – More natural summer water temperatures and late summer temperature ranges in some tailwaters.	Adverse – Unreplaced loss of scrub/shrub habitats due to higher summer pool levels.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Slightly beneficial – Potential benefits to eagles and gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.
Preferred	No change – Longer time of low DO discharges at one dam (would be corrected).	Few changes from Base Case – Less natural water temperatures in some tailwaters; more natural in others.	Slightly adverse – Unreplaced loss of scrub/shrub habitats due to higher summer pool levels; no change from Base Case on Kentucky Reservoir.	No change – Existing trends would continue.	Slightly beneficial – Increased minimum flow would benefit aquatic species; no effects on terrestrial species.	Slightly beneficial – Potential benefits to eagles and gray bats.	No change – Existing trends would continue.	No change – Existing trends would continue.

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5.14 Managed Areas and Ecologically Significant Sites

5.14.1 Introduction

Changes in reservoir operations are not likely to eliminate or alter the boundaries of managed areas and ecologically significant sites. Reservoir operations changes, however, could affect the resources that managed areas were established to address, thereby affecting their integrity. As described in Section 4.14, the most frequently cited management objectives for potentially affected managed areas and ecologically significant sites are protection of state- and federal-listed species, water-dependent bird habitat management, and recreation use. Habitat protection is an underlying objective of most managed areas and ecologically significant sites. Managed areas on reservoir or tailwater shorelines are most vulnerable to direct impacts, while upland and headwater areas are less vulnerable and therefore were eliminated from further assessment.

Potential indirect effects of increased shoreline development—including habitat fragmentation, the spread of invasive species, the presence of feral animals, increased visitor pressure, sedimentation, and erosion—were considered negligible, because only the rate of development may vary among alternatives (see Section 5.15, Land Use), and not, ultimately, the location or amount of developed acreage.

5.14.2 Impact Assessment Methods

The effects of each policy alternative on managed area resources and uses, including wetlands, terrestrial ecology, endangered and threatened species, and recreation, are addressed in Sections 5.8 (Wetlands), 5.10 (Terrestrial Ecology), 5.13 (Threatened and Endangered Species), and 5.24 (Recreation), respectively.

The evaluation in Section 5.8, Wetlands, included wetland attributes such as location, type, and function, as well as managed wetlands such as those subimpoundments that are seasonally drained and flooded for waterfowl management purposes. The integrity of some of the largest managed areas relies on the ability to raise and lower water levels in these managed wetlands. Many managed areas and ecologically significant sites also protect “unmanaged” wetlands for wildlife or endangered species habitat; therefore, all wetland types and functions are critical to the integrity of managed areas and ecologically significant sites.

The most likely effects of changes in reservoir operations on terrestrial ecology (see Section 5.10, Terrestrial Ecology) would be to lowlands and reservoir-associated wildlife. Particularly vulnerable resources include bottomland hardwood forests, scrub/shrub wetlands, annual flats plant communities, and globally rare wetland communities—many of which are protected within managed areas and ecologically significant sites.

Many threatened and endangered species occur in managed areas and ecologically significant sites, some of which were established to conserve these species. Those most likely to be affected by changes in the reservoir operations policy are the aquatic species along the least modified stream reaches, including warm tributary tailwaters, flowing mainstem reaches, some pooled mainstem reaches, and cool-to-warm tributary tailwaters (see Section 5.13, Threatened and Endangered Species). Alternatives that alter water temperature, DO, and quantity of water may produce conditions more or less similar to the natural conditions in which threatened and endangered species thrive.

For each policy alternative, the combined effects on the resources described above were evaluated for significance to the operational integrity of managed areas and ecologically significant sites as a group, because many of these sites fulfill multiple and varied management objectives. The evaluations focused on wetlands and managed subimpoundments, the managed area resources with the greatest potential to be affected by the policy alternatives.

5.14.3 Base Case

Under the Base Case, managed areas and ecologically significant sites would remain in their current state of management, subject to natural fluctuations. In general, these sites meet their management objectives under existing operating conditions and would continue to do so. The general trend of slight shifts in wetland location, type, and function (see Section 5.8, Wetlands) would have little effect on managed area integrity. The stress exhibited in some bottomland hardwoods, particularly water tupelo, from excessive periods of inundation under the current water regime (see Section 5.10, Terrestrial Ecology) could affect the integrity of a few sites such as the 281-acre Muddy Bottoms TVA HPA on Wheeler Reservoir and portions of the 34,500-acre Wheeler NWR.

5.14.4 Commercial Navigation Alternative

Conditions under the Commercial Navigation Alternative would be generally similar to those for the Base Case. The greatest change affecting managed areas would be the higher winter pools and slight increases in the duration of water cover over flats and shoreline. This would adversely affect management of migratory shorebirds while slightly benefiting other wildlife. Management of waterfowl subimpoundments in refuges and waterfowl management areas on Kentucky, Barkley, and Wheeler Reservoirs may be adversely affected if higher late-winter and spring water levels hinder their dewatering.

5.14.5 Reservoir Recreation Alternative A and Tailwater Habitat Alternative

Under Reservoir Recreation Alternative A and the Tailwater Habitat Alternative, mean summer pool duration and winter pool elevations would increase on many mainstem reservoirs and selected tributary reservoirs. This increase in water availability would benefit aquatic bed wetlands but would result in slightly adverse effects on other wetland types (primarily flats, scrub/shrub, and forested wetlands, and associated wildlife), and adverse effects on late-summer and early-fall migrating shorebirds targeted by many of the state and federal wildlife refuges. Higher winter water levels on Wheeler and Douglas Reservoirs could adversely affect the management of waterfowl impoundments as described for the Commercial Navigation Alternative. Overall, Reservoir Recreation Alternative A and the Tailwater Habitat Alternative would result in slightly adverse to beneficial effects on managed areas and ecologically significant sites.

5.14.6 Reservoir Recreation Alternative B and Tailwater Recreation Alternative

Under Reservoir Recreation Alternative B and the Tailwater Recreation Alternative, mean summer pool duration would extend several weeks longer than under Reservoir Recreation Alternative A, and winter pool elevations would increase on many mainstem reservoirs and selected tributary reservoirs. The timing of the increase in water would slightly benefit some wetlands and wildlife habitat functions but would adversely affect flats, scrub/shrub, and forested wetlands, hindering protection of these wetland types in areas such as Rankin Bottoms. These alternatives also would increase the risk of crop flooding in waterfowl subimpoundments on Kentucky, Wheeler, and Douglas Reservoirs. The overall effects of these two alternatives on managed areas and ecologically significant sites would be slightly adverse.

5.14.7 Summer Hydropower Alternative

Under the Summer Hydropower Alternative, summer pool duration would be shorter than under the Base Case due to increased power production, and winter pools would be higher on tributary reservoirs. The resulting shifts in reservoir-dependent wetlands would occur too quickly for adaptive changes (Section 5.8, Wetlands), resulting in a substantially adverse effect on wetlands in managed areas. The delayed filling and early drawdown on mainstem reservoirs could have a beneficial effect on waterfowl subimpoundments by facilitating spring dewatering and reducing summer flood risk and subsequent crop loss. Invasive species may become problematic in managed areas. Bottomland hardwoods and some globally imperiled plant communities could be substantially adversely affected by the prolonged drawdown that would allow upland plants to invade and alter community composition. Overall, the Summer Hydropower Alternative would adversely affect many managed areas and ecologically significant sites.

5.14.8 Equalized Summer/Winter Flood Risk Alternative

The higher winter pools and lower but extended summer pools of the Equalized Summer/Winter Flood Risk Alternative would result in slightly adverse impacts on lowland plant communities, including flats, scrub/shrub, and forested wetlands, and associated shorebirds and protected species within managed areas. Low summer pools and delay in filling could hinder waterfowl management by reducing cover and foraging habitat in shoreline wetlands and by reducing late-season flooding opportunities on croplands managed for waterfowl. Higher winter water levels would impair habitat for migrating shorebirds. However, the risk of premature flooding of cropland for wildlife may be reduced by the delayed spring fill associated with this alternative (see Section 5.10, Terrestrial Ecology). The overall combined effects of the Equalized Summer/Winter Flood Risk Alternative on managed areas and ecologically significant sites would be adverse, but slightly less adverse than those for the Summer Hydropower Alternative.

5.14.9 Preferred Alternative

Under the Preferred Alternative, mean summer pool duration and winter pool elevations would increase on many mainstem reservoirs and selected tributary reservoirs. The increase in summer pool duration would result in the same variable impacts on wetlands, migrating shorebirds, and waterfowl subimpoundments as described for the Reservoir Recreation Alternative A and the Tailwater Habitat Alternative. The 0.5-foot increase in winter pool elevations on Wheeler Reservoir would likely have minimal effects on Wheeler NWR subimpoundments. Due in part to concerns over impacts on wildlife refuges, operating guide curves on Kentucky Reservoir would not be changed. Consequently, there would be no material changes in the operation of Kentucky and Barkley Reservoirs and thus no effects on managed areas and ecologically significant sites, including the Tennessee and Cross Creeks NWRs. Overall, the Preferred Alternative would result in slightly adverse effects on managed areas and ecologically significant sites.

5.14.10 Summary of Impacts

Reservoir operations that extend full pool into the fall migration season and increase winter water levels (Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Commercial Navigation Alternative, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative) would generally hamper management of waterfowl and/or shorebird habitat in managed areas on reservoirs. These alternatives also would affect some imperiled plant communities, scrub/shrub, and forested wetlands in managed areas and ecologically significant sites. For Reservoir Recreation Alternative B and the Tailwater Recreation Alternative, these effects would result in slightly adverse impacts on managed area integrity. For Reservoir Recreation Alternative A, the Commercial Navigation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative, these impacts may be partially offset by beneficial effects on some wetland types, associated wildlife, and other managed area resources. The resulting overall effects under these alternatives would be slightly adverse to slightly beneficial. The Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative would result in the greatest adverse effects on managed areas, affecting wetland/waterfowl management efforts and other resources.

Table 5.14-01 Summary of Impacts on Managed Areas and Ecologically Significant Sites by Policy Alternative

Alternative	Description of Impacts
Base Case	No change – Continued difficulty in protecting integrity of bottomland hardwoods (e.g., Muddy Bottoms TVA HPA and Wheeler NWR) and some aquatic endangered species sites.
Reservoir Recreation A	Slightly adverse to slightly beneficial – Effects on certain wetlands; adverse effects on waterfowl subimpoundments and migratory shorebird habitat.
Reservoir Recreation B	Slightly adverse – Effects on waterfowl subimpoundments, habitat for some migratory birds, and scrub/shrub and forested wetlands, beneficial effects on aquatic bed wetlands and associated wildlife.
Summer Hydropower	Adverse – Substantially adverse effects on wetlands; no change to beneficial effects on waterfowl sub-impoundments.
Equalized Summer/Winter Flood Risk	Adverse – Adverse effects on waterfowl subimpoundments, flats, scrub/shrub, and forested wetlands and on some associated wildlife; slight benefits to some wildlife on tributary reservoirs.
Commercial Navigation	Slightly adverse to slightly beneficial – Generally similar to Base Case; continued difficulty protecting integrity of some bottomland hardwoods (e.g., Muddy Bottoms TVA HPA and Wheeler NWR).
Tailwater Recreation	Slightly adverse – Adverse effects on waterfowl sub-impoundments and some other migratory bird habitat, and on protection of scrub/shrub and forested wetlands; slightly beneficial effects on aquatic bed wetlands and associated wildlife.
Tailwater Habitat	Slightly adverse to slightly beneficial – Effects on certain wetlands and lowland habitats; beneficial effects on aquatic bed wetlands; and adverse effects on managed subimpoundments and migratory shorebird habitat.
Preferred	Slightly adverse – Effects on migratory shorebird habitat; variable impacts on wetlands and waterfowl subimpoundments; and overall slightly adverse effects.

HPA = Habitat Protection Area.
NWR = National Wildlife Refuge.

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5.15 Land Use

5.15.1 Introduction

The land use analysis examines the effects of policy alternatives on the rates of residential shoreline development for selected reservoirs (Table 4.15-02), both mainstem and tributary storage. The selected reservoirs were chosen because their respective rates of residential development may be affected by the alternatives to the existing reservoir operations policy that are being considered in the ROS. Some reservoirs may see a slight acceleration or deceleration of buildout, thereby reaching planned capacity somewhat before or after the currently projected buildout date of 2023. As discussed in Section 4.15, residential development is the predominant land use change occurring in the shoreline (primary) and secondary zones of influence around the reservoirs. Consequently, this analysis concentrates on potential impacts from changes in the rate of residential development. Impacts from commercial or industrial development were considered in the Shoreline Management Initiative (SMI) EIS and are expected to be relatively minor in comparison to residential development. Any proposals for such developments requiring TVA approval would be subject to separate environmental review.

Each reservoir is unique, in that the Land Management Plant (LMP) and the SMI govern the available shoreline for residential development (see Section 4.15.2). Consequently, the amount of shoreline available for development varies widely among reservoirs, from as little as 8 percent to as much as 88 percent of total shoreline (Table 4.15-02).

Population in the region is expected to continue to grow, with urbanization applying pressure to some counties more than others. This anticipated growth would continue to create demand for shoreline residential property. Due to the limited availability of developable shoreline property, all reservoir land where residential access is allowed would eventually be fully developed to its planned capacity.

The factors that affect residential development are both external and internal and differing reservoir levels that result from a change in the TVA reservoir operations policy are only one of several factors of influence to be considered when analyzing rates of shoreline residential development.

5.15.2 Impact Assessment Methods

The land use analysis is based on the following information from the SMI:

- The residential development projection (e.g., 38 percent of total shoreline, or 4,192.2 miles) is the maximum system-wide reservoir shoreline property available for residential development. Actual buildout is expected to be less than 38 percent because of environmental safeguards and maintain and gain exchanges, as required by the SMI.

- Sixty-seven percent, or 2,809 miles, of the shoreline property available for residential development is undeveloped.

- The pattern for development is defined for a reservoir on an individual basis by its LMP and varies widely between reservoirs.

- The full residential buildout within the primary zone of influence (the 0.25-mile shoreline band) is likely to occur within 25 years, or approximately 2023.

- The Shoreline Management Policy requires that environmental impacts due to residential development be mitigated according to applicable regulations. Each proposed development is reviewed independently, and the mitigation requirements imposed are project specific.

- The land use analysis used the same population growth and buildout assumptions concluded in the SMI—full buildout is likely to yield 83,000 new lakefront lots, 91,000 new backlots, and an estimated population increase of 396,000 persons.

- Urbanization was identified as a population growth trend that causes some counties to grow faster than others; therefore, population growth is not evenly distributed throughout the region. Localized areas of faster growth were identified in reservoir counties near Knoxville, Tennessee; Huntsville, Alabama; the Nottely and Chatuge Reservoirs in North Georgia; and the Watts Bar area in East Tennessee.

The descriptions of positive and negative factors that influence the rate of shoreline development came from the Lake Improvement Plan (TVA 1990). Interviews with TVA land management specialists indicate that the factors identified in the Lake Improvement Plan continue to be pertinent to this analysis. For example, growth, infrastructure (transportation and utility) improvements, good-quality commercial recreation and reservoir access, scenic beauty, water quality, and property value are some of the factors that are attractive to prospective buyers. Conversely, remoteness, lack of infrastructure and urban amenities, steepness of the land, lack of commercial recreation, and large reservoir fluctuations were considered detractors for prospective buyers. The land use analysis has examined these factors and additional external factors, such as the general state of the economy, attractive mortgage rates, and real estate marketing efforts in order to understand the relationship to shoreline residential development.

TVA land management specialists have been directly involved in the planning process and the development of the specific LMPs. Having the dual role of process participants and long-term observers, these technical specialists were interviewed to obtain their understanding of the relationship between the factors discussed above and the relative rates of development seen at different reservoirs.

This land use analysis assumed that a correlation exists between the management of reservoir elevations and the duration of reservoir water levels, and the perceived desirability of reservoir shoreline for residential development. Table 4.15-02 quantifies the magnitude (in acres and shoreline miles) of shoreline to be converted to residential use within the primary zone. Potential impacts on the rate of shoreline residential development associated with the alternative reservoir operations policies are expected to be indirect, requiring a qualitative approach. The policy alternatives were compared to the Base Case to evaluate the likely effect of each alternative in causing the rate of shoreline residential development to increase or decrease. For this analysis, an increase in the rate of development means that buildout likely would occur sooner than expected under the Base Case; a decrease in the rate of development means that buildout would occur later than expected under the Base Case.

The impacts of the anticipated changes in the rate of development can be viewed as positive or negative, depending on point of view. An increase in the rate of development can result in a beneficial economic impact or an adverse impact on the natural condition of the reservoir shorelines, and the inverse relationship is also true. The terms adverse and beneficial used to describe the impacts of the alternatives pertain to potential effects on the natural condition surrounding the reservoirs. Via several survey instruments, the SMI (TVA 1998) identified that visual quality and the natural aesthetics of the reservoir shorelines are important to large percentages of residents and recreational users.

The criteria for comparing the alternatives included the metrics cited in Section 4.15.3 and were supplemented where possible by the findings of other study teams, and observations derived from reservoir LMPs, TVA Watershed Management Teams, and others. Indirect effects of shoreline residential development on other resource areas are described in the sections for those resources.

5.15.3 Base Case

The Base Case was established as the reference against which to compare the rates of conversion to residential land use affected by each policy alternative. Assuming no change in reservoir operations policy and practice, the buildout projected by the SMI may be regarded as a reasonable basis on which to expect future land use conversion to residential shoreline development to reach planned capacity.

5.15.4 Reservoir Recreation Alternative A

The improved recreational opportunities and visual quality under Reservoir Recreation Alternative A could result in a slight increase in the rate of residential shoreline development. This increase could be slightly adverse to the natural condition of the land surrounding the reservoirs.

5.15.5 Reservoir Recreation Alternative B

The effects on land use under Reservoir Recreation Alternative B would be similar to those described for Reservoir Recreation Alternative A. The slight increase in the rate of residential shoreline development could be slightly adverse to the natural conditions of the land surrounding the reservoirs.

5.15.6 Summer Hydropower Alternative

The effects on land use under the Summer Hydropower Alternative could be slightly beneficial to the natural condition of the land surrounding the reservoirs. A decrease in the rate of residential shoreline development may result from reduced recreational opportunities and visual quality.

5.15.7 Equalized Summer/Winter Flood Risk Alternative

The likely effects on land use under the Equalized Summer/Winter Flood Risk Alternative could be no change or a slight benefit to the natural condition of the land surrounding the reservoirs. A slight decrease in the rate of residential shoreline development may result from reduced recreational opportunities and visual quality.

5.15.8 Commercial Navigation Alternative

No change to the natural condition of the land surrounding the reservoirs is anticipated under the Commercial Navigation Alternative. No change in the rate of residential shoreline development on the affected reservoirs is anticipated, because summer recreation levels would not change from the Base Case.

5.15.9 Tailwater Recreation Alternative

The effects on land use under the Tailwater Recreation Alternative would be similar to those described for Reservoir Recreation Alternative B. A slightly adverse effect on the natural condition of the land surrounding the reservoirs is anticipated for the same reasons.

5.15.10 Tailwater Habitat Alternative

The effects on land use under the Tailwater Habitat Alternative could range from no change to a slightly adverse effect on the natural condition of the land surrounding the reservoirs, similar to those described for Reservoir Recreation Alternative B.

5.15.11 Preferred Alternative

The effects on land use under the Preferred Alternative would be similar to those described for Reservoir Recreation Alternative A. The improved recreational opportunities and visual quality could result in a slight increase in the rate of residential shoreline development. This increase could be slightly adverse to the natural condition of the land surrounding the reservoirs.

5.15.12 Summary of Impacts

A number of factors influence the rate of shoreline residential development, such as the overall condition of the economy and the attractiveness of mortgage rates. These factors are broad based and would apply to development at all reservoirs. Other factors, such as urbanization, developed infrastructure and recreation, and reservoir fluctuation are apt to be reservoir specific—with attributes at certain reservoirs more likely to attract development. Those reservoirs are likely to develop faster than other reservoirs. In all cases, all of these factors apply to all of the alternatives being considered to varying degrees.

The land use analysis concluded that the reservoir operations policy can influence the rate of shoreline residential development but is not a determining factor when compared to other factors, such as urbanization and the health of the economy. Table 5.15-01 summarizes anticipated impacts on land use by policy alternative. Shoreline development is expected to occur as projected in the SMI, and none of the alternatives would affect the identified 38-percent total buildout. The land use analysis did find that some alternatives, including the Preferred Alternative, could contribute to a slight increase in the rate of residential shoreline development. Increased summer pool durations and winter flood guide levels, as described in the Preferred Alternative, would provide for an overall increase in reservoir recreational opportunities and visual quality. Improvements to these public values could result in a slight increase in the rate of shoreline development. Both the planning and management processes ensure that the environmental impacts of future development are addressed by the appropriate regulations in place for each proposed project.

Table 5.15-01 Summary of Impacts on Land Use by Policy Alternative

Alternative	Description of Impacts
Base Case	Buildout to 38% would occur as projected in the Shoreline Management Initiative (by 2023).
Reservoir Recreation A	Slightly adverse effects on natural conditions would occur because of a slight increase in the rate of residential shoreline development.
Reservoir Recreation B	Slightly adverse effects on natural conditions would occur because of a slight increase in the rate of residential shoreline development.
Summer Hydropower	Slightly beneficial effects on natural conditions would occur because a decrease in the rate of residential shoreline development may result in a slight benefit to the natural condition of land surrounding the reservoirs.
Equalized Summer/Winter Flood Risk	No change to slightly beneficial effects on natural conditions would occur because of a slight decrease in the rate of residential shoreline development.
Commercial Navigation	No change to natural conditions would occur.
Tailwater Recreation	Slightly adverse effects on natural conditions would occur because of a slight increase in the rate of residential shoreline development.
Tailwater Habitat	No change to slightly adverse effects on natural conditions would occur because of a slight increase in the rate of residential shoreline development.
Preferred	Slightly adverse effects on natural conditions would occur because of a slight increase in the rate of residential shoreline development.

5.16 Shoreline Erosion

5.16.1 Introduction

Erosion caused by TVA system operations occurs in both the reservoirs and the tailwater riverine sections. This section analyzes the impacts of reservoir operation alternatives on erosion in reservoirs and tailwaters, and provides a relative ranking of the impacts of the alternatives.

5.16.2 Impact Assessment Methods

Erosion in reservoirs is primarily influenced by wave energy affecting the shoreline and dislodging soil particles. Wave energy is derived from two sources: wind-generated waves and boat-generated waves. Wind waves are a function of the wind velocity and the fetch, the open distance, across the reservoir along which waves can build energy. Boat-generated waves in TVA reservoirs are due to recreational boat traffic and commercial activities, such as barge traffic. In general, commercial boat traffic is more prominent on TVA mainstem reservoirs than on tributaries.

In reservoirs, the area that is subject to wave action at the highest normal reservoir elevations is of the most interest. This zone is now subject to modification by water, whereas areas down slope have been subject to wave action and exposure to weather for decades. This zone has property than can be affected by erosion, and is of most concern for cultural resources (see Sections 4.18 and 5.18, Cultural Resources). For this analysis, the shoreline erosion zone is defined as the elevations between the June 1 flood guide elevation and 3 feet below the June 1 flood guide.

Wave energy is particularly important in the shoreline erosion zone; boat waves are more frequent due to summer recreational use and there are known critically eroded areas in the shoreline erosion zone (see the description of TVA ALIS data in Section 4.16). Much of the shoreline considered "poor" in the ALIS data set has a vertical or steep bank that is vulnerable to wave action. Relatively gentle slopes distribute wave energy over a large area, while steep banks absorb all of the energy in a small area. If a reservoir is not held at a higher water elevation for as long, these areas do not see as much wave action, and the wave energy is generally distributed over less abrupt slopes. If the reservoir is not filled as full, these areas never see wave action, and the waves generally only affect areas that have already eroded to a flatter slope. Conversely, if the reservoir surface elevation is held in the shoreline erosion zone longer, erosion effects are exacerbated. Shoreline shape (convex vs. concave, and radius of curvature) and the angle of wave action relative to the shoreline can have a large affect on local rates of erosion. Combined with the wind exposure, this factor makes islands and peninsulas more prone to erosion than coves or straight shore lines.

Another form of erosion of concern in reservoirs is mass wasting. Mass wasting is the slumping, sliding, or toppling of sections of bank, caused by structural failure. An example of this is the slumping of cohesive, saturated soils from a steep embankment when water levels are dropped. Mass wasting is usually caused by erosion of the shoreline at the toe of the slope or by undercutting of steep slopes. The resulting slope failure may occur after drawdown, but is not caused by drawdown.

Raindrops that land on exposed, unvegetated soils can initiate the erosion process by dislodging soil particles from the force of raindrop impact on the ground. This process is of concern to the TVA reservoir shorelines in the drawdown zone between maximum pool elevation and winter pool elevation. This drawdown zone has been exposed to raindrop impacts for many decades. It is likely that where there is rocky soil or shallow soil over bedrock, most of these soils have already eroded. Erosion in the drawdown zone may cause minor water quality impacts, but there is generally less concern about this erosion because usable land is not lost by this process. Reservoir storage capacity is not lost because eroded material generally originates within the pool. Unlike the shoreline erosion zone, erosion conditions of the drawdown zone have not been surveyed.

At winter pool elevations, wave energy also affects the shore, which are often unvegetated bare soils. The lowest pool levels can expose the areas around the original stream banks, which are frequently more subject to erosion than thinner, stonier upland soils. On the other hand, boat traffic typically is considerably less in winter than in summer. As with the drawdown zone, the winter pool shoreline conditions have not been surveyed.

Another factor affecting shoreline erosion is potential removal of vegetative cover from the shoreline. As discussed in the SMI EIS, healthy stands of woody and herbaceous vegetation around a riparian zone of a reservoir provide substantial protection of the shoreline from erosion. Development of the shoreline that would modify the shoreline vegetative cover would adversely affect erosion. Modification of shoreline vegetative covers from development was not a major consideration in this analysis for the following reasons. As described in Section 4.16, TVA has permit authority through Section 26a of the TVA Act to require erosion control measures for any shoreline development. In addition, TVA has designated a finite amount of shoreline land that is available for development. Although each of the policy alternatives may slightly modify the anticipated buildout date of the land available for development (see Section 4.15, Land Use), this change is not anticipated to affect the overall erosion conditions of the reservoirs.

Erosion in tributary tailwaters generally takes two forms. Surface erosion is the detachment and transport of surface material by flowing water that affects both the bed and the banks of a stream when they are exposed to flowing water. Mass wasting, as described above, can also occur in tailwaters when shoreline soils are saturated and water levels are dropped, especially where banks are steep.

Because mainstem tailwaters are essentially the upstream end of the next downstream reservoir, erosion in both reservoirs and mainstem tailwaters are influenced more by wave energy, whereas tributary tailwaters are primarily influenced by the forces of flowing water. Therefore, separate analyses were conducted for reservoir and mainstem tailwater shorelines and for tributary tailwater shorelines.

The analysis conducted for this EIS considered the following elements to evaluate potential impacts of reservoir operations policy alternatives. Three primary factors were evaluated:

- Duration of reservoir elevations in the shoreline erosion zone. Longer periods at high pool levels would cause wave energy to exacerbate existing erosion.

- Changes in boat-wave energy from recreational boat activity and commercial barge operations. Longer periods at high pool levels would result in higher recreational boat traffic, which would accelerate the rate of erosion.

- Cumulative shear stress hours over a year. None of the alternatives would increase existing maximum tailwater flows, so peak shear stresses would remain the same. However, some alternatives would change the duration and balance between the annual peak flows and secondary peak flows and could result in higher net cumulative shear stress over the annual cycle, potentially resulting in increased erosion.

Other potential contributing factors that were considered include:

- Erosion of the drawdown zone between maximum pool elevation and winter pool elevation due to raindrop impact forces on bare unvegetated soils and from mass wasting of saturated soils from the drawdown action;

- Erosion of the shorelines at winter pool elevations, which may erode bare unvegetated shorelines;

- Development of the shoreline—removal of vegetation on the shoreline—can accelerate erosion; however, existing TVA policies and land management practices were anticipated to eliminate or render unsubstantial any differences in development-related erosion potential between the policy alternatives; and,

- Changes in reservoir surface area—higher reservoir levels create longer distances for wind energy to build up. None of the policy alternatives were anticipated to modify the surface areas of the reservoirs to the degree that a change in wind fetch would be measurable; therefore, this metric was not considered in the analysis.

Data used to evaluate the potential changes in erosion from the policy alternatives are summarized in the tables below.

Table 5.16-01 provides the percent change in the duration of reservoir pool levels in the shoreline erosion zone compared to the Base Case that is projected for each representative reservoir. The number of days at shoreline erosion zone elevations is an indicator of the relative impacts from wave energy affecting shorelines; higher values show a higher relative risk of increase in shoreline erosion.

Table 5.16-01 Comparison of Duration of Reservoir Surface Elevations in the Shoreline Erosion Zone of Policy Alternatives to Base Case for Representative Reservoirs

	Alternative							
	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Watauga	66.7%	241.7%	41.7%	166.7%	0.0%	75.0%	141.7%	33.3%
S. Holston	77.8%	111.1%	-22.2%	-22.2%	0.0%	155.6%	111.1%	77.8%
Boone	0.0%	-4.8%	-66.7%	-52.4%	0.0%	-4.8%	0.0%	4.8%
Cherokee	133.3%	200.0%	-16.7%	-100.0%	0.0%	200.0%	233.3%	50.0%
Douglas	27.3%	63.6%	-54.5%	-100.0%	0.0%	63.6%	127.3%	-9.1%
Fontana	71.4%	128.6%	-42.9%	-100.0%	0.0%	128.6%	171.4%	57.1%
Norris	100.0%	144.4%	-22.2%	-100.0%	0.0%	122.2%	166.7%	66.7%
Chatuge	42.9%	64.3%	-14.3%	-100.0%	0.0%	50.0%	114.3%	14.3%
Nottely	100.0%	137.5%	-12.5%	-75.0%	0.0%	100.0%	212.5%	50.0%
Hiwassee	33.3%	77.8%	-55.6%	-100.0%	0.0%	44.4%	122.2%	22.2%
Blue Ridge	53.8%	53.8%	-38.5%	-100.0%	0.0%	53.8%	153.8%	7.7%
Tims Ford	0.0%	15.8%	-57.9%	-100.0%	0.0%	15.8%	0.0%	0.0%
Ft Loudon	3.0%	3.0%	-45.5%	-27.3%	0.0%	3.0%	3.0%	0.0%
Watts Bar	3.0%	3.0%	-45.5%	-9.1%	-6.1%	3.0%	3.0%	0.0%
Chickamauga	7.4%	7.4%	-44.4%	-11.1%	3.7%	7.4%	7.4%	3.7%
Nickajack	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Guntersville	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wheeler	32.1%	28.6%	-32.1%	-3.6%	3.6%	28.6%	32.1%	10.7%
Wilson	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Pickwick	33.3%	29.6%	-29.6%	0.0%	0.0%	29.6%	33.3%	14.8%
Kentucky	22.7%	136.4%	-22.7%	0.0%	136.4%	136.4%	22.7%	-4.5%
Mean tributary	**58.9%**	**102.8%**	**-30.2%**	**-65.2%**	**0.0%**	**83.7%**	**129.5%**	**31.2%**
Mean mainstem	**11.3%**	**23.1%**	**-24.4%**	**-5.7%**	**15.3%**	**23.1%**	**11.3%**	**2.7%**
Mean overall	**38.5%**	**68.7%**	**-27.7%**	**-39.7%**	**6.6%**	**57.7%**	**78.9%**	**19.0%**

The number of cumulative shear stress hours over a median year in tailwaters is an indication of the degree that shear stress forces may dislodge soil particles from streambanks. Table 5.16-02 compares the cumulative shear stress hours calculated from projected median flows of the policy alternatives to the Base Case. The days exhibiting highest flows are typically in spring, with minimal flows in late spring-early summer, and some high-flow periods in fall, but the alternatives change the relative duration of the spring and fall peak discharges. Because maximum generator discharge capacity does not change, the cumulative shear stress calculated from the projected flow curves did not show substantial variability among the alternatives (many are probably within the uncertainty of the models used), and some decrease the potential for erosion compared to the Base Case.

Table 5.16-02 Change in Cumulative Shear Stress of Policy Alternatives Compared to Base Case for Representative Reservoirs

Reservoir	Alternative							
	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Tributary Reservoirs								
Chatuge	-0.6%	-3.6%	-2.2%	-3.7%	NC	-2.2%	-4.3%	-2.0%
Cherokee	2.8%	-3.5%	16.5%	-1.4%	NC	-3.4%	-1.2%	-5.8%
Douglas	-0.1%	-2.0%	0.4%	-1.0%	NC	-1.3%	-3.9%	+0.1%
Nottely	2.3%	-2.8%	-0.3%	-5.1%	NC	-0.2%	-1.5%	-3.4%
Mainstem Reservoirs								
Pickwick	+1.0%	+1.4%	-3.5%	+0.2%	-0.4%	+1.4%	+0.6%	-0.4%

Notes:

NC = No change.

Positive entries designate increase in cumulative shear stress (higher erosion) for this alternative compared to the Base Case; negative entries designate a decrease.

As this analysis developed, it became clear that the reservoirs chosen to represent the affected environment in Chapter 4 did not fully represent the changes in operations in the proposed alternatives. Reservoirs were added to the analysis to fully illustrate the range of impacts from the alternatives.

Projected changes in recreational use of the TVA reservoir system are discussed in Section 4.24, Recreation. Table 5.24-01 provides forecasted recreational use numbers in user days over the 35 TVA projects, and Table 5.24-02 provides an overall summery of the forecasts. The recreation analysis did not consider projections for each individual reservoir. The main recreational factor of interest for the erosion analysis is the overall projected changes in recreation use from the Base Case. Also of interest are the projected changes in recreational use below the dams (tailwaters). This information is summarized in Table 5.16-03.

Table 5.16-03 Summary of Change from Base Case in Recreation Use by Policy Alternative (August, September, and October)

	Alternative							
	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Public access use below dams	No change	Slight increase	Slight decrease	Slight decrease	No change	Slight increase	No change	No change
Overall projected change	Large increase	Large increase	Moderate decrease	Slight increase	Slight decrease	Large increase	Large increase	Moderate increase

5.16.3 Base Case

The Base Case would result in continued erosion of reservoir shorelines and implementation of treatments and BMPs by TVA and others to improve shoreline conditions. Reservoir shorelines would continue to erode at their present rate, or potentially at a slightly accelerated rate due to projected increased recreational use.

As with reservoir shorelines, tributary tailwater streambanks would continue to erode under the Base Case at their present rate or potentially at a slightly accelerated rate due to projected increased recreational use.

5.16.4 Reservoir Recreation Alternative A

Duration of pool levels in the shoreline erosion zone under Reservoir Recreation Alternative A would be substantially longer in most reservoirs compared to the Base Case, thereby increasing the existing rate of erosion. Increased recreational boating would also contribute to erosion of the shoreline. Higher winter levels would decrease exposure of any sediment deposits formed since impoundment and the original stream channel and floodplains. This would reduce erosion in these areas. Overall the effect of Reservoir Recreation Alternative A on reservoir shoreline erosion is projected to be adverse.

Under Reservoir Recreation Alternative A, the higher winter pool increases discharges during the early spring, already the highest-discharge period. This is mitigated during drawdown in fall, when discharges are generally a little lower than Base Case for a longer period than the spring peak. The net effect is that there is likely to be little change in potential for tailwater erosion under this alternative.

5.16.5 Reservoir Recreation Alternative B and Tailwater Recreation Alternative

Reservoir Recreation Alternative B would substantially increase the duration in the shoreline erosion zone in most reservoirs, especially tributary reservoirs. A large increase in boat activity is also projected. Therefore, this alternative has high erosion potential. The Tailwater Recreation Alternative would also increase shoreline erosion zone durations at most reservoirs, but not to the degree of Reservoir Recreation Alternative B in the tributaries. Large increases in boat wave energy are also projected for the Tailwater Recreation Alternative. Higher winter levels would decrease exposure of any sediment deposits formed since impoundment and the original stream channel and floodplains. This would reduce erosion in these areas.

Under Reservoir Recreation Alternative B and the Tailwater Recreation Alternative, there would be longer periods of high flows during the early spring, already the highest-discharge period in the tailwaters of the representative reservoirs. This is mitigated during drawdown in fall, when discharges are generally a little lower than Base Case for a longer period than the spring peak. The net effect is that there is likely to be little change in potential for tailwater erosion under this alternative.

5.16.6 Summer Hydropower Alternative

The Summer Hydropower Alternative would result in shorter periods of wave impact in the shoreline erosion zone than the Base Case and a consequent decrease in existing reservoir shoreline erosion. There would also be a large decrease in erosion from a corresponding decrease in recreational boating. Higher winter levels would decrease exposure of any sediment deposits formed since impoundment and the original stream channel and floodplains. This would reduce erosion in these areas.

Tailwater cumulative shear stress results were highly variable for this alternative. The largest impact for any of the cases calculated occurred for the Cherokee tailwater, where there was a 17 percent increase in cumulative shear stress, suggesting the potential for a slight increase in erosion rates there if this alternative were chosen. Other tailwaters would see increases small enough that they are unlikely to be noticeable.

5.16.7 Equalized Summer/Winter Flood Risk Alternative

The Equalized Summer/Winter Flood Risk Alternative generally would result in substantially shorter durations of high pool elevations than the Base Case except at Watauga. A slight increase in recreational boating activities is projected. The lower duration at shoreline erosion zone elevations and higher winter pool elevations would reduce the area of the exposed drawdown zone to rainfall impacts. Except in Tims Ford, higher winter levels would decrease exposure of the sediment deposits formed since impoundment and the original stream channel and floodplains. This would reduce erosion in these areas; lower winter elevations in Tims Ford would increase erosion in these areas. Overall, this alternative would likely result in less erosion than the Base Case.

Cumulative shear stress analysis indicates that there is likely to be little change in potential for tailwater erosion under this alternative.

5.16.8 Commercial Navigation Alternative

The Commercial Navigation Alternative is the only policy alternative that would result in substantial changes to commercial boat traffic. This alternative, which enhances navigation in the mainstem by deepening the channel, would allow for barges to be loaded more fully. The heavier barges would have a deeper draft, which would send more wave energy to the shorelines. However, fewer trips are projected under this alternative. The reduction in trips would likely offset the increased wave energy from the heavier barges, and no substantial change in erosion from the Base Case would be caused by commercial boat traffic.

Other erosion impacts under the Commercial Navigation Alternative would be similar to those described for the Base Case, particularly for tributary reservoirs, where this alternative makes little or no change in operation. There is only slight change in cumulative sheer stress. The duration at high-pool elevation for each representative reservoir would be similar to the Base Case, and no change in recreational use is projected for the Commercial Navigation Alternative.

5.16.9 Tailwater Habitat Alternative

Summer water levels under the Tailwater Habitat Alternative would be in the shoreline erosion zone for substantially longer durations than under the Base Case, especially on tributary reservoirs, resulting in more erosion. A large increase in recreational boating would result in a corresponding increase in erosion.

Tailwater cumulative sheer stress shows little change.

5.16.10 Preferred Alternative

The Preferred Alternative would increase the duration of pool levels in the shoreline erosion zone in most tributary reservoirs and would increase the erosion in these areas. There would be little change on mainstem reservoirs. Higher winter levels on tributary reservoirs would decrease exposure of any sediment deposits formed since impoundment and the original stream channel and floodplains reducing erosion rates in these areas. The overall result on reservoir shoreline erosion would be slightly adverse.

Changes in potential for tributary tailwater erosion would vary between reservoirs. Because the amount of change is small, the net impact of this alternative would be minimal.

5.16.11 Summary of Impacts

Table 5.16-04 provides a summary of impacts on erosion by policy alternative. The Base Case would result in continued erosion of reservoir and tailwater shorelines, and implementation of treatments and BMPs by TVA and others to improve shoreline conditions. Recreational use of the TVA system is projected to increase under the Base Case; therefore, erosion could accelerate. As described in the table, Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative are anticipated to increase the rate of erosion compared to the Base Case. The Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative are anticipated to decrease the rate of erosion, while the Commercial Navigation Alternative is anticipated to cause similar erosion effects as the Base Case. Based on an analysis of cumulative shear stress in tailwaters, there would not be substantial impacts from any of the alternatives.

Table 5.16-04 Summary of Impacts on Shoreline Erosion by Policy Alternative

Alternative								
Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Reservoir Effects								
No change – Shoreline erosion would continue at existing rates.	Adverse – Longer reservoir pool durations at summer levels and large increases in recreational boat waves would increase reservoir shoreline erosion.	Adverse – Longer reservoir pool durations at summer levels and large increases in recreational boat waves would result in an increase in existing erosion.	Beneficial – Shorter reservoir pool durations at summer levels and a large decrease in recreational boat waves would decrease existing erosion.	Beneficial, especially on tributary reservoirs – Shorter reservoir pool durations at summer levels and a smaller drawdown zone affected by raindrop impact would result in less reservoir shoreline erosion.	No change – Shoreline erosion would continue at existing rates.	Adverse – Longer reservoir pool durations at summer levels and large increases in recreational boat waves would increase reservoir shoreline erosion.	Substantially adverse – Substantially longer reservoir pool durations at summer levels and large increases in recreational boat waves would result in an increase in existing erosion.	Slightly adverse – Longer reservoir pool duration at summer levels in some reservoirs would result in an increase in erosion on some reservoirs.
Tailwater Effects								
No change – Shoreline erosion would continue at existing rates.	No change – Shoreline erosion would continue at existing rates.	No change – Shoreline erosion would continue at existing rates.	No change – Shoreline erosion would continue at existing rates.	No change – Shoreline erosion would continue at existing rates.	No change – Shoreline erosion would continue at existing rates.	No change – Shoreline erosion would continue at existing rates.	No change – Shoreline erosion would continue at existing rates.	No change – Shoreline erosion would continue at existing rates.

5.17 Prime Farmland

Farmland conversion, primarily to residential and commercial development, was considered the major factor in the loss of prime farmland. In addition, soil erosion was considered a by-product of land use change.

The impact analysis focused on the lands extending from the reservoir shoreline out to 0.25 mile. These lands could be indirectly affected by farmland conversion and soil erosion due to land use changes brought about by changes in the reservoir operations policy. As appropriate, more detailed analysis using criteria established by the FPPA (7 CFR 658.1 et. seq.) will be conducted at the county level as LMPs for specific reservoirs are written and updated.

Soil erosion along the shoreline, which is discussed in more detail in Section 5.16, Shoreline Erosion, initially was thought to affect prime farmland. After preliminary investigation, shoreline erosion was not considered a substantial impact on prime farmland and is not considered further in this section.

5.17.1 Impact Assessment Methods

Impacts on prime farmland by soil erosion were analyzed qualitatively by using the following guidelines:

- Reservoir operations that would increase the rate of development along the shoreline of the reservoirs and rivers would result in the loss of farmland.
- Factors influencing erosion include changes in land use that result in the removal of vegetation, changes in vegetative cover, and exposure of soil.

An assessment of the general extent of prime farmland within the TVA region was conducted using data provided by county offices of the NRCS. Farmland conversion was estimated by qualitatively looking at how land use changes, as described in Section 5.15, Land Use, would affect prime farmland around the reservoirs. The impact analysis focused on the backlands (lands extending from the shoreline out to 0.25 mile), which would be indirectly affected by changes in TVA operations.

The erosion assessment considered forestland to be the least susceptible to erosion while herbaceous cover, such as lawns and cropland (particularly row crops), were considered more vulnerable to erosion (Brady 1990). In addition, the anticipated increase in foot and vehicle traffic associated with roads and trails was assumed to result in additional areas of exposed soils.

Anticipated impacts by alternatives were assessed relative to the Base Case, which includes ongoing impacts as a result of existing operations, as well as impacts resulting from adjacent land uses related to commercial/industrial business, farming, and residential activities outside the control of TVA. The Base Case had established under the SMI a total residential buildout of 38 percent for the entire TVA system shoreline, which was projected to occur by 2023. The proposed alternatives, which also would be required to comply with the SMI, would differ from the Base Case by influencing the rate of development (see Section 4.15, Land Use).

5.17.2 Base Case

Based on farmland conversion data, the loss of farmland outlined in Section 4.17 is expected to continue under the Base Case. Farmland conversion at the county level ranged from a decline in acreage of 29 percent to an increase of 3.6 percent (Table 4.17-03). The total loss of prime farmland under the Base Case is considered minimal compared to the prime farmland resources within the counties bordering the Tennessee River watershed. In addition, the loss of prime farmland within the study area (0.25 mile from reservoir shorelines) is minimal compared to the total area (counties that surround TVA reservoirs). The loss would be attributed to factors outside the control of TVA, including proximity of reservoirs to large urban populations.

The erosion potential on prime farmland was assumed to involve the conversion of farmland to non-farm uses, which would affect erosion. The erosion potential of soils in the backlands was estimated to be moderate based on data available from the NRCS. Present TVA standards for soil stabilization and vegetation management under Section 26a regulations minimize the impact of erosion. The major difference in the erosion rate between the Base Case and the policy alternatives would result from a change in the rate of development in areas outside TVA jurisdiction, where county soil erosion and stabilization regulations are variable to non-existent. Sections 4.16 and 5.16, Shoreline Erosion, provide a detailed discussion of shoreline erosion.

5.17.3 Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Tailwater Recreation Alternative, and Tailwater Habitat Alternative

The rates of farmland conversion and soil erosion under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative may be slightly higher than under the Base Case. The amount of farmland conversion under the Base Case was considered minimal, and the additional conversion under these alternatives is small.

5.17.4 Summer Hydropower Alternative and Equalized Summer/Winter Flood Risk Alternative

Under the Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative, the rate of land use changes resulting in conversion of prime farmland is not expected to change, and the amount of land use conversion is expected to be the same as under the Base Case. Land use conversion rates may diminish slightly due to the decrease in summer recreation opportunity.

The rate of soil erosion is expected to decrease compared to the Base Case, as a result of a reduced rate of development.

5.17.5 Commercial Navigation Alternative

The Commercial Navigation Alternative would result in similar impacts on prime farmland and soil erosion as described for the Base Case.

5.17.6 Preferred Alternative

The Preferred Alternative would result in increased conversion of prime farmland and soil erosion, similar to the effects of Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative, as this alternative provides increased recreation opportunities and related development compared to the Base Case.

5.17.7 Summary of Impacts

Because the land use buildout rate described in the SMI would occur under all alternatives, including the Base Case, the conversion of prime farmland to 2030 would be similar under all alternatives. Development may be accelerated under certain alternatives, however, resulting in an accelerated rate of prime farmland conversion. Erosion controls in the backlands would continue to depend on county-specific regulations, which govern land development and erosion from construction sites.

Table 5.17-01 provides a summary of impacts on prime farmland and soils by policy alternative. Under the Base Case and the Commercial Navigation Alternative, farmland conversion and soil erosion were considered minimal within 0.25 mile of the TVA shoreline. Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative would increase the rates of farmland conversion and soil erosion. Because the Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative would result in slower rates of farmland conversion, impacts on prime farmland and soils would be less than under the Base Case. Under all alternatives, the total amount of prime farmland converted is expected to be minimal compared to the total acreage within the counties that border the TVA reservoir system.

Table 5.17-01 Summary of Impacts on Prime Farmland and Soils by Policy Alternative

Alternative	Description of Impacts
Base Case	No change – Farmland conversion is considered minimal compared to overall resources of counties bordering the TVA system. Section 26a regulations would minimize erosion on land bordering shoreline. Erosion controls in backlands depend on county regulations, which are variable.
Reservoir Recreation A	Slightly adverse – Farmland conversion and resultant soil erosion are projected to increase at a slightly faster rate than under the Base Case, but the total amount of farmland conversion through 2030 is expected to be similar to the Base Case.
Reservoir Recreation B	Slightly adverse – Farmland conversion and resultant soil erosion are projected to increase at a faster rate than under Reservoir Recreation Alternative A, but the total amount of farmland conversion through 2030 is expected to be similar to the Base Case.
Summer Hydropower	Slightly beneficial – Farmland conversion and resultant soil erosion are projected to be slower than under the Base Case. The total amount of farmland conversion through 2030 may be less than the Base Case.
Equalized Summer/Winter Flood Risk	Slightly beneficial – Farmland conversion and resultant soil erosion are projected to be slower than under the Base Case. The total amount of farmland conversion through 2030, however, maybe less than the Base Case.
Commercial Navigation	No change – Farmland conversion and resultant soil erosion are projected to be at a similar rate to the Base Case, and the total amount of farmland conversion through 2030 is expected to be similar to the Base Case.
Tailwater Recreation	Slightly adverse – Farmland conversion and resultant soil erosion are projected to increase at a faster rate than under Reservoir Recreation Alternative B, but the total amount of farmland conversion through 2030 is expected to be similar to the Base Case.
Tailwater Habitat	Slightly adverse – Farmland conversion and resultant soil erosion are projected to increase at a slightly higher rate than under the Base Case, but the total amount of farmland conversion through 2030 is expected to be similar to the Base Case.
Preferred	Slightly adverse – Farmland conversion and resultant soil erosion are projected to increase at a higher rate than under the Base Case, but the total amount of farmland conversion through 2030 is expected to be similar to the Base Case.

5.18 Cultural Resources

5.18.1 Introduction

Reservoir operations have the potential to result in both direct and indirect impacts on historic properties (archaeological sites and historic structures). The primary direct impact of reservoir operations on historic properties, in particular on archaeological sites, is soil erosion by rainfall, streamflow, and wave action from wind and recreational boat traffic. Another direct impact is exposure by elevation fluctuations that result in saturation or alternate saturation/drying of archaeological deposits and historic structures. Indirect impacts include development of the shoreline and back-lying lands, changes to the view shed, and looting/vandalism or disturbance from recreational activity at historic properties. To address these concerns, the analyses of three other resource areas (Shoreline Erosion, Land Use, and Visual Resources) were used in conjunction with a quantitative assessment of known historic property location data.

Consultations with the seven State Historic Preservation Officers (SHPOs) and other consulting parties under the requirements of Section 106 of the NHPA have resulted in agreement(s) stipulating the actions TVA will take to avoid or reduce the adverse effects of the selected alternative on historic properties. The agreement(s) developed through this process are provided in Appendix H.

5.18.2 Impact Assessment Methods

The shoreline erosion analysis evaluated the potential for a change in erosion, which can disturb or destroy intact archaeological deposits—resulting in a loss of site integrity and adversely affecting site significance (i.e., its eligibility for listing in the NRHP). Three erosion zones concern historic properties: the summer pool shoreline, the winter pool drawdown, and the tailwater streambanks. Alternatives with greater potential for erosion along the shoreline and streambanks were considered to be adverse for historic properties. Conversely, alternatives that may reduce erosion in those areas were expected to be beneficial for historic properties. Alternatives with longer durations at summer pool elevation decrease erosion in the winter pool drawdown zone and were considered beneficial for historic properties in those areas.

Results of the land use analysis were included in the assessment because of the relationship between shoreline development and the destruction of archaeological sites and historic structures and landscapes. Alternatives with higher water levels for longer periods of time encourage shoreline development. These alternatives are anticipated to result in the most adverse impact on historic properties, while alternatives with lower water levels for longer periods of time are expected to have less impact.

Results of the visual resources studies were included because scenic integrity or attractiveness can promote development, and development can adversely affect historic properties. Alternatives that would result in less overall fluctuation in pool levels would improve scenic integrity and overall scenic attractiveness, and are anticipated to result in the most adverse impact on historic properties.

In addition to the results of these three analyses, a quantitative assessment of the number of archaeological sites located between June 1 pool level and winter pool at each reservoir was used to rank the alternatives (Table 5.18-01). Historic properties located in the winter pool drawdown are directly affected by reservoir operations through saturation and drying of archaeological materials and erosion of historic foundations. Indirectly, they are affected by site vandalism and looting or disturbance from recreational activity. Except for the Commercial Navigation Alternative, under all alternatives fewer archaeological sites would be located in the drawdown. Consequently, the project effects for these alternatives would be decreased compared to the Base Case. The number of archaeological sites at June 1 pool level and from June 1 pool level to 2 km above June 1 pool level was the same for all alternatives and therefore has no comparative value.

Table 5.18-01 NRHP Archaeological Sites by Zone and Policy Alternative

Alternative	Zone				Total[1]
	Below Winter Pool Level	Between Winter Pool and June 1 Pool Levels	At June 1 Pool Levels	June 1 Pool Level to 2 km above June 1 Pool Level	
Base Case	74	1,400	75	235	**1,784**
Reservoir Recreation A	290	1,184	75	235	**1,784**
Reservoir Recreation B	495	979	75	235	**1,784**
Summer Hydropower	391	1,083	75	235	**1,784**
Equalized Summer/ Winter Flood Risk	293	1,181	75	235	**1,784**
Commercial Navigation	74	1,400	75	235	**1,784**
Tailwater Recreation	442	1,032	75	235	**1,784**
Tailwater Habitat	529	945	75	235	**1,784**
Preferred	329	1,145	75	235	**1,784**

NRHP = National Register of Historic Places.

[1] These numbers do not match those in Tables 4.18-01 and 4.18-03, because the approximately 200 sites for which no elevation data were available were not included in the impacts analysis. Locating the data was not feasible and would not affect the conclusions.

5.18.3 Base Case

Shoreline Erosion. The Base Case would result in continued erosion of reservoir shorelines and tailwater streambanks.

Exposure by Elevation Fluctuations. The largest number of NRHP-eligible archaeological sites would be located between summer and winter pools under the Base Case and the Commercial Navigation Alternative.

Land Development. Under the Base Case, reservoir elevations and drawdown schedules would not change. Development of mainstem and tributary reservoir shorelines would continue at the same rate.

Visual Impacts. The existing scenic integrity would continue; changes in viewsheds would be related to continued trends in increased shoreline development and shoreline erosion.

5.18.4 Reservoir Recreation Alternative A

Shoreline Erosion. Longer duration at higher summer pool levels and an anticipated increase in recreational boating under Reservoir Recreation Alternative A would increase existing shoreline erosion. Longer durations at full summer pool would decrease runoff erosion in the drawdown zone. Reservoir releases would generally be at higher flows for longer durations than under the Base Case under this alternative. Because there would also be more periods of low flow, the overall change in tailwater shoreline erosion potential would be minimal. Impacts on archaeological site erosion rates are projected to be adverse under Reservoir Recreation Alternative A due to the increases in reservoir shoreline erosion.

Exposure by Elevation Fluctuations. Reservoir Recreation Alternative A has 1,184 NRHP-eligible archaeological sites located between summer and winter pool elevations. This alternative would slightly decrease the number of archaeological sites in the drawdown zone that are exposed to saturation and drying compared to the Base Case. Indirectly, this alternative would slightly decrease impacts from exposure to vandalism, looting, and disturbance from recreational activity.

Land Development. Reduced summer pool drawdowns and higher winter pools under Reservoir Recreation Alternative A could induce a slight acceleration in the rate of development, which would slightly increase impacts on historic properties.

Visual Impacts. Reservoir Recreation Alternative A would moderately improve scenic integrity because of less overall fluctuations in pool levels and generally higher pool levels. Improvements to visual integrity could accelerate the rate of shoreline development, which could slightly increase impacts on historic properties.

5.18.5 Reservoir Recreation Alternative B and Tailwater Recreation Alternative

Shoreline Erosion. Longer duration at higher summer pool levels and an anticipated increase in recreational boating under Reservoir Recreation Alternative B would increase existing shoreline erosion. Longer durations at full summer pool would decrease runoff erosion in the drawdown zone. As noted in Section 5.16, Shoreline Erosion, the Tailwater Recreation Alternative would increase summer pool erosion to a higher degree than under Reservoir Recreation Alternative B. Under both of these alternatives, reservoir releases would generally be at higher flows for longer durations than under the Base Case. Because there would also be more periods of low flow, the overall change in erosion potential would be minimal. Impacts on archaeological site erosion rates are projected to be adverse under Reservoir Recreation Alternative B and substantially adverse under the Tailwater Recreation Alternative due to the increases in reservoir shoreline erosion.

Exposure by Elevation Fluctuations. Reservoir Recreation Alternative B and the Tailwater Recreation Alternative have 979 and 1,032 NRHP-eligible archaeological sites, respectively, located between summer and winter pool elevations. They have the second and third lowest number of archaeological sites that can be exposed the changing water levels. These alternatives would reduce the number of sites in the drawdown that are exposed to saturation and drying compared to the Base Case. Indirectly, this alternative would decrease the effects resulting from exposure to vandalism, looting, and disturbance from recreational activity because fewer sites would be exposed.

Land Development. Reservoir Recreation Alternative B and the Tailwater Recreation Alternative are expected to increase the rate of open space development. An increase in development would increase impacts on historic structures and archaeological sites.

Visual Impacts. Under Reservoir Recreation Alternative B and the Tailwater Recreation Alternative, there would be an overall much greater reduction in pool level fluctuations, longer duration of pool levels at higher elevations, and higher winter pool levels. These alternatives would provide the greatest improvement of scenic integrity. Improvement to visual integrity could encourage development, which is anticipated to increase impacts on historic properties.

5.18.6 Summer Hydropower Alternative

Shoreline Erosion. Shorter periods of higher summer pool levels under the Summer Hydropower Alternative would slightly decrease existing erosion. Earlier drawdowns would result in shorter periods at higher flows and less erosion of the shoreline and tailwater streambanks. Longer periods of winter drawdown would increase runoff erosion in the drawdown zone.

Exposure by Elevation Fluctuations. The Summer Hydropower Alternative has 1,083 NRHP-eligible archaeological sites located between summer and winter pool elevations. This alternative would slightly decrease the number of archaeological sites and historic structures in the drawdown zone that are exposed to saturation and drying compared to the Base Case. Indirectly, this alternative would slightly decrease the effects resulting from exposure to vandalism, looting, and disturbance from recreational activity.

Land Development. Increased summer drawdowns under the Summer Hydropower Alternative could slow the rate of land use conversion. A decrease in development would be slightly beneficial to historic properties.

Visual Impacts. Under the Summer Hydropower Alternative, the overall reduction of the duration when pool levels are at higher levels would slightly decrease scenic integrity and may reduce the rate of development, which would decrease impacts on historic properties.

5.18.7 Equalized Summer/Winter Flood Risk Alternative

Shoreline Erosion. Shorter reservoir pool durations at summer levels and a smaller drawdown zone affected by rainfall would result in slightly less erosion and would decrease impacts on historic properties in these areas. Longer periods of winter drawdown may increase erosion in the winter pool drawdown zone and may increase impacts on historic properties located in these areas.

Exposure by Elevation Fluctuations. The Equalized Summer/Winter Flood Risk Alternative has 1,181 NRHP-eligible archaeological sites located between summer and winter pool elevations. This alternative would slightly reduce the number of archaeological sites and historic structures in the drawdown zone that are exposed to saturation and drying compared to the Base Case. Indirectly, slightly fewer sites under this alternative would be exposed to vandalism, looting, and disturbance from recreational activity, compared to the Base Case.

Land Development. The Equalized Summer/Winter Flood Risk Alternative would result in no change to a slight decrease in the rate of shoreline development, which would result in a slightly beneficial impact on historic properties.

Visual Impacts. The Equalized Summer/Winter Flood Risk Alternative would reduce elevation fluctuations and maximum reservoir levels would be lower. Low water levels might decrease the scenic integrity of the shoreline and reduce development, which could slightly decrease impacts on historic properties.

5.18.8 Commercial Navigation Alternative

Shoreline Erosion. The Commercial Navigation Alternative would result in continued erosion of reservoir shorelines and tailwater streambanks similar to the Base Case.

Exposure by Elevation Fluctuations. The Commercial Navigation Alternative, along with the Base Case, has the largest number (1,400) of NRHP-eligible archaeological sites located between summer and winter pool elevations. The effects of site exposure would be the same as the Base Case.

Land Development. Reservoir elevations and drawdown schedules would not change under the Commercial Navigation Alternative, resulting in continued development of the shorelines on mainstem and tributary reservoirs.

Visual Impacts. Scenic integrity would be slightly improved under the Commercial Navigation Alternative, primarily for the mainstem reservoirs. Mainstem reservoirs would have less pool level fluctuations. Tributary reservoirs would be the same as under the Base Case. Slightly improved scenic integrity along the mainstem reservoirs could affect the rate of shoreline development and might slightly increase impacts on historic properties.

5.18.9 Tailwater Habitat Alternative

Shoreline Erosion. Summer levels would be at high elevations for longer durations than under the Base Case, resulting in substantially more potential for shoreline erosion. As stated in Section 5.16, Shoreline Erosion, reservoir releases would generally be at higher flows for longer durations than under the Base Case. Because there would also be more periods of low flow, the overall change in erosion potential would be minimal.

Exposure by Elevation Fluctuations. The Tailwater Habitat Alternative has 945 NRHP-eligible archaeological sites located between summer and winter pool elevations. This alternative has the fewest number of sites in the area that would be affected by changing water levels and would decrease the number of archaeological sites and historic structures in the drawdown that would be exposed to saturation and drying compared to the Base Case. Indirectly, this alternative would decrease the effects resulting from exposure to vandalism, looting, and disturbance from recreational activity.

Land Development. The Tailwater Habitat Alternative could induce acceleration in the rate of development around affected reservoirs but would not increase the total amount of land developed adjacent to the reservoir shoreline. Therefore, slightly increased impacts on historic properties could occur.

Visual Impacts. The Tailwater Habitat Alternative generally would provide the longest duration of high pool elevations of all the alternatives. The greatly increased scenic integrity under this alternative could promote development, which could increase the rate of shoreline development but not the overall amount of development due to restrictions outlined in TVA's SMI. Therefore, impacts on historic properties would be slightly adverse.

5.18.10 Preferred Alternative

Shoreline Erosion. Archaeological site erosion rates along reservoir shorelines would increase slightly at those reservoirs with a slightly longer duration of pool elevation in the shoreline erosion zone due to increased exposure to wind- and boat-driven wave action.

Archaeological site erosion rates in the winter drawdown zone would slightly decrease at those reservoirs with longer summer pool durations, because the duration of exposure would decrease. In addition, fewer sites would be exposed to winter drawdown erosion at those reservoirs with higher winter pool elevations.

As noted in Section 5.16, Shoreline Erosion, shoreline erosion would not increase in tributary tailwaters under this alternative. Therefore, no substantial change in impacts on archaeological sites in these areas is anticipated. On the mainstem reservoirs, tailwater archaeological site erosion rates depend more on pool elevations than on flow rates and cumulative shear stress. Slightly adverse impacts are anticipated in these areas.

Exposure by Elevation Fluctuation. On most tributary reservoirs, the zone in which archaeological resources are subjected to exposure by elevation (i.e., the drawdown zone) would be decreased because of higher winter pool elevations. The exceptions are those reservoirs where no operational changes would occur. On mainstem reservoirs, the size of the fluctuation zone would remain the same; but the duration of exposure to looting, vandalism, and recreational activity would be decreased on those reservoirs with summer pool durations.

Land Development. As noted in the assessment methods, land development is considered to have an adverse effect on historic properties of all types. Because total development buildout is expected to eventually occur at all reservoirs, only the rate of adverse impact on historic properties would be affected. On most tributary reservoirs the rate of impact is expected to increase because of longer summer pool durations and/or higher winter pool elevations. The rate of impact on mainstem reservoirs would not change appreciably because of the relatively small difference between summer and winter pool elevations (less than 5 feet at all except Chickamauga Reservoir). Pickwick Reservoir may be an exception because of a substantial increase (64 percent) in the duration of the summer pool.

Visual Impacts. The setting/visual landscape is considered an important aspect of some kinds of historic properties (for example, historic structures). On those reservoirs where land development rates are expected to increase (most of the tributary reservoirs and Pickwick), the visual integrity of such resources could be compromised. (Also see the discussion in Chapter 6, Cumulative Impacts).

5.18.11 Summary of Impacts

All alternatives, including the Base Case, would result in adverse impacts on NRHP-eligible archaeological sites and historic structures through erosion from rainfall, streamflow, and wave action resulting from wind and recreational boat traffic. Another direct impact under all alternatives is the exposure of archaeological deposits and historic structures to saturation and drying in the drawdown zone.

Changes in the existing reservoir operations policy could affect archaeological sites and historic structures indirectly. These impacts include exposure of historic properties in the drawdown to vandalism, looting, and disturbance from recreational activity. Other indirect impacts are development along the shoreline and in back-lying lands, and changes to visual or scenic integrity that may influence development.

Considering the relative consequences and impacts of potential effects related to the policy alternatives, a ranking based on an increase or decrease of effects compared to the Base Case was derived (Table 5.18.02).

The Base Case would result in adverse effects on historic properties, as discussed in Section 4.18. All the policy alternatives would continue to adversely affect historic properties. Compared to the Base Case, the Commercial Navigation Alternative would result in little or no change to ongoing impacts. The Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative would decrease direct and indirect impacts, resulting in a slight benefit for historic properties compared to the Base Case. The remaining five policy alternatives would increase direct and indirect impacts on historic properties and were considered slightly adverse to adverse.

Table 5.18-02 Relative Ranking of Impacts on Cultural Resources by Policy Alternative

Alternative	Direct Effects					Indirect Effects			
	Erosion[1]			Exposure by Elevation Fluctuations[2]	Overall Ranking of Direct Effects[3]	Shoreline and Back-Lying Land Development[4]	Visual Impacts	Exposure by Elevation Fluctuations[2]	Overall Ranking of Indirect Effects
	Reservoir Erosion Shoreline Zone	Winter Pool Drawdown	Tailwater Streambanks						
Base Case	No change	No change	No change	No change	No change – Impacts would continue at existing rates due mainly to erosion.	No change	No change	No change	No change – Impacts would continue at existing rates due to land development.
Reservoir Recreation A	Increase	Decrease	No change	Slight decrease	Adverse – Shoreline erosion would increase.	Slight increase	Increase	Slight decrease	Slightly adverse – Land development would increase.
Reservoir Recreation B	Increase	Decrease	No change	Decrease	Adverse – Shoreline erosion would increase.	Slight increase	Increase	Decrease	Slightly adverse – Land development would increase.
Summer Hydropower	Decrease	Decrease	No change	Slight decrease	Beneficial – Shoreline erosion would decrease.	Slight decrease	Decrease	Slight decrease	Slightly beneficial – Slight decrease in land development.
Equalized Summer/ Winter Flood Risk	Decrease	Decrease	No change	Slight decrease	Beneficial – Shoreline erosion would decrease.	No change to slight decrease	Decrease	Slight decrease	Slightly beneficial – Slight decrease in land development.

Table 5.18-02 Relative Ranking of Impacts on Cultural Resources by Policy Alternative (continued)

Alternative	Direct Effects					Indirect Effects			
	Erosion[1]								
	Reservoir Erosion Shoreline Zone	Winter Pool Drawdown	Tailwater Streambanks	Exposure by Elevation Fluctuations[2]	Overall Ranking of Direct Effects[3]	Shoreline and Back-Lying Land Development[4]	Visual Impacts	Exposure by Elevation Fluctuations[2]	Overall Ranking of Indirect Effects
Commercial Navigation	No change	Slight decrease	No change	No change	No change	No change	Slight increase	No change	No change
Tailwater Recreation	Increase	Decrease	No change	Decrease	Adverse – Shoreline erosion would increase.	Slight increase	Increase	Decrease	Slightly adverse – Land development would increase.
Tailwater Habitat	Large increase	Decrease	No change	Decrease	Substantially adverse – Large increase in shoreline erosion.	No change to slight increase	Increase	Decrease	Slightly adverse – Slight increase in land development.
Preferred	Slight increase	Decrease	No change	Decrease	Slightly adverse – Slight increase in shoreline erosion.	Slight increase	Increase	Slight decrease	Slightly adverse – Slight increase in land development.

1 From rainfall, streamflow, and wave action (wind and recreational boat traffic).
2 Saturation/drying of archaeological deposits and historic structures in the drawdown; vandalism, looting, and disturbance from recreational activity.
3 Based on the assumption that all impact concerns are equally important.
4 See Section 5.15, Land Use.

5.19 Visual Resources

5.19.1 Introduction

The elements of scenic attractiveness, landscape visibility, and scenic integrity that were used to inventory and describe visual resource conditions also provided the framework and guidelines for completing an assessment of potential impacts for the alternatives considered. Of these elements, scenic integrity is the primary element as it categorizes the important visual changes related to each alternative and ultimately indicates the extent to which existing scenic attractiveness would be affected.

5.19.2 Impact Assessment Methods

For this analysis, it was assumed that minimizing exposed reservoir bottoms and shoreline ring effects resulting from lower pool levels would help maintain or enhance the positive scenic character and attractiveness of the reservoirs. The duration of views and the season in which different degrees of contrast occur were also considered when evaluating potential impacts. For example, less contrast during the primary viewing period of late spring through late fall would provide the greatest benefit to the visual resources in the project area. Based on these factors, potential impacts on visual resources were evaluated using the following criteria:

- The difference in pool level fluctuations compared to the Base Case reservoir operations;
- The number of days that reservoir level is within 3 feet of the highest median pool elevation and the period in which this occurs; and,
- The late October median pool level elevation.

The first criterion provides a framework for determining whether the overall shoreline ring effect would remain the same or be reduced in maximum contrast compared to the Base Case condition and indicates the degree to which reservoir bottoms and flats would be exposed. The second criterion indicates the duration and period in which reservoir levels would remain at an elevation that maintains the natural appearance of the shoreline and, conversely, the amount of time that the effects of lower pool levels would be evident. The third criterion provides a comparison of reservoir elevations during the fall foliage viewing period and the resulting degree of contrast that would occur during this important viewing period, when tributary reservoir levels are under unrestricted drawdown conditions.

This information was extracted from the WSM and is listed by policy alternative for each representative reservoir used in the visual resources assessment. Tables 5.19-01 through 5.19-03 provide summaries of the comparison data for each of the evaluation criteria. The data were then compared to determine the effect on visual integrity for each alternative. Results were characterized according to whether visual integrity would remain the same, be reduced, or be improved in comparison to conditions under the Base Case.

Table 5.19-01 Water Level Fluctuations for Representative Reservoirs by Policy Alternative

Reservoir	Policy Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Tributary Reservoirs									
Boone	26.0	26.0	26.0	26.0	21.0	26.0	26.0	26.0	20.0
Cherokee	40.1	29.9	19.7	29.2	18.7	40.3	19.7	25.0	27.1
Fontana	71.7	77.5	49.0	51.6	32.0	73.5	49.0	59.0	52.5
Tims Ford	17.5	13.0	17.0	17.0	19.1	18.0	17.0	13.0	18.0
Watagua	21.0	13.1	4.6	15.4	9.0	21.4	10.8	7.4	8.2
Mainstem Reservoirs									
Chickamauga	6.2	4.7	4.7	6.3	7.2	4.7	4.7	4.7	6.2
Guntersville	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Kentucky	5.3	5.3	3.0	4.7	5.3	3.0	3.0	5.3	4.7
Wheeler	4.7	3.2	3.2	4.8	4.7	3.2	3.2	3.2	4.7

Note: Values represent the difference in feet between the highest and lowest median elevation points.

Source: TVA file data.

Table 5.19-02 Duration at High-Pool Elevations for Representative Reservoirs by Policy Alternative

Reservoir	Policy Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Tributary Reservoirs									
Boone	147	147	147	49	70	147	147	147	147
Cherokee	49	98	126	35	91	49	126	133	70
Fontana	49	84	112	28	42	49	112	133	84
Tims Ford	133	133	154	56	91	133	154	133	133
Watagua	84	140	182	126	112	84	210	203	133
Mainstem Reservoirs									
Chickamauga	196	210	210	105	168	203	210	210	196
Guntersville	364	364	364	364	364	364	364	364	364
Kentucky	154	189	364	126	154	364	364	189	154
Wheeler	196	364	364	133	189	364	364	364	217

Note: Values indicate the number of days that median pool levels would be within 3 feet of the highest pool elevation.

Source: TVA file data.

Table 5.19-03 Late October Median-Pool Level for Representative Reservoirs by Policy Alternative

Reservoir	Policy Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Tributary Reservoirs									
Boone	1,372.9	1,372.9	1,369.8	1,356.0	1,375.6	1,372.9	1,369.8	1,372.9	1,372.9
Cherokee	1,037.9	1,047.6	1,060.5	1,042.7	1,066.1	1,037.9	1,060.7	1,058.4	1,048.9
Fontana	1,653.3	1,658.0	1,681.7	1,652.5	1,666.4	1,652.7	1,681.6	1,684.8	1,664.3
Tims Ford	881.3	881.3	880.8	871.0	869.7	881.3	880.8	881.3	881.3
Watagua	1,940.0	1,948.6	1,955.8	1,943.3	1,953.7	1,940.0	1,946.5	1,956.5	1,951.1
Mainstem Reservoirs									
Chickamauga	678.5	679.4	679.3	676.0	676.4	678.5	679.3	679.4	678.7
Guntersville	593.6	593.6	593.9	593.3	593.6	593.6	593.9	593.6	593.9
Kentucky	354.7	355.6	357.1	354.3	354.7	356.0	357.1	355.6	354.7
Wheeler	552.0	553.5	553.7	551.0	551.9	552.5	553.7	553.5	552.8

Note: Values indicate elevation in feet for the median pool levels during the last week in October.

Source: TVA file data.

It is important to note that review of all the probable elevation data developed for the project confirmed that the representative reservoirs selected for this analysis are illustrative of the visual changes that would occur under each of the alternatives for all mainstem and tributary reservoirs in the TVA system. Run-of-river reservoirs were also investigated for elevation changes associated with each policy alternative. Pool elevations for these reservoirs would not change under any of the alternatives; therefore, visual integrity would not be affected.

Other qualitative measures used in the assessment of visual resources were based on indirect visual effects resulting from erosion factors, land use patterns, and development that may result from the alternatives (see Sections 4.15 and 5.15 [Land Use], and Sections 4.16 and 5.16 [Shoreline Erosion]).

5.19.3 Base Case

Under the Base Case, the existing scenic integrity levels would continue to be a component of the viewed landscape. The only changes that would occur would be related to continued trends in increased residential development and the resulting impacts on shoreline aesthetics. Implementation of the guidelines identified in the SMI (TVA 1998) would help to reduce or eliminate some of the factors contributing to lower scenic integrity levels that are associated with shoreline development. Actions to reduce the effects of exposed structures or other elements that cause visual discord when pool levels are lower would increase visual integrity. Erosion factors associated with existing reservoir operations may also contribute to reduced scenic integrity, especially for mainstem reservoirs.

5.19.4 Reservoir Recreation Alternative A

Reservoir Recreation Alternative A would improve the overall scenic integrity for both tributary and mainstem reservoirs. For the representative tributary reservoirs, Boone would remain the same while the others would be slightly to moderately improved. All mainstem representative reservoirs would see some level of improvement in scenic integrity, with the most noticeable changes at Chickamauga Reservoir and Wheeler Reservoir.

Changes in reservoir operations under Reservoir Recreation Alternative A would result in less overall fluctuation in pool levels, higher pool levels during the primary viewing period, higher winter levels for most reservoirs, and higher October water levels. These changes would reduce the contrast in the ring effect and the amount of exposed reservoir bottoms and flats.

Overall, Reservoir Recreation Alternative A would moderately improve visual integrity, with a resulting improvement in overall scenic attractiveness.

5.19.5 Reservoir Recreation Alternative B and Tailwater Recreation Alternative

Reservoir Recreation Alternative B and the Tailwater Recreation Alternative would result in similar effects as those described for Reservoir Recreation Alternative A but would result in a higher level of improvement of scenic resources. Overall, there would be a much greater reduction in pool level fluctuations, a longer duration of pool levels at higher elevations, and higher October reservoir levels. Winter pool elevations also would be viewed at higher levels than under Reservoir Recreation Alternative A.

Based on direct effects, Reservoir Recreation Alternative B and the Tailwater Recreation Alternative would provide the greatest improvement of scenic integrity and overall scenic attractiveness compared to all other alternatives.

5.19.6 Summer Hydropower Alternative

Although the Summer Hydropower Alternative would result in overall lower fluctuation levels for tributary reservoirs that would be similar to results under Reservoir Recreation Alternative A, the Summer Hydropower Alternative would also result in an overall reduction of the duration when pool levels are at higher elevations. This reduction would be substantial for some tributary reservoirs, such as Boone and Tims Ford. A shorter duration of higher water levels also was noted for the mainstem reservoirs when compared to the Base Case. The shorter duration would result in lower reservoir levels being observed for a longer time during the primary viewing period. It was also noted that the minimum pool levels reached under abnormal rainfall years for some of the tributary reservoirs under the Summer Hydropower Alternative would be extremely lower than those under the Base Case. Overall, late October reservoir levels would tend to be lower under the Summer Hydropower Alternative when compared to the other alternatives.

The Summer Hydropower Alternative would moderately decrease scenic integrity, with a resulting decrease in overall scenic attractiveness.

5.19.7 Equalized Summer/Winter Flood Risk Alternative

Although the Equalized Summer/Winter Flood Risk Alternative would include very favorable reductions in fluctuation levels (some equal to or better than those for Reservoir Recreation Alternative B and the Tailwater Recreation Alternative), the reductions would be accomplished at the expense of overall lower maximum reservoir levels. For some tributary reservoirs (such as Fontana), maximum reservoir levels would be 21 feet lower than under Base Case operations. This modification will create a short-term year-round shoreline ring effect. Natural succession is expected to re-establish vegetation in this area. However, the affected zone would most likely require several years to be restored to a fully vegetated shoreline. The visual effects on mainstem reservoirs under the Equalized Summer/Winter Flood Risk Alternative would be similar to those under the Summer Hydropower Alternative.

The Equalized Summer/Winter Flood Risk Alternative would decrease scenic integrity, with a resulting decrease in overall scenic attractiveness.

5.19.8 Commercial Navigation Alternative

The Commercial Navigation Alternative is similar to the Base Case for the tributary reservoirs. There would be some improvement for mainstem reservoirs, resulting in an overall slight improvement in scenic integrity levels.

5.19.9 Tailwater Habitat Alternative

The Tailwater Habitat Alternative would blend many of the positive attributes of Reservoir Recreation Alternative A and Reservoir Recreation Alternative B. While the degree of fluctuation levels lies between these two alternatives, the Tailwater Habitat Alternative generally would provide the longest duration of high pool elevations of all the alternatives. Fall pool level elevations also generally would be higher.

The Tailwater Habitat Alternative would result in greatly improved scenic integrity, with a resulting increase in overall scenic attractiveness.

5.19.10 Preferred Alternative

The Preferred Alternative would improve the overall scenic integrity for tributary reservoirs. Visual resources at mainstem reservoirs would be similar to those under the Base Case, although scenic integrity would be slightly improved for selected reservoirs such as Wheeler.

Visual resources at all representative tributary reservoirs, except Tims Ford, would be improved in the form of less overall fluctuation in pool levels, longer duration of higher pool levels during the primary viewing period, and higher October reservoir levels. Winter levels would also be higher. Visual resources at Tims Ford would be similar to those under the Base Case. The Preferred Alternative is the only alternative that would result in less pool level fluctuation for Boone Reservoir.

Overall, the Preferred Alternative would moderately improve visual integrity, with a resulting improvement in overall scenic attractiveness.

5.19.11 Summary of Impacts

Table 5.19-04 provides a summary of the direct effects on scenic integrity levels for the representative reservoirs associated with each of the alternatives. Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative would provide the greatest degree of improvement in scenic integrity and overall scenic attractiveness. Reservoir Recreation Alternative A and the Preferred Alternative would moderately improve scenic integrity. Effects under the Commercial Navigation Alternative would be similar to those under the Base Case. The Summer Hydropower Alternative and Equalized Summer/Winter Flood Risk Alternative would reduce scenic integrity.

Table 5.19-04 Summary of Impacts on Scenic Integrity by Policy Alternative

Alternative	Description of Impacts
Base Case	No change – Current scenic integrity levels would continue to be a component of the viewed landscape. The only changes that would occur would be related to continued trends in increased residential development and the resulting impacts on shoreline aesthetics. Erosion factors associated with current reservoir operations may also contribute to additional reduction in scenic integrity.
Reservoir Recreation A	Beneficial – Overall scenic integrity for both tributary and mainstem reservoirs would be moderately improved with a resulting improvement in scenic attractiveness. Changes in reservoir operations would result in less overall fluctuations in pool levels, higher pool levels during the primary viewing period, higher winter levels for most reservoirs, and higher October water levels.
Reservoir Recreation B	Substantially beneficial – Overall scenic integrity for both tributary and mainstem reservoirs would be greatly improved with a resulting improvement in scenic attractiveness. Changes in reservoir operations would result in much greater reductions in pool level fluctuations, a longer duration of pool levels at higher elevations, and higher October reservoir levels. Winter pool elevations also would be viewed at higher levels.
Summer Hydropower	Adverse – Overall scenic integrity for both tributary and mainstem reservoirs would be moderately reduced, with a resulting decrease in scenic attractiveness. Overall lower fluctuation levels. For tributary reservoirs, favorable reductions in fluctuation levels would be offset by an overall reduction of the duration when pool levels are at higher elevations. This reduction is substantial for some reservoirs. A shorter duration of higher water levels will also occur with the mainstem reservoirs.
Equalized Summer/Winter Flood Risk	Slightly adverse – Overall scenic integrity for both tributary and mainstem reservoirs would be slightly reduced with a resulting decrease in scenic attractiveness. Favorable reductions in fluctuation levels would be accomplished at the expense of overall lower maximum reservoir levels. These modifications would result in a short-term year-around shoreline ring. The affected zone would most likely take several years to be restored to a fully vegetated shoreline.
Commercial Navigation	Slightly beneficial – Overall scenic integrity would be slightly improved. There would be some improvement for mainstem reservoirs while tributary reservoirs would be similar to the Base Case.
Tailwater Recreation	Substantially beneficial – Overall scenic integrity for both tributary and mainstem reservoirs would be greatly improved with a resulting improvement in scenic attractiveness. Changes in reservoir operations would result in much greater reductions in pool level fluctuations, a longer duration of pool levels at higher elevations, and higher October reservoir levels. Winter pool elevations also would be viewed at higher levels.
Tailwater Habitat	Substantially beneficial – Overall scenic integrity for both tributary and mainstem reservoirs would be greatly improved with a resulting improvement in scenic attractiveness. Changes in reservoir operations would result in less overall fluctuations in pool levels, a much longer duration of pool levels at higher elevations, and higher October reservoir levels. Winter pool elevations also would be viewed at higher levels.
Preferred	Beneficial – Overall, scenic integrity for tributary reservoirs would be moderately improved, with a resulting improvement in scenic attractiveness. Changes in reservoir operations for tributary reservoirs would result in less overall fluctuation in pool levels, longer duration of higher pool levels, and higher October reservoir levels. Winter pool elevations would also be viewed at higher levels for the tributary reservoirs. Visual resources at mainstem reservoirs would be similar to the Base Case, with only slight improvement evident in selected reservoirs due to a slightly longer duration of higher pool levels during summer and slightly higher October pool levels.

5.20 Dam Safety

5.20.1 Introduction

This assessment of environmental consequences focuses on whether implementation of a new reservoir operations policy would change reservoir elevations in a manner that would affect the structural stability of the dams and their appurtenant structures.

5.20.2 Impact Assessment Methods

An assessment of the effect of the alternatives on reservoir levels was performed. Maximum simulated reservoir levels were reviewed and the reservoir levels under the alternatives were compared to those seen in the Base Case. Simulated maximum levels predicted to exceed those under the Base Case were evaluated. If the increase was small relative to the total head or if the duration of higher head was limited, the alternatives were considered to not result in an adverse effect on dam safety. Maximum design flood levels for each alternative were determined as a part of the flood risk studies and were compared with the design flood elevations under the Base Case.

Limits on reservoir drawdown rates were included in each alternative and were not violated.

For those reservoirs where leakage is a function of reservoir levels, the review of the reservoir levels described above was also applied to evaluate the impact of the alternatives on leakage. If the increase in reservoir levels was small relative to the total head and/or the duration of higher head was limited, the effect on leakage would be considered acceptable.

5.20.3 Base Case

With respect to dam safety, the Base Case is the existing condition. Geology and seismology, reservoir levels, reservoir drawdown rates, and leakage would not be affected under the Base Case.

5.20.4 All Action Alternatives

The simulated peak reservoir levels for 99 years of historical inflows indicated that no reservoir operations policy alternative would pose an adverse affect on dam safety relative to the Base Case. The flood risk studies indicated that, for all alternatives, design flood maximum pool levels would increase only slightly with respect to the Base Case, and would not adversely affect the stability of the dams and their appurtenant structures.

Reservoir Drawdown Rates

Because limits on reservoir drawdown rates would be included in each alternative and would not be violated, no impacts are associated with reservoir drawdown rates under the policy alternatives. Table 4.20-01 provides the reservoir rate drawdown limits.

Leakage

Table 4.20-03 lists the projects where leakage is monitored. For those reservoirs where leakage is a function of reservoir levels, the range of reservoir levels would not be affected by any of the policy alternatives.

5.20.5 Summary of Impacts

Reservoir-triggered seismicity does not appear to be a primary factor for TVA dams. The simulated peak reservoir levels for 99 years of historical inflows indicated that no reservoir operations policy alternative would adversely affect dam safety relative to the Base Case. The flood risk studies indicated that, for all alternatives, design flood maximum pool levels would increase only slightly with respect to the Base Case, and would not adversely affect the stability of the dams and their appurtenant structures.

Because the reservoir drawdown rates under the alternatives would not exceed those under the Base Case, a determination of no impact can be made without additional review.

The future effects on leakage at TVA dams and rims due to proposed changes in the operation of its reservoirs would vary. Leakage and seepage at most reservoirs vary with headwater, but not at all reservoirs. Those dams with leaks that vary with headwater and without trends would probably not be affected by reservoirs being maintained at elevations for normal summer pool for longer periods of time than under the Base Case. Also, the dams with leakage that does not fluctuate with headwater elevations should not be affected by extended periods of summer pool.

Dams with leakage that fluctuates with headwater and with existing increasing trends may, over time, be affected by pools being held at summer levels longer. Most likely, the effects would be either a change in the rate of the trends, or some sudden increases with or without a change in the discharge rate.

Table 5.20-01 provides a summary of impacts on dam safety by policy alternative.

Table 5.20-01 Summary of Impacts on Dam Safety by Policy Alternative

Alternative	Description of Impacts
Base Case	Current seismic conditions, leakage, and reservoir levels would continue.
Reservoir Recreation A	Alternative reservoir operations would not affect the range of normal reservoir levels, leakage, or seismicity; design flood maximum pool levels would increase only slightly with respect to the Base Case, and would not adversely affect the stability of the dams and their appurtenant structures.
Reservoir Recreation B	Impacts would be the same as those described for Reservoir Recreation Alternative A.
Summer Hydropower	Impacts would be the same as those described for Reservoir Recreation Alternative A.
Equalized Summer/Winter Flood Risk	Impacts would be the same as those described for Reservoir Recreation Alternative A.
Commercial Navigation	Impacts would be similar to those described for the Base Case.
Tailwater Recreation	Impacts would be the same as those described for Reservoir Recreation Alternative A.
Tailwater Habitat	Impacts would be the same as those described for Reservoir Recreation Alternative A.
Preferred	Impacts would be the same as those described for Reservoir Recreation Alternative A.

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5.21 Navigation

5.21.1 Introduction

A change in the depth of navigation channels could affect the Tennessee River navigation system. Changes in the depth of navigation channels introduced by implementation of any of the policy alternatives may alter movements of bulk cargoes on the Tennessee River, affecting the cost to shippers. The following section analyzes potential changes in shippers costs as influenced by policy alternatives.

5.21.2 Impact Assessment Methods

To assess the impacts of the policy alternatives on navigation, the alternatives were grouped into three categories: (1) the alternative would not change navigation channel pool levels from the existing reservoir operations policy (same as the Base Case), (2) the alternative would increase navigation channel pool levels (a 2-foot increase, when possible, to a 13-foot navigation channel with a 2-foot overdraft protection is a common component of five of the policy alternatives), and (3) the alternative would decrease navigation channel pool levels.

To assess potential impacts on navigation, TVA developed and applied a methodology that used movement surveys of 2,270 origin-destination pairs. These pairs were based on the actual commodity movements of calendar year 2000.

Because of the flexibility created by surface transportation deregulation, it is sometimes difficult to determine the exact rate charged by a carrier on shipments moving under contract. Barge rates are a matter of negotiation between shipper and barge line operator, and these rates are not published in tariff form. Each carrier's rates are based on individual costs and specific market conditions; therefore, rates vary considerably among regions, across time, and from one barge line to another.

The rates for moving grains are a notable exception to negotiated contract rates for barge transport. Contract rates for the movement of grains appear to have peaked in 1986, when approximately 40 percent of all grain was shipped under contract. Since that time, a number of carriers have returned to the use of traditional tariffs as the basis for rate calculations.

Contract rates are also common in pipeline, rail, and motor carrier transportation; like barge rates, they may be maintained in complete confidentiality. In other cases (particularly for grain), tariff rates are still applied; nevertheless, there is seldom any dependable means for determining whether a contract rate or a tariff rate should be used to price a particular movement. A further complication is the use of rebates and allowances by carriers as an incentive to shippers in order to induce higher traffic volumes.

For this study, actual rates, as provided by shippers, receivers, or river port operators, were used whenever possible. All other rates were obtained from published sources or, when this was not possible, were estimated by TVA based on the mode of transportation, the tonnage, and other shipment characteristics. The methodologies used to estimate unobservable rates were developed through extensive contacts with shippers, railroads, motor carriers, and the barge industry. This information was often integrated with confidential federal data and the output of computerized simulation and costing models. The process was both guided and augmented by in-house TVA rating and costing expertise developed through decades of experience as a major shipper of coal and other bulk commodities, and through the implementation of navigation-based economic development programs throughout the Tennessee River basin. Except for grain and feed ingredients, unobservable barge rates were calculated through the application of a computerized barge-costing model developed by TVA.

Three points should be noted regarding the methodological standards applied in this study. First, the standards reflect essentially the same processes TVA has applied (or will apply) in developing transportation rates for other recent (or ongoing) USACE studies. Specifically, the outlined methodology was used in the Ohio River Mainstem Study (USACE 1999) and the Upper Mississippi Navigation Improvement Project Rate Study (USACE 1997), and is being applied in the Missouri River Master Water Control Manual Review and Update (USACE 2002) and the Bayou Sorrel Lock Improvement Plan (USACE 1998) assessment. This uniform approach has facilitated inter-project comparisons. Second, recent methodological improvements enable TVA to produce transportation rate/cost materials that are, simultaneously, more complete and more reliable than the transportation data TVA (or any other agency) has produced for similar studies in the past. Each rate study for each District of the USACE is integrated into a series of databases for quick accessibility and data manipulation. Third, the forecasted rates do not include the water-compelled rate effect. This effect infers that rail rates are lower when water transportation is available to the shipper due to competitive factors and the need of the railroads to maximize utility. The water-compelled rate effect is captured by the model used to estimate the total economic effects of the policy alternatives.

5.21.3 Base Case

Existing and future predicted commodity (2030) movements were compared, and the changes in shipper savings due to continued operation of the water control system under the existing reservoir operations policy were determined. These savings are listed in Table 5.21-01.

Under the Base Case, 2030 tonnage on the regional navigation system is estimated to increase from 38.3 million to 56.5 million tons. Total annual shipper savings is estimated to be $597 million, with an average per-ton increase in shipper savings of $0.45.

The impacts on a per-ton savings are shown in Table 5.21-01.

Table 5.21-01 Tennessee River Shipper Savings under the Base Case

Group	Commodities	Existing Average Per-Ton Savings	2030 Average Per-Ton Savings	Impact Average Per-Ton Savings
1	Coal and coke	$ 8.07	$ 8.03	$ -0.04
2	Aggregates	$10.30	$10.05	$ -0.25
3	All other	$ 6.45	$ 6.12	$ -0.33
4	Iron and steel	$ 8.19	$ 8.18	$ -0.01
5	Grains	$ 8.59	$ 8.29	$ -0.30
6	Chemicals	$19.59	$19.84	$ 0.25
7	Ores and minerals	$10.67	$ 8.95	$ -1.72
8	Petroleum fuel	$ 6.48	$ 7.88	$ 1.40
Average all commodities		**$ 9.24**	**$ 9.69**	**$ 0.45**

5.21.4 Summer Hydropower Alternative

Under the Summer Hydropower Alternative, drawdown of mainstem reservoirs would begin on June 1 and reach normal winter pool levels by mid-September. The spring fill policy would not change. This would result in lower reservoir elevations during 5 months of the year, adversely affecting navigation. Losses in shipper savings would range from approximately $11 million in 2004 to over $17 million in 2030 compared to the Base Case.

5.21.5 Equalized Summer/Winter Flood Risk Alternative

Under the Equalized Summer/Winter Flood Risk Alternative, there is a potential for drawdown for each reservoir above River Mile 649 that would result in a 7-foot channel depth during some months. Two docks at Knoxville could be affected, with a resulting impact of approximately $1.0 million in reduced annual shipper savings compared to the Base Case. Because this potential reduction represents less than 0.05 percent of the RED shipper savings on the river navigation system, the impact was considered insignificant.

5.21.6 Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Commercial Navigation Alternative, Tailwater Recreation Alternative, and Tailwater Habitat Alternative

Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Commercial Navigation Alternative, the Tailwater Recreation Alternative, and the Tailwater Habitat

Alternative would result in increasing channel depth to 13 feet where possible. Compared to the Base Case, changes in shipper savings would occur only under the Commercial Navigation Alternative. Model results for shipper savings under these alternatives are listed in Table 5.21-02.

Table 5.21-02 Tennessee River Shipper Savings under the Commercial Navigation Alternative

Group	Commodities	Base Case 2030 Average Per-Ton Savings	Commercial Navigation Alternative 2030 Average Per-Ton	Impact Average Per-Ton Savings
1	Coal and coke	$ 8.03	$ 8.97	$ 0.94
2	Aggregates	$10.05	$11.03	$ 0.98
3	All other	$ 6.12	$ 6.67	$ 0.55
4	Iron and steel	$ 8.18	$10.11	$ 1.93
5	Grains	$ 8.29	$ 9.62	$ 1.33
6	Chemicals	$19.89	$20.12	$ 0.23
7	Ores and minerals	$ 8.95	$11.36	$ 2.41
8	Petroleum fuel	$ 7.88	$ 7.88	0
Average all commodities		**$ 9.69**	**$10.75**	**$ 1.06**

Table 5.21-02 shows the impacts on a per-ton savings. Shipper savings would increase under the Commercial Navigation Alternative. The increases would range between $2.41 per ton for ores and minerals and $0.23 per ton for chemicals. By 2030, the average per-ton shipper savings increase over the Base Case would be $1.06 per ton. These savings would result in a total additional shipper benefit of $37.7 million annually by 2030, an 8.2-percent increase, under the alternatives with a 13-foot channel depth. These savings also include a reduction of over $10 million from potential 13-foot channel benefits that would accrue due to the constraints of the Chickamauga tailwater and Kentucky Reservoir. Without these constraints, total benefits by 2030 under alternatives with a 13-foot channel depth are estimated at $507 million, an increase of 10.5 percent.

In accordance with RED evaluation policy, these savings are regional, including only shipments originating or destined for Tennessee River system facilities. They do not include additional shipper savings accruing to shippers or receivers outside the system, such as on the Ohio or Mississippi Rivers.

Modal diversion is the shifting of cargoes from barge to the rail or truck mode. Interest exists regarding impacts on modal diversion that would result under various alternatives. At issue is the behavior of shippers to change modes or increase barge shipments for an average gain of $0.45 per ton. Elasticity of modal choice was explored in interviews with shippers. Operators demonstrated highly inelastic modal selection, citing three primary reasons: (1) typically, capital investment to implement modal change is not recoverable; (2) many shippers are captive to the barge mode; and (3) shipment quantities are based on factors other than channel depth.

5.21.7 Preferred Alternative

Under the Preferred Alternative, Kentucky Lock and Dam tailwater would be maintained at an elevation of 301 feet by increasing releases from the Kentucky Reservoir as needed, and Pickwick Landing Lock and Dam tailwater would be adjusted by releases from Pickwick Reservoir when requested by towboat operators. The impact on navigation of this alternative is to allow for 10-foot draft barges on Kentucky, Pickwick, and Barkley Reservoirs during the traditional pool drawdown periods for those docks that can accommodate deeper draft equipment. As with the previous alternative analysis, the shipper saving benefit to non-utility industries in the region was estimated at $0.3 million, and the shipper saving benefit to power plants in the region was estimated at $2.1 million in the first year of implementation.

5.21.8 Summary of Impacts

Table 5.21-03 contains a summary of impacts on navigation by policy alternative. Under the Base Case, total shipper savings in 2030 is estimated at $597 million, with an average per-ton increase in shipper savings of $0.45. Future increased tonnage under the Base Case would result in more barge trips that in turn would result in more fuel consumption and greater air quality impacts.

Under the Summer Hydropower Alternative, drawdown of mainstem reservoirs would begin on June 1 and reach normal winter pool levels by mid-September. The spring fill policy would not change. This would result in lower reservoir elevations during 5 months of the year, adversely affecting navigation. Losses in shipper savings would range from approximately $11 million in 2004 to over $17 million in 2030 compared to the Base Case. Under the Equalized Summer/Winter Flood Risk Alternative, there is a potential drawdown for each reservoir above River Mile 649 that would result in a 7-foot channel depth during some months. Two docks at Knoxville could be affected, with a resulting regional economic impact of approximately $1.0 million in reduced shipper savings compared to the Base Case. Because this potential reduction represents less than 0.05 percent of the RED shipper savings on the river navigation system, the impact was considered insignificant.

Under the Commercial Navigation Alternative, the average per-ton shipper savings increase over the Base Case would be $1.06 per ton. These savings would result in a total additional shipper benefit of $37.7 million annually by 2030, an 8.2-percent increase, under the alternatives with a 13-foot channel depth. These savings are regional, including only shipments originating or destined for Tennessee River system facilities. They do not include additional shipper savings accruing to shippers or receivers outside the system, such as on the Ohio or Mississippi Rivers.

The increased tonnage per barge under the Commercial Navigation Alternative would result in fewer tows for the equivalent tonnage under the Base Case. This would result in smaller impacts on emission shifting and air quality.

Under the Preferred Alternative, Kentucky Lock and Dam tailwater would be maintained at an elevation of 301 feet by increasing releases from Kentucky Reservoir as needed, and Pickwick Landing Lock and Dam tailwater would be adjusted by releases from Pickwick Reservoir when requested by towboat operators. This would allow for 10-foot draft barges on Kentucky, Pickwick, and Barkley Reservoirs during the traditional pool drawdown periods for those docks that can accommodate deeper draft equipment. Shipper savings benefits during the first year of implementation for this alternative were estimated at $0.3 million for non-utility industries in the region and $2.1 million for power plants in the region.

Table 5.21-03 Summary of Impacts on Navigation by Policy Alternative

Alternative	Description of Impacts
Base Case	No change – Regional shipper savings of approximately $378 million are expected to increase at an average annual rate of 1.5 to 2.0 percent, to $597 million by 2030.
Reservoir Recreation A	No changes in shipper savings compared to the Base Case.
Reservoir Recreation B	No changes in shipper savings compared to the Base Case.
Summer Hydropower	Slightly adverse – Mainstem reservoir levels would be lower than under the Base Case during 5 months of the year. Losses in shipper savings would range from approximately $11 million in 2004 to over $17 million in 2030.
Equalized Summer/Winter Flood Risk	Slightly adverse – Potential for drawdown for each reservoir that would result in a 7-foot channel depth during some months. Losses in shipper savings are expected to range from $1.2 million in 2004 to $1.9 million in 2030.
Commercial Navigation	Slightly beneficial – Shipper savings would increase by $17 million under the 13-foot channel option. Increased tonnage per barge would result in fewer impacts related to emission shifting and air quality.
Tailwater Recreation	No changes in shipper savings compared to the Base Case.
Tailwater Habitat	No changes in shipper savings compared to the Base Case.
Preferred	Slightly beneficial – Shipper savings would increase by approximately $2.4 million in 2004 due to changes that would allow for 10-foot draft barges on Kentucky, Pickwick, and Barkley Reservoirs during the traditional pool drawdown periods for those docks that can accommodate deeper draft equipment.

5.22 Flood Control

5.22.1 Introduction

The factors used to describe the existing flood risk condition, peak discharge, and potential flood damage were again used to assess the impact of each alternative considered.

5.22.2 Impact Assessment Methods

The analysis described in Section 4.22.3 was performed for each alternative. The RiverWare model used to predict discharges was reconfigured to mimic the various alternative operations policies to predict flows at each of 48 critical locations. The critical locations include dams and damage centers (Table 5.22-01).

Table 5.22-01 Critical Locations for Evaluation of Flood Risk Potential

Dams	
Apalachia	Little Bear Creek
Bear Creek	Melton Hill
Blue Ridge	Nickajack
Boone	Normandy
Calderwood	Norris
Cedar Creek	Nottely
Chatuge	Ocoee #1
Cheoah	Ocoee #3
Cherokee	Pickwick
Chickamauga	South Holston
Chilhowee	Tellico
Douglas	Tims Ford
Fontana	Upper Bear Creek
Fort Loudoun	Watauga
Fort Patrick Henry	Watts Bar
Great Falls	Wheeler
Guntersville	Wilson
Hiwassee	
Damage Centers	
Chattanooga, TN	Huntsville, AL
Clinton, TN	Kingsport, TN
Copperhill, TN/McCaysville, GA	Knoxville, TN
Decatur, AL	Lenoir City, TN
Elizabethton, TN	Savannah, TN
Fayetteville, TN	South Pittsburg, TN
Florence, AL	

The impact of each alternative was measured by changes in:

- The peak flows predicted for the 99 years of historical inflows;
- The peak flows predicted for the design storms; and,
- The potential damage due to flooding from historical inflows.

The downstream limit of TVA's detailed flood risk simulation model was Savannah, Tennessee. The analysis at Savannah was comprehensive and included both period-of-record flow frequency curves and analysis of a large number of hypothetical design storms.

Separate from its modeling of flood risks, TVA did consider flooding effects downstream from Savannah. For Kentucky Reservoir, TVA conducted a detailed investigation of the effect of different operations alternatives on the volume of water discharged from Pickwick Landing Dam. This investigation included the identification of the 10 largest annual and seasonal volumes discharged over 1–, 3–, 7–, 10–, 15–, and 30–day durations in the 99–year simulated period of record. For each of these events, the incremental volumes discharged into Kentucky Reservoir under each alternative were compared to the Base Case. This analysis showed that for these large storms it is reasonable to expect that the difference between Pickwick discharge under the Base Case and under any of the action alternatives, including the Preferred Alternative, can be temporarily stored in the Kentucky pool.

The intent of the flood risk study was to define the range of operating policy modifications that could be made without unacceptably increasing flood risk at any critical location, including Savannah and Kentucky Reservoir.

TVA developed a flood risk evaluation criterion for the ROS. As compared to Base Case, no acceptable policy alternative should increase overall flood risk and associated flood damages for those flood events with a recurrence interval of 500 years or less. Overall flood risk and associated damage considers offsetting increases and decreases of flood risk and damage in localized areas. Policy alternatives that did not meet this criterion were deemed unacceptable from a flood risk perspective. The evaluation was based on:

- A 99-year period of record continuous simulation (1903–2001), for which recurrence intervals of annual and seasonal peak discharges were assigned using a standard hydrologic formula, and

- Discrete simulations for a series of hypothetical events (design storms), for which recurrence intervals were estimated based on the volume-duration-frequency characteristics of total inflow upstream of the point in question.

Because of the uncertainty associated with the recurrence interval of regulated, hypothetical design storms, TVA considered those events with recurrence intervals up to 700 years. The hypothetical events are scaled replicas of the largest flood events observed across the Tennessee Valley within the 99-year period of record. A total of 138 separate design storms were developed in an effort to capture the watershed flood potential of events with a wide variation in the spatial and temporal distribution of runoff.

All of the alternatives investigated, with the exception of Base Case, can be characterized by a reduction in flood storage allocation at certain projects during certain seasons of the year. Any reduction in flood storage allocation must, by definition, be accompanied by an increase in flood risk, since the volume available to temporarily store large runoff volumes is reduced. For an alternative to be judged to satisfy the flood risk evaluation criteria described above, this increase in flood risk must be limited to those events with recurrence intervals larger than the 500-year event. The 500-year event was judged to be a reasonable standard that would allow TVA to investigate meaningful modifications to the reservoir operations policy while maintaining consistency with TVA's historical flood control mission.

Peak Flow

As described in Section 4.22.3, the annual and seasonal peak discharge at each critical location was identified for each year in the 99-year simulation of the Base Case. The peak discharges were sorted in descending order, assigned a recurrence interval using a standard hydrologic formula, and then plotted on probability paper to estimate the relationship between the magnitude of a peak discharge at a given location and the probability of occurrence of that discharge. A similar analysis was performed for each alternative. The impact of each alternative on flood flow frequency was determined by comparing the plotted flood flow frequency data for each policy alternative with the data from the Base Case.

The impact of Reservoir Recreation Alternative A on annual peak discharges from Chickamauga Dam is shown in Figure 5.22-01. This figure shows that operation of the reservoir system under Reservoir Recreation Alternative A would increase the annual peak discharges over those in the Base Case at this location across much of the range of recurrence intervals represented. At Chickamauga Dam, discharges in excess of about 150,000 cfs are of particular concern because of the immediate potential for downstream flooding in Chattanooga. This flow is indicated by the horizontal line labeled "Discharge When Damage Begins" in Figure 5.22-01. Any instances for which the alternative peak discharges are higher than the corresponding Base Case discharges in that region of the flood flow frequency plot at or above 150,000 cfs would therefore be an indication that increased flooding could be expected under that alternative.

As shown in Figure 5.22-01, an increase in peak discharge from Chickamauga Dam under Reservoir Recreation Alternative A can be expected for discharges with an annual probability of exceedance of between 0.05 (corresponding to a recurrence interval of 20 years) and 0.03 (corresponding to a recurrence interval of about 33 years; this recurrence interval is shown by a dashed vertical gridline in Figure 5.22-01). For this range of recurrence intervals, peak discharges are above the "damage begins" threshold. The increases in peak discharge evident under Reservoir Recreation Alternative A for events with exceedance probabilities larger than about 0.25 (recurrence intervals less than 4 years) would not be associated with increased flooding damage at Chattanooga. Flood flow frequency plots at other locations were evaluated in a similar manner, with each evaluation performed relative to an appropriate "damage begins" threshold discharge, based on consideration of potential damage to habitable residential, commercial, and industrial structures, and other areas such as farmlands.

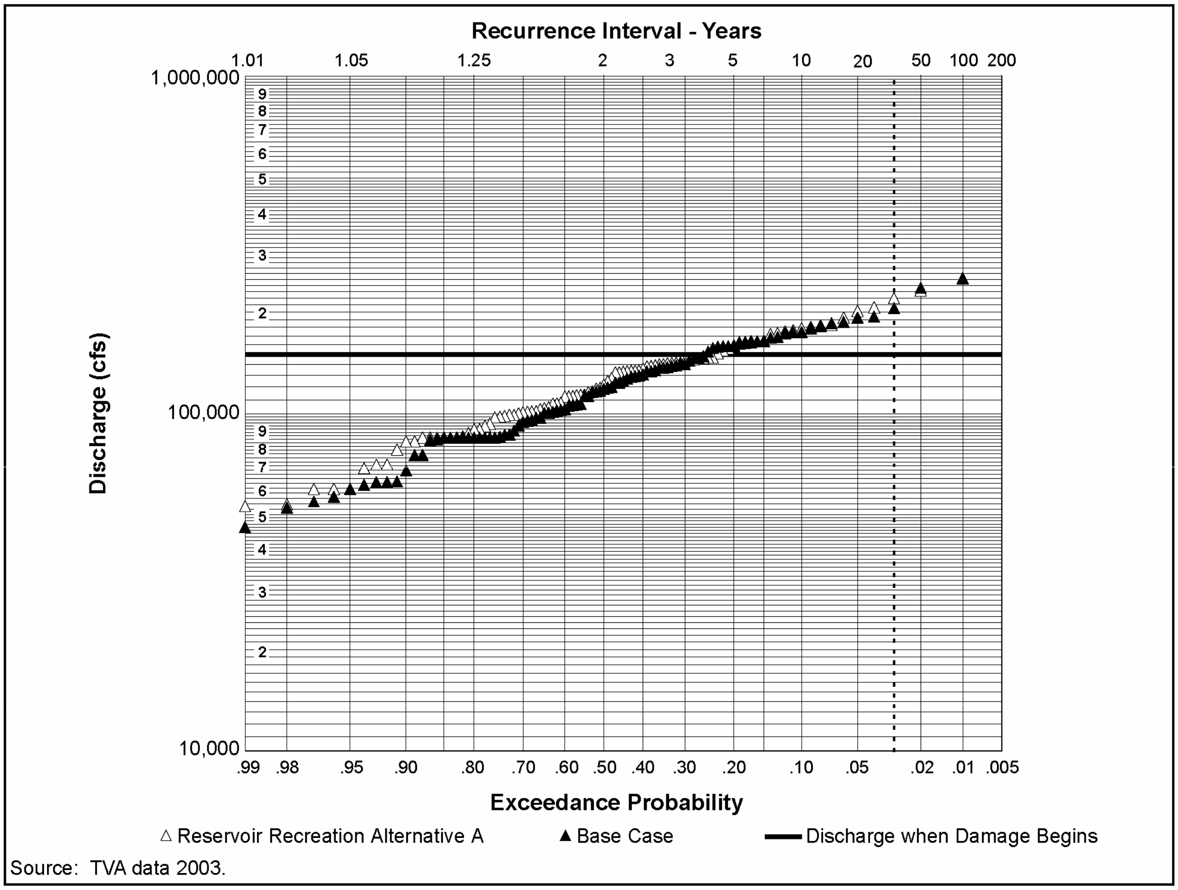
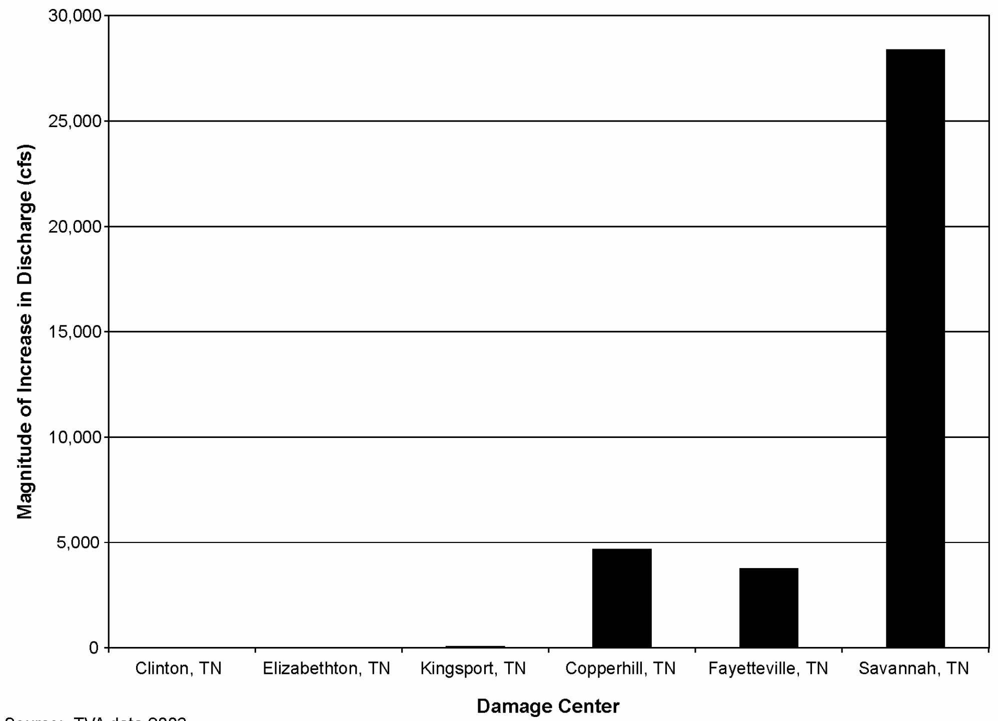


Figure 5.22-01 Simulated Annual Flood Flow Frequency for Chickamauga Dam (1903 to 2001)

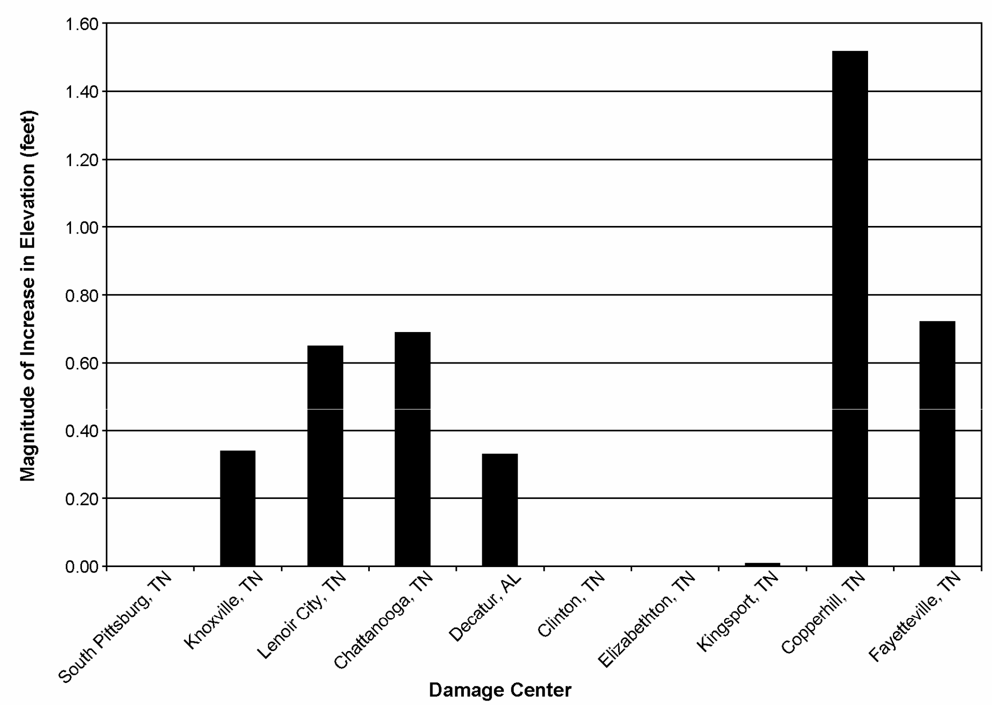
Annual and seasonal flood flow frequency plots were thus developed at each critical location to reflect the effects of each policy alternative. Figures 5.22-02 (a) and (b) show the incremental increase (with respect to the Base Case) in the largest of the simulated peak flows and/or elevations under Reservoir Recreation Alternative A for some of the 13 damage centers.

For the design storms, the scaled-up historical inflows were modeled in a series of discrete (as opposed to continuous) RiverWare simulations. The peak discharge for each storm event was then plotted versus the month and day of the historical storm peak, overlaying the policy alternative and the Base Case peak flows for comparison. Figure 5.22-03 illustrates the impact of Reservoir Recreation Alternative A in terms of peak discharge at Chickamauga for each design storm (based on historical inflows increased by a factor of 1.5). In some cases, such as the design storm that peaked on April 6 (1977), the impact is measurable as the peak discharge increases from 274,000 cfs under the Base Case to 296,000 cfs under Reservoir Recreation Alternative A. In the design storm that peaked on May 9 (1984), however, no measurable increase in the peak discharge is seen.



Source: TVA data 2003.

Figure 5.22-02a Increase in Simulated Peak Flow for Largest Event in 99-Year Period of Record for Six Flood Damage Centers in the Tennessee Valley Region under Reservoir Recreation Alternative A



Source: TVA data 2003.

Figure 5.22-02b Increase in Simulated Peak Elevation for Largest Event in 99-Year Period of Record for 10 Flood Damage Centers in the Tennessee Valley Region under Reservoir Recreation Alternative A

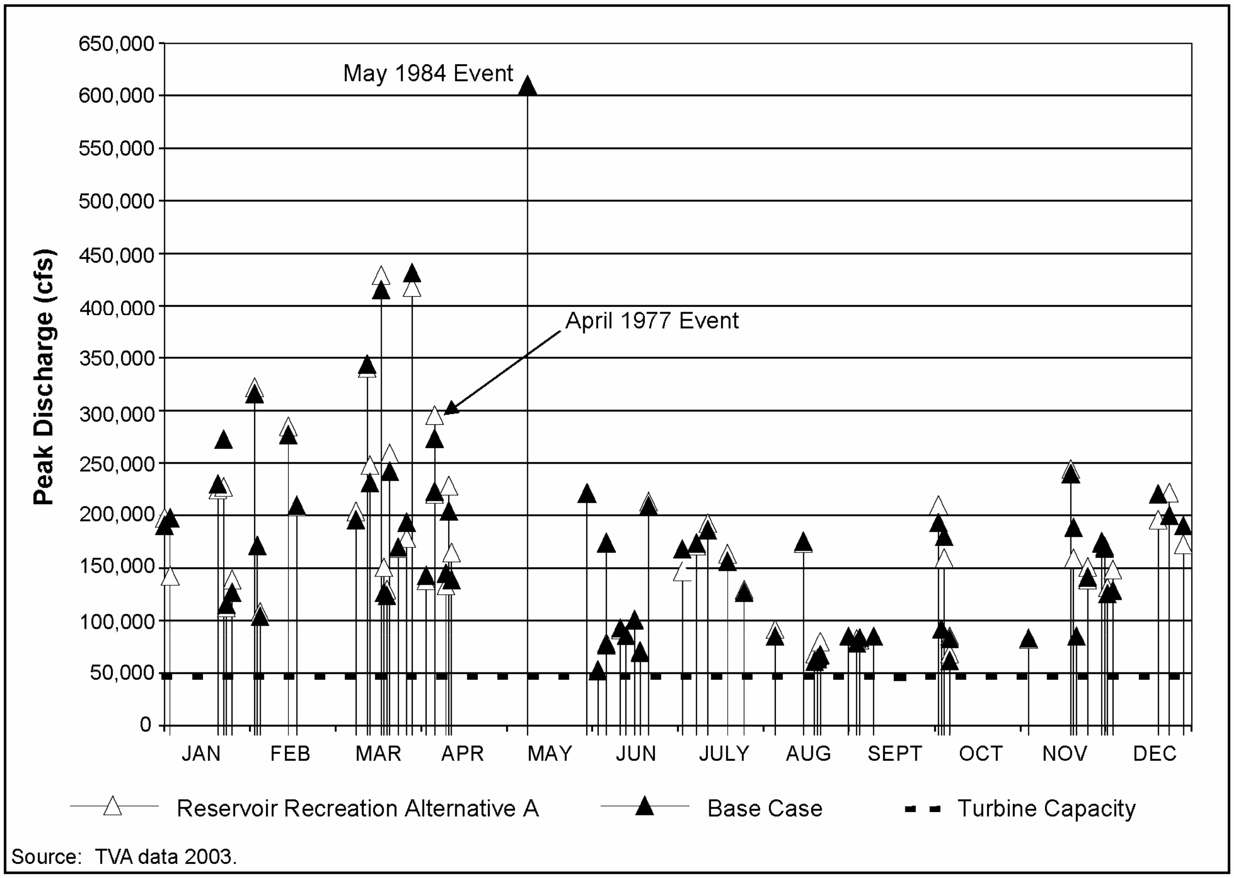
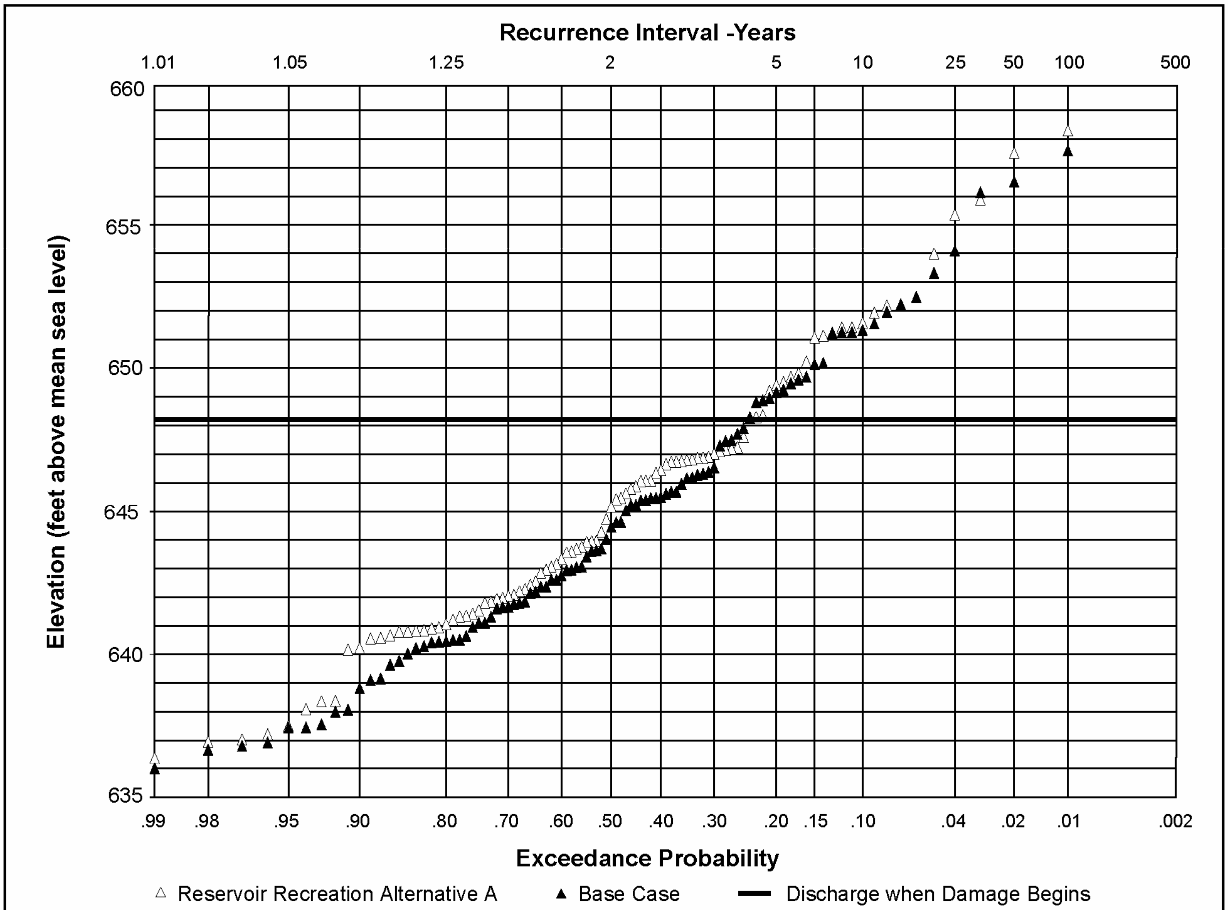


Figure 5.22-03 Peak Discharges from Hypothetical Design Storms for Chickamauga Dam (Scaling Factor 1.50)

Potential Damage

After identifying the change in peak flow for historical storms, peak flows at damage center locations were converted to corresponding elevations and the effect of the change was evaluated. Elevation frequency plots were prepared in a manner similar to the flood flow frequency plots. As an example, the annual peak elevations at Chattanooga are presented in Figure 5.22-04 for Reservoir Recreation Alternative A and the Base Case. Also identified in Figure 5.22-04 is the elevation at which damage in Chattanooga begins.

Figure 5.22-04 illustrates that, under Reservoir Recreation Alternative A, the annual peak water elevation is expected to exceed that for the Base Case over most of the range of recurrence intervals shown in the figure. For those elevation frequency points above the "damage begins" line, the elevation difference between the Reservoir Recreation Alternative A and Base Case points ranges from less than zero to about 1.3 feet (at a recurrence interval of 25 years).



Source: TVA data 2003.

Figure 5.22-04 Simulated Annual Elevation Frequency in Chattanooga, Tennessee (1903 to 2001)

Next, the expected effects of those alternatives for which detailed flood risk simulations were completed were evaluated and summarized at each of 48 locations in the Valley, noting the locations and seasons where the effect of the alternatives would be to cause additional damage. If peak levels (flows and/or elevations) either did not increase or remained at non-damaging levels, the alternative was considered to cause no additional damage. If the alternative would increase peak levels from non-damaging levels to damaging levels, or from lower to higher damaging levels, it was considered to cause additional damage. This process was completed for each alternative compared to the Base Case for both the 99 years of historical inflows and the design storms. The results of the evaluation of flood risk simulations are summarized in the matrix formats contained in Tables 5.22-02 through 5.22-07.

Table 5.22-02 Summary Matrix Evaluation of the Effect of Reservoir Recreation Alternative A on Flood Risk

Location	Period of Record – 99 Years					Design Storms with 1.5 Multiplier					Design Storms with 2.0 Multiplier				
	Season					Season					Season				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Tributary Dams															
South Holston															
Watauga															
Cherokee								2	3					1	
Douglas								2	1	1			4	1	1
Fontana							1	2	1	2		1	2		1
Norris								1					1		
Chatuge						1		2		1	1	1	1		1
Nottely						2		1	1	1	2		2		3
Hiwassee										2			1		1
Blue Ridge						1	1	2	2	1			1		2
Tims Ford							2								
Great Falls															
Mainstem Dams															
Fort Loudoun							1	2					5	1	1
Watts Bar						2		6			1	1	7		
Chickamauga						3	1	2	2		4	1	5		
Nickajack						3	2	3	1		3	2	8		
Guntersville						4	1	1			3	2	5		
Wilson						3	1	2			3	4	4		
Pickwick						3	2	1			2	3	3	1	
Damage Centers															
Kingsport								1							
Clinton								2					3		
Copperhill								2		1			3		
Elizabethton										1				2	1
Fayetteville												1			
Knoxville						3	2	4	3	1	4		6	3	3
Lenoir City							1	4	1				5		2
Chattanooga						2	1	3	2		3	3	8		
Decatur						1	2	1				1	4		
Florence						4	2	1			3	4	4	3	
Savannah						2	2	1			3	2	3	1	

Notes:

An unshaded cell indicates that, for a given alternative, no increase in peak discharge in the zone above the "damage begins" line was observed in that season for that location relative to the Base Case; a shaded cell indicates that a given alternative produced an increase in peak discharge for one or more points in the zone above the "damage begins" line.

The numbers indicate that the number of hypothetical events for which an increase in peak discharge was observed, that the peak discharge is above the "damage begins" line, and that the approximate recurrence interval of the event falls between 100 and 700 years.

Table 5.22-03 Summary Matrix Evaluation of the Effect of Reservoir Recreation Alternative B on Flood Risk

Location	Period of Record – 99 Years					Design Storms with 1.5 Multiplier					Design Storms with 2.0 Multiplier				
	Season					Season					Season				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Tributary Dams															
South Holston							1	1							
Watauga															
Cherokee								1	3				1		
Douglas						1		2	1	2	1		3		2
Fontana						3	1	3	1	2	2	2	2		1
Norris								1					1		
Chatuge						1	1	2		1	3	1	2		1
Nottely						2	2	1	1	1	2		3		3
Hiwassee							2			2			1		1
Blue Ridge						1			1	1			1		2
Tims Ford								1			2				
Great Falls															
Mainstem Dams															
Fort Loudoun							1	4					5		1
Watts Bar						1	2	6				1	8		
Chickamauga						3	2	3	2		3	2	6		
Nickajack						3	3	4	1		3	3	9		
Guntersville						3	3				3	3	6	1	
Wilson						4	2				3	4	4		
Pickwick						3	2				2	3	3	1	
Damage Centers															
Kingsport								2							
Clinton						1		2					1		
Copperhill										1			1		
Elizabethton														2	
Fayetteville											2			1	
Knoxville						3	1	5	3	1	3		2	3	3
Lenoir City							1	5	1		1		6		2
Chattanooga						4	2	3	2		3	4	7		
Decatur						1	4	1			1	1	5		
Florence						3	2				3	4	4	3	1
Savannah						3	2				3	2	3	1	

Notes:

An unshaded cell indicates that, for a given alternative, no increase in peak discharge in the zone above the "damage begins" line was observed in that season for that location relative to the Base Case; a shaded cell indicates that a given alternative produced an increase in peak discharge for one or more points in the zone above the "damage begins" line.

The numbers indicate that the number of hypothetical events for which an increase in peak discharge was observed, that the peak discharge is above the "damage begins" line, and that the approximate recurrence interval of the event falls between 100 and 700 years.

Table 5.22-04 Summary Matrix Evaluation of Effect of the Equalized Summer/Winter Flood Risk Alternative on Flood Risk

Location	Period of Record – 99 Years					Design Storms with 1.5 Multiplier					Design Storms with 2.0 Multiplier				
	Season					Season					Season				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Tributary Dams															
South Holston								1							
Watauga															
Cherokee															
Douglas															
Fontana												2	1		
Norris															
Chatuge							1				3	1			1
Nottely							1	1			1		2		2
Hiwassee															
Blue Ridge							2								1
Tims Ford															
Great Falls															
Mainstem Dams															
Fort Loudoun													3		
Watts Bar							2				1	1	2		
Chickamauga						1	2	2			2	2	2		
Nickajack							3	2			2	3	5		
Guntersville						1	6	1		1	1	3	7		
Wilson						1	3	1			2	4	2		
Pickwick							3	1			1	3	3		
Damage Centers															
Kingsport															
Clinton						2		1							
Copperhill								1							
Elizabethton								2		1			1	1	1
Fayetteville															
Knoxville						1	1	3	2	1	2		2	1	4
Lenoir City								4					3		
Chattanooga						1	2	2			2	3	3		
Decatur							5	1				1	4		
Florence						1	4	1			2	4	3	2	1
Savannah							3	1			2	2	3		

Notes:

An unshaded cell indicates that, for a given alternative, no increase in peak discharge in the zone above the “damage begins” line was observed in that season for that location relative to the Base Case; a shaded cell indicates that a given alternative produced an increase in peak discharge for one or more points in the zone above the “damage begins” line.

The numbers indicate that the number of hypothetical events for which an increase in peak discharge was observed, that the peak discharge is above the “damage begins” line, and that the approximate recurrence interval of the event falls between 100 and 700 years.

Table 5.22-05 Summary Matrix Evaluation of Effect of the Commercial Navigation Alternative on Flood Risk

Location	Period of Record – 99 Years					Design Storms with 1.5 Multiplier					Design Storms with 2.0 Multiplier				
	Season					Season					Season				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Tributary Dams															
South Holston															
Watauga															
Cherokee															
Douglas															
Fontana							1					2			
Norris															
Chatuge															
Nottely															
Hiwassee													1		
Blue Ridge															
Tims Ford															
Great Falls															
Mainstem Dams															
Fort Loudoun								2					5		
Watts Bar								5				1	6		
Chickamauga						1	1	3	1		3	2	5		
Nickajack							2	3			2	2	4		
Guntersville						2	3	1		1	3	2	5		
Wilson						2	2	1			2	2	4	1	
Pickwick						2	3	1				3	3	1	
Damage Centers															
Kingsport															
Clinton															
Copperhill															
Elizabethton															
Fayetteville															
Knoxville						4	2	4	4	1	3		5		2
Lenoir City								3					5		
Chattanooga						1	1	3	1		3	3	4		
Decatur						1	6				1	1	4		
Florence						4	4	1			3	4	4	2	
Savannah						2	2	1			1	2	3	1	

Notes:

An unshaded cell indicates that, for a given alternative, no increase in peak discharge in the zone above the "damage begins" line was observed in that season for that location relative to the Base Case; a shaded cell indicates that a given alternative produced an increase in peak discharge for one or more points in the zone above the "damage begins" line.

The numbers indicate that the number of hypothetical events for which an increase in peak discharge was observed, that the peak discharge is above the "damage begins" line, and that the approximate recurrence interval of the event falls between 100 and 700 years.

Table 5.22-06 Summary Matrix Evaluation of Effect of the Tailwater Habitat Alternative on Flood Risk

Location	Period of Record – 99 Years					Design Storms with 1.5 Multiplier					Design Storms with 2.0 Multiplier				
	Season					Season					Season				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Tributary Dams															
South Holston															
Watauga															
Cherokee								2	3					2	
Douglas						1		2	1	2	1		4		2
Fontana						2	2		2	2	1	2	2	1	1
Norris								2					1		
Chatuge						1	1	2		1	4	1	2	1	1
Nottely						2		1	1	1	3		4		3
Hiwassee										2	1		2	1	1
Blue Ridge						1	5	3	2	1	4	1	2		2
Tims Ford							2								
Great Falls															
Mainstem Dams															
Fort Loudoun							1	3	2		1		5		1
Watts Bar						2		7			1	1	7		
Chickamauga						3	1	3	2		5	3	7		
Nickajack						3	2	3	1		3	2	7	1	
Guntersville						4	3	1			3	3	4		
Wilson						4	2	1			3	3	4		
Pickwick						4	2	1			2	3	3	1	
Damage Centers															
Kingsport								1							
Clinton						1		2					2		
Copperhill							2	2		1	3		4		
Elizabethton										1				2	1
Fayetteville												1			
Knoxville						4	1	4	1	1	4		6	4	2
Lenoir City							1	4	1		1		5		2
Chattanooga						2	1	3	2		5	4	8		
Decatur						1	5					1	4		
Florence						4	2	1	2		3	4	4	2	1
Savannah						3	2	1			3	2	3	1	

Notes:

An unshaded cell indicates that, for a given alternative, no increase in peak discharge in the zone above the “damage begins” line was observed in that season for that location relative to the Base Case; a shaded cell indicates that a given alternative produced an increase in peak discharge for one or more points in the zone above the “damage begins” line.

The numbers indicate that the number of hypothetical events for which an increase in peak discharge was observed, that the peak discharge is above the “damage begins” line, and that the approximate recurrence interval of the event falls between 100 and 700 years.

Table 5.22-07 Summary Matrix Evaluation of Effect of the Preferred Alternative on Flood Risk

Location	Period of Record – 99 Years					Design Storms with 1.5 Multiplier					Design Storms with 2.0 Multiplier				
	Season					Season					Season				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Tributary Dams															
South Holston															
Watauga															
Cherokee															
Douglas								1							
Fontana									1				1		1
Norris								1							
Chatuge													1		
Nottely									1				1	2	
Hiwassee										1			2		1
Blue Ridge								1			1		1	1	
Tims Ford															
Great Falls															
Mainstem Dams															
Fort Loudoun								2					3		
Watts Bar							1	2				1	2		
Chickamauga						2	1	2	1			1	2	2	
Nickajack						1	1	1	1			3	2		
Guntersville						2	1	4				2	3		
Wilson						2	2	2				1	1		
Pickwick						2	2					1	1		
Damage Centers															
Kingsport								1	1						
Clinton								1					1		
Copperhill								2					2		
Elizabethton							1			1			1	1	1
Fayetteville															
Knoxville							2	3	1	1	2		1		1
Lenoir City								3			1		1	1	
Chattanooga						2	1	2	1			2	1		
Decatur							3	2					4		
Florence						2	2	3				3	1		
Savannah						1	3				1	1	1	2	

Notes:

An unshaded cell indicates that, for a given alternative, no increase in peak discharge in the zone above the “damage begins” line was observed in that season for that location relative to the Base Case; a shaded cell indicates that a given alternative produced an increase in peak discharge for one or more points in the zone above the “damage begins” line.

The numbers indicate that the number of hypothetical events for which an increase in peak discharge was observed, that the peak discharge is above the “damage begins” line, and that the approximate recurrence interval of the event falls between 100 and 700 years.

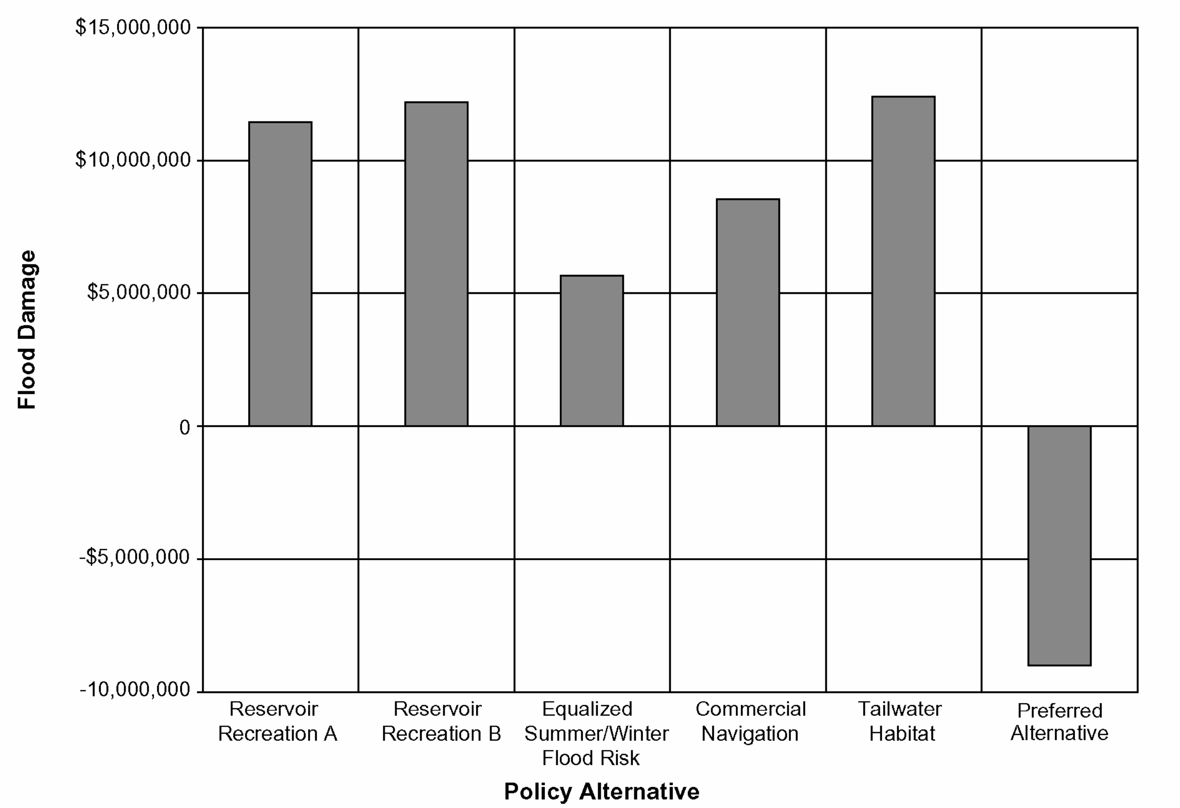
Detailed flood risk simulations were not conducted for the Summer Hydropower Alternative or the Tailwater Recreation Alternative. As discussed in Section 5.22.4, these alternatives were judged to be sufficiently similar to Reservoir Recreation Alternative B to allow meaningful conclusions concerning their impacts on flood risk. Reservoir Recreation Alternative B specifies a greater reduction in available flood storage with respect to the Base Case than either the Summer Hydropower Alternative or the Tailwater Recreation Alternative.

Tables 5.22-02 through 5.22-07 each include a list of selected locations, with a series of columns either shaded or unshaded to the right of the locations. The columns are in three main groups, and each group consists of five columns. These columns are labeled 1 through 5 and indicate the seasons used in the analysis. Column 1 corresponds to the season of October and November, column 2 to December through February, column 3 to March through May, column 4 to June and July, and column 5 to August and September. The left-hand column grouping is for the period of record 99-year continuous simulation. The center column grouping is for the design storms generated using a scaling factor of 1.5, and the right-hand column grouping is for the design storms generated using a scaling factor of 2.0.

An unshaded cell indicates that no increase in peak discharge for a given alternative relative to the Base Case in the zone above the “damage begins” line was observed in that season for that location. A shaded cell indicates the opposite: a given alternative produced an increase in peak discharge for one or more points in the zone above the “damage begins” line. Note that any observed increases in peak discharge above the “damage begins” line for a specific recurrence interval (from the period of record simulation analysis) or a specific hypothetical event (from the analysis of discrete design storms) result in a cell being shaded. In many instances, decreases in peak discharges for other recurrence intervals or hypothetical events were also observed; these instances are not noted in Tables 5.22-02 through 5.22-07.

The numbers in the design storm summary column groupings indicate the number of hypothetical events for which an increase in peak discharge was observed and for which the following conditions were satisfied: the peak discharge for the given alternative is above the “damage begins” line and the approximate recurrence interval of the event falls between 100 and 700 years (approximate recurrence intervals were computed based on considerations of the sum of all upstream local inflow volumes prior to any translation in space or time). While precise recurrence intervals have not been established for any hypothetical design storms, the adopted approach was intended to allow consideration of those flood events with inflow volumes for which a reasonable degree of regulation could be expected.

The extent of each alternative’s impact was estimated by determining the increase in flood damage at Chattanooga above that expected under the Base Case due to the largest historical event within the 99-year period of record. As described in Section 4.22.4, the basis for the estimate was the inventory of the properties located in the floodplain and included the value of the structures and their contents plus an estimate of 20 percent of the direct loss to account for the indirect losses. The additional damage expected at Chattanooga from the largest historical event is presented in Figure 5.22-05. The increases in expected damage shown, range from $6 million under the Equalized Summer/Winter Flood Risk Alternative to over $12 million under Reservoir Recreation Alternative B and the Tailwater Habitat Alternative. These increases would be similar to the level of damage experienced in Chattanooga in the recent May 2003 storm (where flood damage was estimated at $18 million) (TVA 2003).). Figure 5.22-05 shows that the Preferred Alternative would result in a reduction of damage at Chattanooga of over $9 million.



Source: TVA data 2003.

Figure 5.22-05 Expected Additional Dollar Damage at Chattanooga by Policy Alternative Evaluated in Detail Relative to the Base Case for the Largest Event in 99-Year Period of Record

To rank each alternative according to its overall impact on expected damage, it is more appropriate to evaluate the cumulative flood damage, or average annual damage, rather than damage from a single storm. This average annual damage accounts for how frequently an area is damaged. Total flood damage for the 99-year period of record was calculated for each alternative and averaged over the 99 years. The increase in average annual damage relative to the Base Case presented in Figure 5.22-06 illustrates that the Preferred Alternative would result in the least impact, reducing average annual damage by about $ 82,000 at Chattanooga. Reservoir Recreation Alternative B and the Tailwater Habitat Alternative would result in the greatest adverse impact.

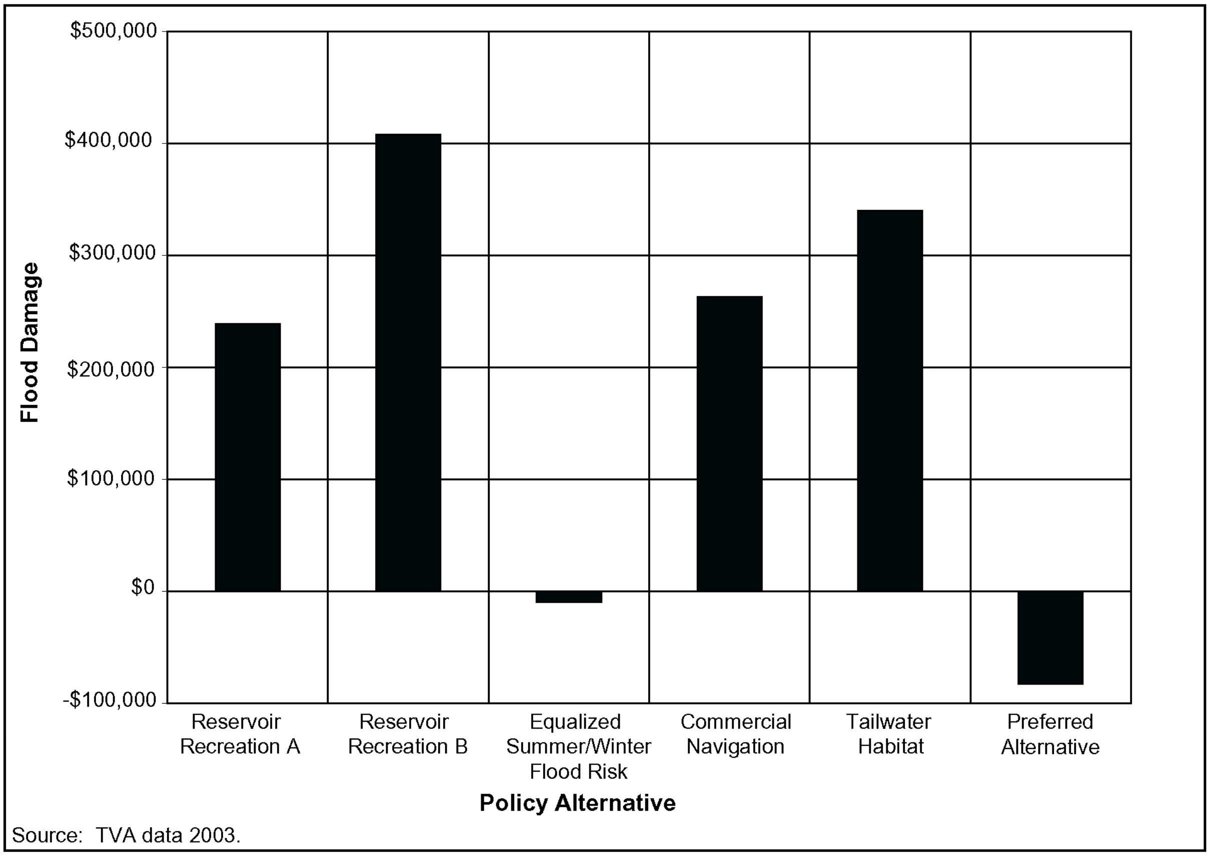


Figure 5.22-06 Expected Change in Average Annual Damage at Chattanooga by Policy Alternative Evaluated in Detail Relative to the Base Case for the 99-Year Period of Record

5.22.3 Base Case

Under the Base Case, the only expected changes to flood risk would be related to continued trends in land use and development in the floodplain, and their impacts on watershed runoff characteristics and potential damage.

Peak Flow. Peak discharges that result from operation of the reservoir system under the Base Case are expected to be no different from those under the existing policy.

Potential Damage. Although the peak discharges are not expected to change under the Base Case, the potential damage expected may change from existing conditions because of changes in development in the floodplain (see Section 4.22.4).

Flood Recovery Policy. The flood recovery policy under the Base Case is the existing policy; therefore, no impacts would occur.

5.22.4 Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Summer Hydropower Alternative, Tailwater Recreation Alternative, and Tailwater Habitat Alternative

Within this grouping of alternatives, detailed flood risk simulations were performed only for Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and the Tailwater Habitat Alternative.

The Summer Hydropower Alternative and the Tailwater Recreation Alternative were not included in detailed flood risk simulations. These alternatives were judged to be sufficiently similar to alternatives that were evaluated in detail to allow drawing meaningful conclusions about their impact on flood risk. Reservoir Recreation Alternative B specifies a more aggressive reduction in available flood storage (with respect to the Base Case) than either the Summer Hydropower Alternative or the Tailwater Recreation Alternative. Increases in flood risk under these alternatives can reasonably be expected to be bounded by any increases evidenced under Reservoir Recreation Alternative B.

These alternatives all specify a reduction in flood storage associated with a combination of extending current summer pool levels and raising winter pool levels, both on tributary and mainstem projects. They form a logical grouping and exhibit similar results, as shown in Tables 5.22-02, 5.22-03, and 5.22-06. The analysis of impacts was performed on a seasonal basis.

For Season 1 (October and November), the Tailwater Habitat Alternative demonstrates the greatest increases in flood risk, particularly in the North Georgia tributary projects and on the mainstem. Reservoir Recreation Alternative A shows the least increase in flood risk, with the majority of the tributary projects showing no increases in flood risk throughout the range of historical and hypothetical flood events investigated.

For Season 2 (December through February), Reservoir Recreation Alternative B and the Tailwater Habitat Alternative demonstrate similar increases in flood risk, with Reservoir Recreation Alternative B causing more increased risk in the Holston River projects and the Tailwater Habitat Alternative increasing risk on the Ocoee and Elk Rivers. Reservoir Recreation Alternative A generally shows the smallest increase in flood risk in this season.

For Season 3 (March through May), Reservoir Recreation Alternative B shows the smallest increases in flood risk on the tributary projects, with Reservoir Recreation Alternative A and the Tailwater Habitat Alternative showing approximately equal, larger increases in risk on these projects. All three alternatives show relatively uniform increases in flood risk throughout almost all of the mainstem projects.

Seasons 4 (June and July) and 5 (August and September) are almost identical for the three alternatives, with increases in flood risk primarily in the North Georgia tributary projects and at the upper and lower ends of the mainstem.

All of the damage centers show increases in flood risk throughout the year, particularly in Seasons 2 and 3. The increase in risk is smallest at Clinton, Kingsport, and Fayetteville. The mainstem damage centers are most affected during the late fall to spring period of October through May. The increases in flood risk, in general, are smallest in the summer months of June through September throughout the system.

With respect to flood risk, the Tailwater Recreation Alternative is nearly identical to Reservoir Recreation Alternative B. The Tailwater Recreation Alternative includes a provision for recreation flows between June 1 and Labor Day at some projects that is not included in Reservoir Recreation Alternative B. Otherwise, the alternatives are the same. For the purposes of this analysis, the impacts of the Tailwater Recreation Alternative were assumed to be identical to those of Reservoir Recreation Alternative B.

The Summer Hydropower Alternative was developed to enhance summer hydropower production and would result in summer reservoir pool levels lower than under the other policy alternatives at most, but not every, project. Increases in flood risk in summer would therefore be generally less under this alternative. However, this alternative is identical to Reservoir Recreation Alternative B with respect to winter pool levels for tributary projects (no changes are proposed to mainstem winter pool levels under the Summer Hydropower Alternative). The winter flood risk impacts at tributary projects and damage centers noted for Reservoir Recreation Alternative B would therefore also apply to the Summer Hydropower Alternative.

The Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Summer Hydropower Alternative, Tailwater Recreation Alternative, and Tailwater Habitat Alternative would result in unacceptable flood risk.

5.22.5 Equalized Summer/Winter Flood Risk Alternative

The Equalized Summer/Winter Flood Risk Alternative is unique in that it was developed with the intention of providing approximately equal flood protection throughout each season. In general, implementation of this alternative would involve raising winter pools and lowering summer pools for both tributary and mainstem projects. Because it is unique, impacts with respect to flood risk under this alternative were evaluated independently of the other alternatives. Table 5.22-04 summarizes the results of this evaluation.

Increases in flood risk on the tributary projects would primarily be limited to Season 2. On the mainstem projects, increases in flood risk would be more generally distributed through the winter months, with increases in most locations for Seasons 1 through 3. The damage centers of Kingsport and Elizabethton associated with tributary projects show increased flood risk; the risk at Elizabethton would be increased throughout the year. Damage centers on the mainstem from Knoxville through Savannah show increased flood risk under this alternative, primarily in Seasons 2 and 3.

The Equalized Summer/Winter Flood Risk Alternative would result in unacceptable flood risk.

5.22.6 Commercial Navigation Alternative

The Commercial Navigation Alternative was also evaluated independently. This alternative was developed to enhance navigation, with operational changes being limited to mainstem reservoirs. Table 5.22-05 summarizes the results of this evaluation.

As expected, Table 5.22-05 shows very little increase in flood risk on any of the tributary projects and damage centers. Minor increases in flood risk at Fontana and Hiwassee reflect changes in operations associated with enhancing navigation and most likely could be readily mitigated.

Increases in flood risk on the mainstem would be more widespread and primarily would occur in Seasons 1 through 3. This increase in risk is associated with the increase in winter mainstem pool levels, which are a fundamental aspect of the Commercial Navigation Alternative. All mainstem damage centers show an increase in flood risk in Season 3, and all but Lenoir City an increase in Season 2.

The Commercial Navigation Alternative would result in unacceptable flood risk.

5.22.7 Preferred Alternative

The Preferred Alternative was developed to address the flood damage issues associated with each of the policy alternatives evaluated in the DEIS, as documented in Tables 5.22-01 through 5.22-06. The alternative was developed by modifying flood guide curves and regulating zones for a wide range of tributary and mainstem projects such that the increases in peak flood discharges and associated damages evident in the policy alternatives evaluated in the DEIS were effectively eliminated. Changes to individual project guide curves and regulating zones were made to address flood damage issues immediately downstream of that project as well as at downstream damage centers such as Knoxville or Chattanooga. Table 5.22-07 summarizes the results of this evaluation.

The Preferred Alternative is characterized by higher winter flood guides for most tributary storage projects (including Watauga, South Holston, Boone, Cherokee, Douglas, Chatuge, Nottely, Hiwassee, Fontana, and Norris), slightly lower summer flood guides for several tributary storage projects (including Cherokee, Douglas, Nottely, Hiwassee, and Blue Ridge), and a delayed fill for the mainstem projects above Chattanooga. The effect of these changes on the tributary projects, as compared to the Base Case, would be generally higher winter pool levels, slightly lower June 1 pool levels, and generally higher median Labor Day pool levels. For the mainstem projects, this alternative would produce generally higher median Labor Day pool levels.

The increase in flood risk associated with the Preferred Alternative, while limited to relatively rare events, is a necessary outcome of the reduction in flood storage at certain projects. However, this increase was deemed acceptable, based on the criteria developed to determine flood risk acceptability (see Section 5.22.2).

5.22.8 Summary of Impacts

The change in flood risk for the alternatives evaluated in detail as compared to the Base Case is summarized in Tables 5.22-02 through 5.22-07. Table 5.22-08 presents a summary of impacts on flood control by policy alternative. For some areas within the reservoir system, the policy alternatives evaluated in the DEIS would increase flood risk to an extent that additional structural or other damage would occur as compared to the Base Case. The increase in flood risk is primarily attributable to the reduction in available flood storage in the tributary and mainstem reservoirs. All of the policy alternatives except for the Preferred Alternative would result in unacceptable flood risk.

The flood risk evaluation indicates that, compared to Base Case, all policy alternatives are characterized by a slight increase in flood risk at the PMF level, which is the largest event that can reasonably be expected to occur. TVA has not evaluated the range of recurrence intervals over which a change in flood risk associated with a given policy alternative may occur.

The Preferred Alternative satisfies the flood damage criterion established for this study. While Table 5.22-07 shows that some increases in peak discharge were noted at a few locations in some seasons, these increases were generally offset by similar reductions in peak discharge for other events in the same season.

Table 5.22-08 Summary of Impacts on Flood Control by Policy Alternative

Alternative	Description of Impacts
Base Case	No change – Under the Base Case, the only changes to flood risk that are expected would be related to continued trends in land use and development in the floodplain and the related effects on watershed runoff characteristics and increased potential for damage. Average annual flood-related damages under this alternative would be approximately $1,460,000.
Reservoir Recreation A	Adverse – Reservoir Recreation Alternative A would increase flood risk with respect to the Base Case. Average annual damage would be higher than under the Base Case. Average annual flood-related damages under this alternative would be approximately $1,880,000, an increase of about 29% relative to the Base Case. This alternative would result in unacceptable flood risk.
Reservoir Recreation B	Substantially adverse – Reservoir Recreation Alternative B would increase flood risk to an extent similar to Reservoir Recreation Alternative A, although more adverse. Average annual flood-related damages under this alternative would be approximately $2,180,000, the highest of the policy alternatives and an increase of about 49% relative to the Base Case. This alternative would result in unacceptable flood risk.
Summer Hydropower	Adverse – Detailed flood risk simulations for the Summer Hydropower Alternative were not performed. However, the level of impact relative to flood risk is expected to be bounded by the alternatives evaluated in detail. Average annual flood-related damages under this alternative are estimated at approximately $1,830,000, an increase of about 25% relative to the Base Case. This alternative would result in unacceptable flood risk.
Equalized Summer/Winter Flood Risk	No change – The Equalized Summer/Winter Flood Risk has the second fewest number of areas within the system where, for certain times of the year, additional damage would occur. The alternative would have a lower expected average annual damage than under the Base Case. Average annual flood-related damages under this alternative would be approximately $1,500,000, an increase of about 3% relative to the Base Case. This alternative would result in unacceptable flood risk.
Commercial Navigation	Adverse – The Commercial Navigation Alternative would result in the fewest number of areas within the system where, for certain times of the year, additional damage would occur. Nevertheless, average annual damage expected would be higher than under Reservoir Recreation Alternative A. Average annual flood-related damages under this alternative would be approximately $2,000,000, an increase of about 37% relative to the Base Case. This alternative would result in unacceptable flood risk.
Tailwater Recreation	Substantially adverse – Detailed flood risk simulations for the Tailwater Recreation Alternative were not performed. The level of impact on flood risk is expected to be similar to that of Reservoir Recreation Alternative B. Average annual flood-related damages under this alternative are estimated at approximately $2,050,000, an increase of about 40% relative to the Base Case. This alternative would result in unacceptable flood risk.

Table 5.22-08 Summary of Impacts on Flood Control by Policy Alternative (continued)

Alternative	Description of Impacts
Tailwater Habitat	Substantially adverse – The Tailwater Habitat Alternative would increase flood risk to an extent similar to Reservoir Recreation Alternative A, although more adversely. Average annual flood-related damages under this alternative would be approximately $2,110,000, an increase of about 44% relative to the Base Case. This alternative would result in unacceptable flood risk.
Preferred	No change – No overall increase in peak flood discharges is expected for any location for floods falling within the range of recurrence intervals adopted for this study. Average annual flood related damages under this alternative are approximately $1,370,000, a decrease of about 6% relative to the Base Case.

5.23 Power

5.23.1 Introduction

Changes to TVA’s reservoir operations policy may cause changes in the cost of hydropower and non-hydropower production, and in power system reliability. To assess these effects, the impact of each alternative was determined by calculating generation, capital improvement, and other power system costs predicted for each policy alternative, and then comparing those costs to the Base Case.

As previously noted, TVA performs power system studies semi-annually to forecast the future 20-year energy demand. To maintain consistency with the balance of TVA’s power system studies, the scope of the power generation studies performed in support of this EIS spans the 19-year period from 2004 through 2022. The 20-year forecast was extrapolated to estimate the forecast through 2030.

5.23.2 Impact Assessment Methodology

The impact of each alternative was measured by the increase or decrease in the power cost expected under the Base Case and that predicted for each policy alternative. For the Base Case, TVA’s total power sales revenue was estimated for each year from 2004 to 2030 based upon the January 2003 power supply planning forecast. Then for each policy alternative, the change in power supply cost was estimated. The effects of each alternative were represented as an equivalent potential rate increase or the change in power supply cost as a percentage of total power sales revenue. This analysis was performed as follows:

- **Power Supply Analysis.** TVA performed an analysis to determine the effect on power supply costs of changes in hydropower and non-hydropower power production under each alternative. This analysis included the production cost of power; a reliability analysis; and costs associated with derate of coal and nuclear units, ancillary services, and other non-generating costs.

- **Economic Analysis.** The direct effects of the alternatives on power generation, as modeled by an equivalent potential rate increase, were used as inputs to the REMI model to evaluate their impact on the regional economy.

Power Generation Dispatch and Reliability

The power supply analysis included the use of three computer models: (1) the WSM for TVA's hydrological and hydroelectric system, (2) the RELY capacity planning model, and (3) the PROSYM power production costing model. The data and methodology used to estimate the impact on its system-wide power supply cost were the same data and models that TVA uses for operations and planning. A summary description of each of these models can be found in Appendix C, Model Descriptions and Results.

The evaluation process included five steps as follows:

Step 1. Hydropower Generation

Weekly water releases are scheduled to provide for benefits such as navigation, system minimum flows, and flood control. Hydropower generation is dispatched to most efficiently generate power using these releases. The WSM was used to simulate weekly hydropower generation production for each alternative based on hydrologic conditions, considering the various constraints on water releases for other purposes. TVA then subtracted the weekly hydroelectric power production predicted by the WSM from the total system demand.

Step 2. Reliability

For each alternative, TVA then evaluated the power system's ability to reliably meet the "hydro-adjusted" summer and winter peak loads using the RELY model. RELY is a generation reliability model used to determine the capacity needed to maintain the reliability of the power system. RELY calculated the TVA system loss of load probability (LOLP) hourly for the summer and winter peak load seasons through 2022. The results were based on generating resource capacity, power purchases, expected equivalent forced outage rates, planned outages, the hourly load forecast, contract load available for interruptions and load forecast uncertainty. The impact of the hourly dispatch was analyzed weekly to determine the changes in capacity needs under each alternative and to compare them to the capacity needs of the Base Case. If necessary to maintain acceptable reliability with respect to meeting the "hydro-adjusted" summer and winter load peaks, the additional fixed (capital) and variable (operations and maintenance, and fuel) cost of new generation resources, whether owned by TVA or contracted by TVA with other generators, was determined. For the purpose of this analysis, TVA has assumed that any new capacity would be gas-fired combined-cycle (baseload) or simple-cycle (peaking). Implementation of any alternative could affect the environment and would require environmental review and other studies to select the preferred type of new capacity.

Step 3. Dispatch of Non-Hydropower Generation

The PROSYM dispatch model was then used to determine the most efficient combination of non-hydropower generation assets to meet the "hydro-adjusted" power demand. PROSYM, combined with TVA's power generation system data, was used to determine which generating resources should be operated to meet demand at the lowest cost. The PROSYM model scheduled all of TVA's other power resources on an hourly basis and estimated the effects of the alternatives on power supply cost. These effects include the associated re-dispatch in fossil units, purchase and sale of power outside TVA power system, ancillary services, emissions, the incremental nuclear outages associated with essential cooling water temperature limitations, and the operating costs of existing cooling towers to reduce the amount of thermal plant discharges in order to avoid coal and nuclear unit derates.

TVA currently operates cooling towers at Watts Bar, Browns Ferry, and Sequoyah Nuclear Plants and the Paradise Fossil Plant. Watts Bar Nuclear Plant condenser cooling water is cooled continuously by its towers, while the others use the cooling towers for some period of time each year to supplement their once-through cooling systems. Cooling tower use reduces the amount of heat discharged to the Tennessee River by these plants, which helps TVA comply with water temperature limits (see Section 2.3.3). The costs to operate these cooling towers are a part of the cost of power.

Step 4. Coal Unit Derates

TVA used its water quality models to simulate operations for each of the alternatives and predict water temperatures at the coal and nuclear plant discharge structures. These predicted water temperatures were compared with NPDES permit and NRC license limitations, and units were derated or shut down to maintain compliance. The potential nuclear unit derates and shutdowns due to essential cooling water temperature limitations were accounted for in the PROSYM model, using thermal-forced outage rates during the appropriate seasons. The effect of each alternative on coal unit derates, however, was not included in the PROSYM analysis and was estimated separately.

The cost of generation losses due to coal unit derates was valued differently for peak and off-peak power. The value of energy lost during peak periods was assumed to be the cost of replacing it with power purchased on an hourly basis in the bulk power market. Energy lost off-peak was valued by assuming replacement with energy from the most likely source, the next higher cost TVA coal units. The net cash impact off-peak was computed as the difference between the generating cost of the derated plant and the average generating costs of the replacement energy. For those periods when the replacement energy was expected to be at or below costs at the derated plants, the net cash impact was assumed to be zero.

Step 5. Other Non-Generation Costs

Other factors that affect the cost of meeting the power demand include the cost of aeration required to maintain DO concentrations in tailwaters, additional capital costs for construction of new cooling towers if necessary to reduce thermal plant derates, and the cost of shipping coal on the Tennessee River to fuel some of TVA's coal plants.

To maintain water quality below 16 of TVA's hydropower dams (see Appendix A, Table A-05), TVA currently supplements the DO concentrations by various methods, including auto-venting turbines, surface water pumps, oxygen injection systems, aerating weirs, and blowers (see Section 2.3.6). The cost includes purchase, installation, and operation and maintenance of aeration equipment.

The analysis of the alternatives revealed that, although the additional use of existing cooling towers would be needed at times, no new cooling towers would be warranted. Only the cost of additional use of existing cooling towers is included in the power cost impacts.

Coal that fuels TVA's coal-fired power plants is currently shipped via barge to some plants; rail and truck transport are also used for coal deliveries in some cases. Depending on location, barge transport is often the lowest-cost method of transport (see Section 5.21, Navigation). The cost of shipping coal is also a part of the fuel cost and therefore a part of the total cost of power.

5.23.3 Base Case

Under the Base Case, the power system would be operated to provide for the changing power demand from 2004 through 2030 at the lowest cost, based on current and forecast conditions. The Base Case also differs from existing conditions as a result of capacity additions from the HMOD projects and at Browns Ferry Nuclear Plant, and increased operational flexibility provided by the Hydro Automation Program (as described in Section 3.3.1).

Power Generation Dispatch and Reliability

The mix of generation dispatched to meet demand under the Base Case would remain similar to current conditions, with hydropower generation dispatched primarily to meet peak power needs. Planned nuclear and hydropower capacity additions would support a portion of the changing demand. The shift from industrial to residential and commercial load forecast for the period through 2030 would mean a greater need for on-peak energy supplied by hydropower and other peaking resources. Additional peaking capacity would be needed to maintain acceptable system reliability. Since hydropower resources would grow very little, this need for additional on-peak energy would be met by first shifting any hydropower that is currently off-peak to on-peak. The balance of on-peak generation required would be provided by increased operation of TVA's combustion turbine and pumped storage units and generation purchased from non-TVA generators.

Although no nuclear plant shutdowns have occurred historically as a result of the essential cooling water temperature limitations of the NRC license, severe meteorological conditions (hot, dry summers) similar to those experienced in the summer of 1993, could result in forced shutdowns of one or more TVA nuclear units for several days every 10 years on average under the Base Case. The effects of these conditions were included in the reliability and power supply analyses and factored into the power supply costs for the Base Case.

Coal Unit Derates

Under the Base Case, some derate of the coal units would be necessary to maintain compliance with NPDES temperature limits, similar to existing conditions.

Other Non-Generation Costs

Existing aeration facilities would continue to be operated similar to present levels in order to achieve existing DO targets.

The restart and operation of Browns Ferry Unit 1 will require construction of an additional cooling tower. Use of cooling towers would increase to ensure that the maximum cooling water discharge temperature and the temperature rise between intake and discharge, as measured by stations in the reservoir, remain within approved regulatory limits.

Coal shipping costs would be similar to existing costs.

Power Supply Costs

The total power sales revenue for the Base Case was estimated for each year from 2004 to 2030 based on the January 2003 power supply planning forecast. This forecast included the consideration of all the power supply and non-generating costs described for the Base Case.

5.23.4 Reservoir Recreation Alternative A

Power Generation Dispatch and Reliability

As detailed in Table 5.23-01 and Table 5.23-02, the timing of hydropower generation would be shifted under Reservoir Recreation Alternative A from late summer, (when the peak demand is highest and, therefore, replacement energy is most costly), to early winter (when replacement energy is less costly). The total annual hydropower generation on average would be similar to, although slightly higher than, the hydropower generation expected under the Base Case (Table 5.23-02). In response to the shift in hydropower generation, other more costly peaking generation resources, such as coal, combustion turbine units, Raccoon Mountain pumped storage, or purchased power, would be dispatched to replace the reduced hydropower generation during these times. In addition, because hydropower is shifted off peak, it could displace some coal-fired generation.

Similar to (although more often than) the Base Case, severe meteorological conditions like those experienced in summer 1993, could result in forced nuclear plant shutdowns of one or more TVA nuclear units for several days every 10 years on average. These shutdowns could be required to comply with the essential cooling water temperature limitations of the NRC license. The effects of these conditions were included in the reliability and power supply analyses, and were factored into the power supply costs for Reservoir Recreation Alternative A.

Table 5.23-01 Effect of Policy Alternatives on Hydropower Generation Relative to the Base Case

Alternative	January–March (Weeks 1–12)	April–May (Weeks 13–21)	June–July (Weeks 22–30)	August–Labor Day (Weeks 31–35)	Labor Day–December (Weeks 36–52)
Reservoir Recreation A	Somewhat higher generation due to higher winter levels		Much lower generation due to releases of only minimum flows	Much lower generation; hydro releases are still restricted, but increased minimum flows would reduce losses	Somewhat higher generation as unrestricted drawdown resumes
Reservoir Recreation B and Tailwater Recreation	Much higher generation due to higher winter levels		Much lower generation due to releases of only minimum flows		Slightly lower; unrestricted drawdown resumes but only to higher winter levels
Summer Hydropower	Somewhat higher generation due to higher winter levels		Much higher generation due to unrestricted drawdown		Much lower; unrestricted drawdown resumes but only to higher winter levels
Equalized Summer/ Winter Flood Risk	Much higher generation due to higher winter levels		Much lower due to generally lower summer levels and releases of only minimum flows unless additional is necessary to maintain flood storage	Much lower; releases are still restricted, but increased minimum flows would reduce losses	Much lower due to higher winter reservoir levels
Commercial Navigation	Hydropower generation is very similar to the Base Case				
Tailwater Habitat	Much higher generation due to higher winter levels		Much lower due to releases of only minimum flows		Similar generation
Preferred	Somewhat higher generation due to higher winter levels		Much lower generation; hydro releases are still restricted, but increased minimum flows through this period would reduce losses		Slightly lower; unrestricted drawdown resumes but only to higher winter levels

Table 5.23-02 Effect of Policy Alternatives on Shift of Hydropower Generation Relative to the Base Case

Alternative	Increase/Decrease in Hydropower Generation as a Percentage of Base Case Hydropower Generation					
	January–March (Weeks 1–12) (%)	April–May (Weeks 13–21) (%)	June–July (Weeks 22–30) (%)	August–Labor Day (Weeks 31–35) (%)	Labor Day–December (Weeks 36–52) (%)	Annual (%)
Reservoir Recreation A	6	7	-19	-16	6	0.5
Reservoir Recreation B	14	13	-19	-39	-2	-1.3
Summer Hydropower	9	7	30	6	-30	-0.9
Equalized Summer/ Winter Flood Risk	14	26	-24	-19	-22	-4.9
Commercial Navigation	1	7	-1	0	-1	0.5
Tailwater Recreation	Similar to Reservoir Recreation B					
Tailwater Habitat	11	13	-19	-37	-1	-1.6
Preferred	6	8	-11	-12	-2	-0.4

Note: A negative number indicates that hydropower generation under the alternative would be less than under the Base Case. A positive number indicates that hydropower generation under the alternative would be more than under the Base Case.

Source: TVA Weekly Scheduling Model.

Coal Unit Derates

The reduction in summer hydropower production would be offset to some extent by maintaining the average weekly 25,000-cfs flow at Chickamauga Reservoir to provide cooling water for power plants and minimize summer power plant derates. Even with these higher minimum flows under Reservoir Recreation Alternative A, additional derates of the coal units relative to the Base Case would be necessary to maintain compliance with NPDES temperature limits. The estimated cost of these additional derates is presented in Table 5.23-03.

Other Non-Generation Costs

Aeration costs under Reservoir Recreation Alternative A would be higher than under the Base Case and would include a capital cost expenditure for additional equipment in 2004 and an annual operations and maintenance cost for each year from 2004 through 2030. There would be no change in coal shipping rates (Table 5.23-03).

Power Supply Costs

The effect of power generation dispatch, generation losses at coal and nuclear plants due to water temperature limits, and cost for additional cooling tower use on power supply costs was estimated for each year from 2004 to 2030. The average change in power cost for Reservoir Recreation Alternative A could be represented by a hypothetical rate increase of 0.3 percent, as shown in Table 5.23-03.

Table 5.23-03 Impacts on Power Generation—Annual Production Costs (2010) (dollars in millions)

Alternative	Power Supply Costs	Coal Unit Derate Costs	Aeration Equipment Costs	TVA Coal Shipping Costs	Total Costs	Hypothetical Rate Increase[1] (percent)
Base Case	$0	$0	$0	$0	$0	0%
Reservoir Recreation A	$28	$1.1	$0.6	$0	$30	0.3%
Reservoir Recreation B	$65	$1.3	$0.8	$0	$67	0.6%
Summer Hydropower	-$4	$0.8	$0.4	$6	$3	0.0%
Equalized Summer/ Winter Flood Risk	$104	$3.8	$0.7	$0	$108	1.2%
Commercial Navigation	-$4	$0.4	$0.6	-$9	-$11	-0.1%
Tailwater Recreation	$65	$0.2	$0.7	$0	$66	0.6%
Tailwater Habitat	$294	-$0.2	$0.7	$0	$295	3.3%
Preferred	$13	-$0.2	$1.2	$0	$14	0.2%

Note: Projected costs for 2010 are indicative of trends.

[1] The total costs are expressed as a percentage of total annual TVA power sales revenues each year for the period 2004 through 2030, and the hypothetical rate increase is the 27-year average of these percentages.

Source: TVA Power Planning Group.

5.23.5 Reservoir Recreation Alternative B and Tailwater Recreation Alternative

Power Generation Dispatch and Reliability

Under Reservoir Recreation Alternative B and the Tailwater Recreation Alternative, the effect on hydropower generation would be similar to Reservoir Recreation Alternative A although more adverse. The total annual hydropower generation on average would be about 1 percent less than the hydropower generation expected under the Base Case (Table 5.23-02). The timing of the generation would be shifted under Reservoir Recreation Alternative B and the Tailwater Recreation Alternative from late summer to early winter (Table 5.23-02), reducing the availability of hydropower to meet summer peak loads. As in Reservoir Recreation Alternative A, although to a greater extent, other higher marginal cost peaking generation units would need to be run to replace the shifted hydropower generation.

Similar to (although more often than) Reservoir Recreation Alternative A, forced nuclear plant shutdowns of one or more TVA nuclear units for several days every 10 years on average would be necessary to comply with the essential cooling water temperature limitations of the NRC license. The effects of these conditions were included in the reliability and power supply analyses, and were factored into the power supply costs for Reservoir Recreation Alternative B and the Tailwater Recreation Alternative.

Coal Unit Derates

Continuation of releases from Chickamauga Reservoir at the present 13,000-cfs level, coupled with the shift of hydropower generation from summer to fall, would increase slightly the frequency of derating coal units under Reservoir Recreation Alternative B over that expected under Reservoir Recreation Alternative A. Under the Tailwater Recreation Alternative, the additional releases for tailwater recreation would almost eliminate additional coal unit derates as compared to the Base Case.

Other Non-Generation Costs

Aeration costs under Reservoir Recreation Alternative B would be slightly higher than under Reservoir Recreation Alternative A; under the Tailwater Recreation Alternative, costs would be slightly lower than under Reservoir Recreation Alternative B. There would be no change in coal shipping rates.

Power Supply Costs

The average change in power cost could be represented by a hypothetical rate increase of 0.6 percent for both Reservoir Recreation Alternative B and the Tailwater Recreation Alternative, as shown in Table 5.23-03.

5.23.6 Summer Hydropower Alternative

Power Generation Dispatch and Reliability

Under the Summer Hydropower Alternative, the effect on hydropower generation relative to the Base Case would be to decrease hydropower generation in fall when generation is less valuable and increase hydropower generation during the summer and winter peak demand periods (Table 5.23-01). Although the total annual hydropower generation on average would be about 1 percent lower than the hydropower generation expected under the Base Case (Table 5.23-02), availability of the hydropower generation during the peak demand periods offsets somewhat the use of higher cost generation, leaving the overall power supply costs essentially the same as the Base Case.

The Summer Hydropower Alternative would reduce the number of days that one or more nuclear units would need to be shutdown once every 10 years on average to comply with the essential cooling water temperature limitations of the NRC license. The effects of these conditions were included in the reliability and power supply analyses, and were factored into the power supply costs for the Summer Hydropower Alternative.

Coal Unit Derates

Reservoir releases to maximize summer hydropower generation would not be sufficient to avoid additional coal unit derates; the costs are indicated in Table 5.23-03.

Other Non-Generation Costs

Aeration costs for the Summer Hydropower Alternative would be lower than under Reservoir Recreation Alternative A but similarly include a capital cost expenditure for additional equipment in 2004, and an annual operations and maintenance cost for each year from 2004 through 2030. Reservoir operations under the Summer Hydropower Alternative would also hamper navigation and increase the shipment cost of coal for TVA's coal units.

Power Supply Costs

Under the Summer Hydropower Alternative, there would be essentially no change in average power cost, as shown in Table 5.23-03.

5.23.7 Equalized Summer/Winter Flood Risk Alternative

Power Generation Dispatch and Reliability

Under the Equalized Summer/Winter Flood Risk Alternative, the effect on hydropower generation relative to the Base Case would be a decrease in hydropower generation in summer and fall and an increase during winter (Table 5.23-02). As under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, and the Tailwater Recreation Alternative, although to a greater extent, other higher marginal cost peaking generation units would need to be run to replace the shifted hydropower generation. In addition to the shift in hydropower, the net average annual hydropower generation loss under the Equalized Summer/Winter flood Risk Alternative relative to the Base Case would be almost 5 percent (Table 5.23-02) due to lower reservoir levels and the resulting lower head on the hydropower units. This loss in total annual generation is large enough to necessitate the purchase of additional baseload energy in addition to the peaking generation to offset shifts.

Under the Equalized Summer/Winter Flood Risk Alternative, similar to (although more often than) Reservoir Recreation Alternative B and the Tailwater Recreation Alternative, additional nuclear plant shutdowns would be necessary to comply with the essential cooling water temperature limitations of the NRC license. The effects of these conditions were included in the reliability and power supply analyses, and were factored into the power supply costs for the Equalized Summer/Winter Flood Risk Alternative.

Coal Unit Derates

The generally lower summer reservoir levels maintained for flood storage under the Equalized Summer/Winter Flood Risk Alternative would reduce the volume of water available for release in late summer, when water temperatures are highest. Of all alternatives, consequently, the Equalized Summer/Winter Flood Risk Alternative would cause the greatest losses due to coal unit derates.

Other Non-Generation Costs

Increased aeration costs for the Equalized Summer/Winter Flood Risk Alternative include a capital cost expenditure for additional equipment in 2004 and an annual operations and maintenance cost for each year from 2004 through 2030. These costs under the Equalized Summer/Winter Flood Risk Alternative would be similar to those under the Tailwater Recreation Alternative. Coal shipping rates would not change.

Power Supply Costs

The average change in power cost under the Equalized Summer/Winter Flood Risk Alternative could be represented by a hypothetical rate increase of 1.2 percent, as shown in Table 5.23-03.

5.23.8 Commercial Navigation Alternative

Power Generation Dispatch and Reliability

Hydropower generation under the Commercial Navigation Alternative would be very similar to the Base Case, with little shift in hydropower generation. Net average annual hydropower generation would be less than 1 percent higher than the Base Case (Table 5.23-02), reflecting a minimal gain due to higher winter levels on the mainstem reservoirs. Power generation dispatch would generally not change under the Commercial Navigation Alternative relative to the Base Case.

Under the Commercial Navigation Alternative, the nuclear plant shutdowns necessary to comply with the essential cooling water temperature limitations of the NRC license would be similar to those under the Base Case.

Coal Unit Derates

Reservoir releases for commercial navigation would not be sufficient to avoid all additional coal unit derates under the Commercial Navigation Alternative.

Other Non-Generation Costs

Increased aeration costs under the Commercial Navigation Alternative would be similar to those for the Base Case. The Commercial Navigation Alternative would increase water levels in the mainstem reservoirs to improve navigation and decrease the shipment cost of coal for TVA's coal units.

Power Supply Costs

The average change in power cost for the Commercial Navigation Alternative could be represented by an equivalent potential rate decrease of 0.1 percent, as shown in Table 5.23-03.

5.23.9 Tailwater Habitat Alternative

Power Generation Dispatch and Reliability

Under the Tailwater Habitat Alternative, reservoir releases would produce variable flows, water depths, and velocities throughout the year that would be more similar to the seasonal variability of runoff and would reduce hourly and daily variability of flows in tailwaters. Actual releases would be determined by the inflow conditions. Peaking hydropower operations would not occur unless the low flow falls below the level needed to operate one unit; then peaking would occur only to the extent necessary to peak one unit at its most efficient setting.

The effect on hydropower generation relative to the Base Case would be a decrease in hydropower generation in summer and fall and an increase during winter and spring (Table 5.23-01). The Tailwater Habitat Alternative would shift the greatest amount of hydropower generation away from May through September. As with all of the alternatives, TVA's response to this shift in hydropower generation would be to replace it with the lowest marginal cost alternative generation resource. Depending on the marginal costs of replacement generation during the May-to-September period, the shifted hydropower generation could be replaced by coal, combustion turbines, pumped storage, or purchased generation. The hydropower that is shifted out of summer would likely also displace coal generation.

Net average annual hydropower generation would be 1.6 percent lower than the Base Case (Table 5.23-02) but would not be large enough to warrant purchase of additional baseload generation.

The nuclear plant shutdowns necessary to comply with the essential cooling water temperature limitations of the NRC license under the Tailwater Habitat Alternative would be similar to those under the Base Case.

Coal Unit Derates

Reservoir releases under the Tailwater Habitat Alternative would improve water temperatures sufficiently to reduce the generation losses due to coal unit derates relative to those expected under the Base Case.

Other Non-Generation Costs

Increased aeration costs under the Tailwater Habitat Alternative would include a capital cost expenditure for additional equipment in 2004 and an annual operating and maintenance cost for each year from 2004 through 2030. These costs under the Tailwater Habitat Alternative would be similar to those under the Tailwater Recreation Alternative. Coal shipping rates would not change.

Power Supply Costs

The Tailwater Habitat Alternative would result in the greatest adverse impact on power costs, with an average change in power cost represented by a hypothetical rate increase of 3.3 percent, as shown in Table 5.23-03.

5.23.10 Preferred Alternative

Power Generation Dispatch and Reliability

For the Preferred Alternative, the total annual hydropower generation on average would be similar to (although slightly lower than) the hydropower generation expected under the Base Case (Table 5.23-02). As detailed in Table 5.23-01 and Table 5.23-02, the timing of hydropower generation would be shifted under the Preferred Alternative from summer (when the peak demand is highest and, therefore, replacement energy is most costly) to winter and early spring (when replacement energy is generally less costly). In response to the shift in hydropower generation, other more costly peaking generation resources (such as coal, combustion turbine units, Raccoon Mountain pumped storage, or purchased power) would be dispatched to replace the reduced hydropower generation during these times. In addition, because hydropower is shifted off peak, it could displace some coal-fired generation.

Similar to (although more often than) Reservoir Recreation Alternative A, nuclear plant shutdowns of one or more TVA nuclear units for several days every 10 years on average would be necessary to comply with the essential cooling water temperature limitations of the NRC license. The effects of these conditions were included in the reliability and power supply analyses, and were factored into the power supply costs for the Preferred Alternative.

Coal Unit Derates

Reservoir releases under the Preferred Alternative would improve cooling water availability or temperatures sufficiently to reduce somewhat the frequency of generation losses due to coal unit derates as compared to those expected under the Base Case.

Other Non-Generation Costs

Under the Preferred Alternative, aeration costs would be substantially higher than under the Base Case and all alternatives considered. The costs would include a capital cost expenditure for additional equipment, expended over a 3-year period from 2004 through 2006 due to the larger costs, and an annual operations and maintenance cost for each year from 2004 through 2030. Coal shipping rates would not change (Table 5.23-03).

Power Supply Costs

The average change in power cost under the Preferred Alternative could be represented by a hypothetical rate increase of 0.2 percent, as shown in Table 5.23-03.

5.23.11 Summary of Impacts

Table 5.23-04 presents a summary of impacts on power by policy alternative. Under each alternative, the use of hydropower generation would shift among the seasons, with hydropower generation during each season either higher or lower than that expected under the Base Case, as presented in Table 5.23-01 and Table 5.23-02. Under all alternatives except the Summer Hydropower Alternative, hydropower generation would generally decrease in summer when the peak demand is highest and replacement energy is most costly, and increase in winter and spring when energy is less valuable. The Commercial Navigation Alternative would shift the least amount of hydropower generation away from summer, followed in order of increasing effect by the Preferred Alternative, Reservoir Recreation Alternative A, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Habitat Alternative, and Reservoir Recreation Alternative B. Under the Summer Hydropower Alternative, hydropower generation would shift from fall, when peak demand is lowest, to the summer and winter peak periods.

The change in dispatch of other power resources in response to hydropower generation shifts would result in the use of more (or in the case of the Summer Hydropower Alternative less) costly generation resources. At times, additional generation capacity would be needed to ensure acceptable system reliability. Under all alternatives except the Summer Hydropower Alternative, the shift in hydropower generation would create the need for increased use of combustion turbines, pumped storage, and purchased power for peaking. The hydropower that is shifted out of summer would likely also displace coal generation. In addition to the shift in hydropower generation away from periods of peak demand, requiring the acquisition of additional peaking generation, the Equalized Summer/Winter Flood Risk Alternative would cause a net annual loss in hydropower generation large enough to necessitate the purchase of additional baseload capacity.

Alternatives that reduce reservoir releases in late summer when water temperatures are highest would also increase the generation lost due to coal and nuclear unit derates. Additional derate of coal units would be necessary under all alternatives except the Preferred Alternative and the Tailwater Habitat Alternative, which show a slight reduction in the cost of coal unit derates.

A third impact on the cost of power production arises from alternatives that would decrease reservoir DO levels. To maintain current targets for tailwater DO levels, additional aeration would be required under all alternatives.

Finally, under those alternatives that would change water levels and flows in the mainstem reservoirs to the extent that navigation would be affected (the Summer Hydropower Alternative and the Commercial Navigation Alternative), the shipment cost of coal for TVA's coal units would change.

The Commercial Navigation Alternative is expected to slightly reduce power costs relative to the Base Case by 0.1 percent over the 2003 through 2030 period. The Summer Hydropower Alternative is expected to result in essentially no effect on power costs relative to the Base Case. The remaining six policy alternatives are expected to increase power costs. Of these six, the greatest increase in power costs relative to the existing operations policy is expected under the Tailwater Habitat Alternative, which is estimated to increase power costs by an average of 3.3 percent over the 2003-through-2030 period. The least increase in power costs relative to the existing operations policy is expected under the Preferred Alternative, which is estimated to increase power costs by an average of 0.2 percent over the period from 2003 through 2030.

Table 5.23-04 Summary of Impacts on Power by Policy Alternative

Alternative	Description of Impacts
Base Case	Power generation would continue to follow existing trends; the annual energy load is expected to increase 1.6 percent on average from 2004 through 2020. The industrial load growth is expected to slow, reducing the demand from the industrial client base and increasing the demand by the commercial and residential clients; this shift would require more peaking and less baseload capacity throughout the 2003 to 2030 period.
Reservoir Recreation A	Total power cost would increase $30 million annually (2010). The total annual hydropower generation would be similar to the Base Case; however, the timing would be shifted from late summer, when the peak demand is highest and replacement energy is most costly, to early winter when energy is less costly. Other more costly generation, such as coal or combustion turbine units, would be dispatched to replace the shifted hydropower generation. • Hydropower generation similar to Base Case • Additional coal derates • Additional nuclear shutdowns • Additional aeration costs • No additional coal shipping costs
Reservoir Recreation B	Total power cost would increase $67 million annually (2010). The effect on hydropower generation would be similar to Reservoir Recreation Alternative A, although more adverse. • Hydropower generation slightly lower than Base Case • Additional coal derates • Additional nuclear shutdowns • Additional aeration costs • No change to coal shipping costs
Summer Hydropower	Total power cost would increase $3 million annually (2010). The effect on hydropower generation relative to the Base Case would be to decrease hydropower generation in fall and increase hydropower generation during the summer and winter peak demand periods. Availability of the hydropower generation during the peak demand periods offset the use of higher cost generation, leaving the overall power supply costs essentially the same as the Base Case. • Hydropower generation slightly lower than Base Case • Additional coal derates· • Fewer nuclear shutdowns • Additional aeration costs • Higher coal shipping costs

Table 5.23-04 Summary of Impacts on Power by Policy Alternative (continued)

Alternative	Description of Impacts
Equalized Summer/Winter Flood Risk	Total power cost would increase $108 million annually (2010). The effect on hydropower generation relative to the Base Case would be to decrease hydropower generation in summer and fall and increase hydropower generation during the winter and spring runoff periods. Other more costly generation, such as coal or combustion turbine units, would be dispatched to replace the shifted hydropower generation. • Greatest loss in hydropower generation of all alternatives • Additional coal derates • Additional nuclear shutdowns • Additional aeration costs • No additional coal shipping costs
Commercial Navigation	Total power cost would decrease $11 million annually (2010). The effect on hydropower generation would be very similar to the Base Case with little shift in hydropower generation. • Hydropower generation similar to the Base Case • Additional coal derates· • No additional nuclear shutdowns · • Additional aeration costs· • Lower coal shipping costs
Tailwater Recreation	Total power cost would increase $66 million annually (2010). The effect on hydropower generation would be similar to Reservoir Recreation Alternative B. • Hydropower generation slightly less than Base Case • Additional coal derates but much less than Reservoir Recreation Alternative B • Additional nuclear shutdowns • Additional aeration costs· • No additional coal shipping costs
Tailwater Habitat	Total power cost would increase $295 million annually (2010). The effect on hydropower generation would be similar to Reservoir Recreation Alternative A although much more adverse. Peaking hydropower operations would be very limited. • Hydropower generation slightly less than Base Case • No additional coal derates· • No additional nuclear shutdowns • Additional aeration costs· • No additional coal shipping costs

Table 5.23-04 Summary of Impacts on Power by Policy Alternative (continued)

Alternative	Description of Impacts
Preferred	Total power cost would increase $14 million annually (2010). The total annual hydropower generation would be similar to the Base Case; however, the timing would be shifted from late summer, when the peak demand is highest and replacement energy is most costly, to early spring when energy is less costly. Other more costly generation, such as coal or combustion turbine units, would be dispatched to replace the shifted hydropower generation. • Hydropower generation similar to Base Case • Fewer coal derates • Additional nuclear shutdowns • Additional aeration costs • No additional coal shipping costs

5.24 Recreation

5.24.1 Introduction

Recreation use of TVA reservoirs and below-dam areas would be affected to varying degrees by changes in reservoir and tailwater management under all policy alternatives except the Base Case. Estimated changes in recreation use in response to operating scenarios under the policy alternatives were evaluated. Estimates represent reservoir and tailwater recreation use of the 35 TVA projects studied in the ROS for the late-summer and early-fall period (August through October). As discussed in Section 4.24, use estimates are presented for those users of public recreational facilities and commercially provided recreational facilities, and users who have private residential access to project reservoirs.

5.24.2 Impact Assessment Methods

Behavioral response models were used to assess potential changes in recreation use in reservoirs and areas downstream in response to policy alternatives. Recreation area users were asked survey questions to ascertain how their use might change with changes in reservoir levels and corresponding tailwater flows. Responses were then used in behavioral models to quantitatively predict changes in recreation use during the August to October period. During this period, the policy alternatives were expected to reflect their primary impacts on levels and flows. Model predictions for changes in recreation use by policy alternative were made relative to the recreation use for the August to October period under the Base Case. Models assumed that the only factors to change would be reservoir levels, while other factors affecting recreation (e.g., the number of facilities) would remain the same. Changes in recreation use during other times of the year were qualitatively evaluated using survey response indicators that allowed generalization on recreation use changes during these other times.

The Base Case is described below specifically for the August through October period (as also described in Section 4.24). The quantitative impacts of the other policy alternatives were compared to the Base Case for the same 3-month period. Changes in recreation use were evaluated for public site users, commercial site users, and private access recreation users.

5.24.3 Base Case

The total annual recreation use under the Base Case is 21.8 million user days (see Section 4.24). During the August through October 2002 period, which is the basis for quantitatively comparing the impacts of the policy alternatives, recreation use is about 6.6 million user days (Table 5.24-01) (also see Appendix D8, Table D8-07).

Table 5.24-01 Recreational Use by Policy Alternative for 2002 (August through October)

Alternative	Total Recreational Use	Total Public Use (Reservoirs and Tailwaters)	Public Reservoir Use	Public Tailwater Use	Commercial Use	Private Use
Base Case	6,569,334	873,924	670,561	203,363	3,844,556	1,850,854
Reservoir Recreation A	7,907,800	896,484	692,160	204,324	3,997,786	3,013,530
Reservoir Recreation B	8,114,041	920,321	711,123	209,198	4,103,949	3,089,770
Summer Hydropower	5,300,096	849,185	655,920	193,265	3,725,224	725,687
Equalized Summer/Winter Flood Risk	6,813,723	859,883	667,534	192,349	3,891,437	2,062,403
Commercial Navigation	6,449,369	873,048	669,945	203,104	3,847,202	1,729,119
Tailwater Recreation	8,115,039	918,551	710,362	208,189	4,107,702	3,088,786
Tailwater Habitat	8,009,471	916,430	712,761	203,669	4,104,229	2,988,812
Preferred	7,735,922	894,110	689,524	204,586	3,950,983	2,890,828

Public recreation use of reservoirs and tailwaters totaled about 874,000 user days during August, September, and October, comprising 13 percent of the total recreation use by all user types during that period. Public recreation use on reservoirs totaled about 671,000 user days, while public use of tailwater areas totaled about 203,000 user days (Table 5.24-01).

Survey results from public access site users showed that air temperature (either too hot or too cold) was reported to be the most important reason for not recreating at TVA reservoirs or below-dam areas during winter (November through February), early spring (March and April) and fall (September and October). Low water levels were listed as the second most important reason for not recreating during these months and were cited as the most important reason for not using the projects during June and July. Results also showed that approximately 40 percent of all individuals surveyed at public access sites stated that nothing could be done to increase their recreation use of ROS projects; approximately 30 percent of respondents indicated that increasing water levels during low use months (typically late fall through early spring) would result in higher use.

Commercial recreation use at the 35 projects totaled over 3.8 million user days during August through October, comprising 59 percent of the total recreation use by all user types (Table 5.24-01). Surveys of commercial operators showed that their services are least likely to be used during December and January due to colder air temperatures. Operators indicating lower use of their facilities during March, April, August, September, and October cited low water levels as the primary reason. Approximately 67 percent of all commercial operators surveyed indicated that increasing water levels would result in an increased number of days that people would use their recreational facilities at ROS projects. Approximately 18 percent indicated that nothing could be done to increase patronage of their facilities.

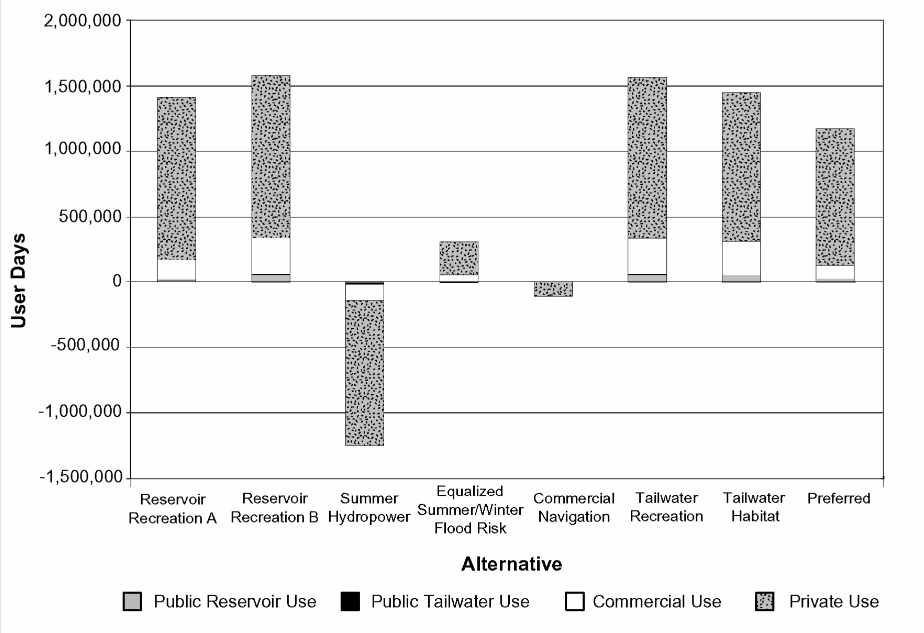
Private recreation use totaled about 1.9 million user days, comprising 28 percent of the total recreation use by all user types (Table 5.24-01). Results of surveys of private property owners adjacent to TVA reservoirs showed that this user group attributes their lack of participation in recreation to be primarily due to water levels, regardless of time of year, even for those months during which water levels are typically at full summer pool levels. Approximately 66 percent of property owners stated that increasing water levels would increase their use of the ROS projects during the periods of low use. Approximately 14 percent stated that nothing could be done to increase their recreation use of the projects.

5.24.4 Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Tailwater Recreation Alternative, Tailwater Habitat Alternative, and Preferred Alternative

Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative all show similar expected results, with recreation use during August through October expected to total between 7.7 and 8.1 million user days (Table 5.24-01). Public access use on reservoirs and tailwaters is expected to total between 894,000 and 920,000 user days, or about 11 percent of total recreation use under these alternatives. Reservoir public use is expected to total between 689,000 and 713,000 user days, or 9 percent of the total recreation use. Public use below project dams is expected to total between 204,000 and 209,000 user days, or 2 percent of all recreation use.

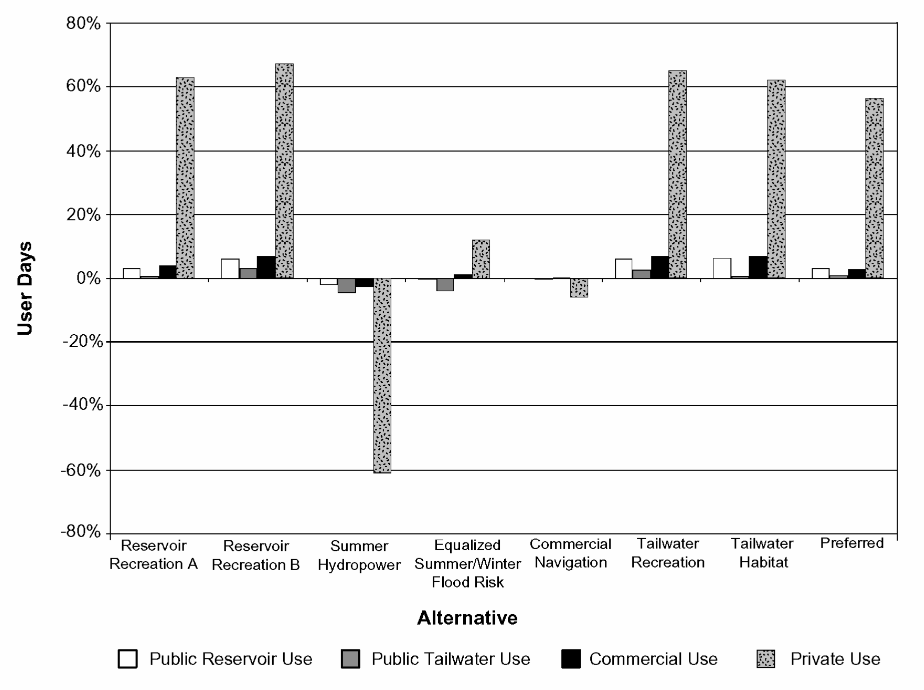
Commercial recreation use under these alternatives is expected to total between 4.0 and 4.1 million user days, or 51 percent of the total recreation use (Table 5.24-01). Private access recreation use under these alternatives is expected to total between 2.9 and 3.1 million user days, or about 37 to 38 percent of all recreation use.

Total recreation use under these alternatives is expected to increase between 1.2 and 1.5 million user days (or about 20 to 23 percent) compared to the Base Case during the August through October period (Figure 5.24-01). The majority of this expected increase is due to an expected increase in private access recreation use of about 61 to 67 percent, or about 1.0 to 1.2 million user days (Figure 5.24-02). All other recreation use types show increases in use but were not as dramatic as the private use increase. Commercial site recreation use is expected to increase by between 2.8 and 7 percent under these alternatives, while public use on tailwaters is expected to increase by 0.2 to 3 percent and public reservoir use is expected to increase by between 3 and 6 percent under these alternatives (Figure 5.24-02).



Note: User day = All or part of one day by one person at one reservoir.
Source: TVA data 2003.

Figure 5.24-01 Changes in Recreation Use during August through October (2002) by Policy Alternative



Note: User day = All or part of one day by one person at one reservoir.
Source: TVA data 2003.

Figure 5.24-02 Percent Changes in Recreation Use by Recreation User Type during August through October (2002) by Policy Alternative

Recreation use of reservoirs and below-dam areas may increase slightly during the remaining months of the year (November through July) as some people take advantage of the overall higher reservoir elevations that would be available. Changes in use would probably occur more during months with good weather and less during colder winter months. Use of riverine areas could decrease slightly during mid-summer due to lower releases but would likely stay about the same during fall. Riverine use attributed to scheduled recreation flow releases would remain the same under Reservoir Recreation Alternative A and Reservoir Recreation Alternative B, would increase appreciably for the Tailwater Recreation Alternative, and would decrease under the Tailwater Habitat Alternative. Because of the cold water and air temperatures during late winter and early spring, use of riverine areas is not expected to change appreciably.

5.24.5 Summer Hydropower Alternative

Recreation use during August through October is expected to total about 5.3 million user days (Table 5.24-01) under the Summer Hydropower Alternative. Public access use on reservoirs and tailwaters is expected to total about 849,000 user days, or about 16 percent of recreation use by all user types. Reservoir public use is expected to total about 656,000 user days, or about 12 percent of the total recreation use under this alternative. Public use below project dams is expected to total about 193,000 user days, or 4 percent of the total recreation use.

Commercial site recreation use under this alternative is expected to total about 3.7 million user days, or 70 percent of the total recreation use (Table 5.24-01). Private recreation use is expected to total about 726,000 user days, or 14 percent of the total recreation use.

In contrast to the previous four alternatives, recreation use under the Summer Hydropower Alternative is expected to decrease during August through October by about 1.3 million user days (or about 19.3 percent) compared to the Base Case (Figure 5.24-01). The majority of this expected decrease is due to an expected decrease in private access recreation use of about 1.1 million user days, or about 61 percent (Figure 5.24-02). Other types of recreation use are also expected to decrease, with commercial site use expected to decrease by 3 percent, public reservoir use expected to decrease by about 2 percent, and public use below project dams expected to decrease by about 5 percent.

Generally, recreation use of project reservoirs and below-dam areas during the remaining months of the year (November through July) would likely experience a decrease due primarily to the much lower water levels occurring during the warm weather months. With respect to the riverine areas, overall boating activity is expected to decrease primarily because the only scheduled recreational release would be below Ocoee #2. If the increased water releases occur on weekdays, boating activity on the tributaries may decrease in locations where scheduled releases do not typically occur. If the increased water releases occur on weekends, a slight increase in boating activity may result. Lower releases on the weekend could lead to an increase in wade fishing on cold-water tributary rivers where trout fishing occurs. Mainstem riverine areas would probably not be affected.

5.24.6 Equalized Summer/Winter Flood Risk Alternative

Recreation use during August through October is expected to total about 6.8 million user days (Table 5.24-01) under the Equalized Summer/Winter Flood Risk Alternative. Public access use on reservoirs and tailwaters is expected to total about 860,000 user days, or about 13 percent of recreation use by all user types. Reservoir public use is expected to total about 668,000 user days, or about 10 percent of the total recreation use under this alternative. Public use below project dams is expected to total about 192,000 user days, or 3 percent of the total recreation use.

Commercial recreation use under this alternative is expected to total about 3.9 million user days, or 57 percent of the total recreation use (Table 5.24-01). Private recreation use is expected to total about 2.1 million user days, or 30 percent of the total recreation use.

Changes in recreation use under this alternative are expected to be relatively minor, with expected increases during August through October of about 244,000 user days (or about 4 percent) compared to the Base Case (Figure 5.24-01). The majority of this expected increase is due to an expected increase in private recreation use of about 212,000 user days, or about 11 percent (Figure 5.24-02). Public reservoir recreation use and commercial recreation use would remain relatively unchanged, with expected changes of -0.5 to 1 percent respectively. Public use of projects tailwaters is expected to decrease by about 5 percent, or 11,000 user days (Figures 5.24-01 and 5.24-02).

In general, the Equalized Summer/Winter Flood Risk Alternative would likely result in overall lower levels of recreation use during spring and summer on reservoirs and below-dam areas due to lower reservoir levels and discharges during the warm-weather seasons. Use during late fall and winter (November through February) may be slightly greater due to the expected higher reservoir elevations during this period. Recreation use of riverine sections would not change for areas where and times when scheduled recreation releases occur, but may decrease slightly during summer and fall as releases would be typically lower than under the Base Case.

5.24.7 Commercial Navigation Alternative

Recreation use during August through October is expected to total about 6.4 million user days under the Commercial Navigation Alternative (Table 5.24-01). Public access use on reservoirs and tailwaters is expected to total about 873,000 user days, or about 13 percent of recreation use by all user types. Reservoir public use is expected to total about 670,000 user days, or about 10 percent of the total recreation use. Public use below project dams is expected to total about 203,000 user days, or 3 percent of the total recreation use.

Commercial site recreation use under the Commercial Navigation Alternative is expected to total about 3.8 million user days, or 60 percent of the total recreation use (Table 5.24-01). Private recreation use is expected to total about 1.7 million user days, or 27 percent of the total recreation use.

Similar to the Equalized Summer/Winter Flood Risk Alternative, changes in recreation use under the Commercial Navigation Alternative are expected to be relatively minor—with an expected decrease of less than 120,000 user days during August through October (or about 2 percent) compared to the Base Case (Figure 5.24-01). The expected decrease is driven by the expected decrease in private access recreation use of about 122,000 user days, or about 7 percent (Figure 5.24-02). Public reservoir recreation use, public use below project dams, and commercial site recreation use would remain relatively unchanged, with expected changes of less than 1 percent.

During the remaining months of the year (November through July), this alternative would likely result in very small changes in use of project reservoirs and downstream areas. The reservoir and below-dam area elevations would be similar to those experienced under the Base Case. Changes in riverine use would also be small, as there would be little change in flow releases and no change in scheduled recreation releases.

5.24.8 Summary of Impacts

Table 5.24-02 provides a summary of the expected changes in recreation by policy alternative. An overall rating is also indicated for each alternative. Four of the alternatives are expected to result in large increases in recreation use: Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative. These alternatives are expected to result in increases in use of between 1.3 and 1.5 million user days. In contrast, the Summer Hydropower Alternative is expected to result in a moderate decrease in recreation use of about 1.3 million user days, and the Preferred Alternative would result in a moderate increase in recreation use of about 1.2 million user days. The Equalized Summer/Winter Flood Risk Alternative and the Commercial Navigation Alternative are expected to result in a slight increase or little change in recreation use.

Table 5.24-02 Summary of Changes in Recreational Use by Policy Alternative (August through October)

Alternative	Recreation Use Types				
	Public Use In Reservoirs	**Public Use in Tailwaters**	**Commercial Use[1]**	**Private Use**	**Overall Rating**
Reservoir Recreation A	Slightly beneficial (3.0%)	No change (0.5%)	Slightly beneficial (4.0%)	Substantially beneficial (63.0%)	Substantially beneficial (20.4%)
Reservoir Recreation B	Slightly beneficial (6.0%)	Slightly beneficial (3.0%)	Slightly beneficial (7.0%)	Substantially beneficial (67.0%)	Substantially beneficial (23.5%)
Summer Hydropower	Slightly adverse (-2.0%)	Slightly adverse (-5.0%)	Slightly adverse (-3.0%)	Substantially adverse (-61.0%)	Adverse (-19.3%)
Equalized Summer/ Winter Flood Risk	No change (-0.5%)	Slightly adverse (-5.5%)	Slightly beneficial (1.2%)	Beneficial (11.0%)	Slightly beneficial (3.7%)
Commercial Navigation	No change (-0.1%)	No change (-0.1%)	No change (0.1%)	Slightly adverse (-6.0%)	Slightly adverse (-1.8%)
Tailwater Recreation	Slightly beneficial (5.9%)	Slightly beneficial (2.5%)	Slightly beneficial (7.0%)	Substantially beneficial (67.0%)	Substantially beneficial (23.5%)
Tailwater Habitat	Slightly beneficial (5.9%)	No change (-0.1%)	Slightly beneficial (7.0%)	Substantially beneficial (61.0%)	Substantially beneficial (21.9%)
Preferred	Slightly beneficial (2.8%)	No change (0.6%)	Slightly beneficial (2.8%)	Substantially beneficial (56.0%)	Beneficial (17.8%)

Note: An increase in recreational use ranging from 0 to 1% was considered No Change, from >1 to 8% was considered Slightly Beneficial, from >8 to 20% was considered Beneficial, and >20% was considered Substantially Beneficial. A decrease in recreational use ranging from 0 to 1% was considered No Change, from >1 to 8% was considered Slightly Adverse, from >8 to 20% was considered Adverse, and >20% was considered Substantially Adverse.

[1] Commercial whitewater rafting activity on Ocoee #2 and Ocoee #3 was considered in this summary. Under the Summer Hydropower Alternative and the Tailwater Habitat Alternative, commercial whitewater releases would be suspended on Ocoee #3. For purposes of this summary, it was assumed that these alternatives would result in the closure of commercial whitewater operations on Ocoee #3. The expected increase in use overall is expected to occur for reservoir use.

5.25 Social and Economic Resources

5.25.1 Introduction

This section considers the potential social and economic effects of implementing an alternative reservoir operations policy, as well as the Base Case. Section 4.25 provides a discussion of the five pathways influencing total economic effects, as well as their respective trends through 2030. The five pathways are navigation, power, water supply, recreation, and property values. An assessment of potential damages associated with flooding is not included in the economic analysis.

This section presents the changes in direct effects and total economic effects resulting from the Base Case and the policy alternatives for each year of the forecast period. The economic model used to estimate the total economic effects of policy alternatives is also briefly discussed.

5.25.2 Impact Assessment Methods

The discussion of impact assessment methods includes a description of the pathways for direct effects, the REMI economic forecasting model, and the total economic effects of policy alternatives.

Pathways for Direct Effects

TVA's operations are linked to the regional level of economic activity by five direct pathways. Changes in the reservoir operations policy would directly affect these five sectors in the following ways:

- Increased (decreased) consumer expenditures from new money coming into (leaving) the region;
- Changes in the cost of production in the region; and,
- Wealth-induced changes in consumer spending.

For any given policy alternative, direct effects associated with all five pathways would occur simultaneously. Direct effects can be either positive or negative. For instance, a policy alternative that extends the summer reservoir levels for an extra month may induce new or additional trips from outside visitors into the region, generating an increase in new money coming into the region. Simultaneously, this alternative policy may increase the costs of production to industries using the TVA system for navigation, water supply, or power generation purposes. Further, the value of shoreline properties may rise as the aesthetic and recreational benefits of living by the reservoirs increase. The implied rise in property-owner wealth may then result in an increase in consumer spending.

The direct economic effects of changes in the reservoir operations policy would then act as stimuli to enhance or decrease the economic growth in the regional economy, which was measured in this EIS as changes to population, employment, gross regional product (GRP), and total personal income (PI). Direct effects that increase new money coming into the region or wealth-induced consumer spending would increase the growth rate of regional employment, GRP, and income. This increase would induce in-migration to the region. Direct effects that change production costs would generally affect the regional economy in both demand-side and supply-side effects. An increase in production costs would increase the cost of doing business in the region and reduce market share, raising prices of final goods and services, and reducing regional consumer spending through a fall in disposable income. On the supply side, increases in production costs would affect local business operating margins. In either case, the region would experience a decline in business sales volume, employment, and income levels.

Changes in these economic variables would then generate further rounds of spending as the effects of the direct stimuli ripple through the economy—a phenomenon known as the multiplier effect. Each additional round of spending would have a smaller effect on the economy than the previous one, as part of the change in spending leaks from the region in the form of imports. The additional rounds of spending and the associated changes in the regional economy are termed secondary effects. These effects were calculated using the REMI economic model, which is discussed later in this section.

The final changes to employment, population, GRP, and PI are the total economic effects of a policy alternative. Total economic effects to the region are therefore the sum of direct and secondary effects. Both the direct effects associated with each of the five direct pathways and the total economic effects to the regional economy under the policy alternatives, including the Base Case, are reported in this section.

The direct effects of a change in the reservoir operations policy include changes in costs or expenditure levels within each of the five regional pathways. The following discussion addresses the direct effects of each policy alternative (including the Base Case), by year, for power supply, navigation, water supply, recreation, and property values.

Power Supply

Operational changes that alter the water availability and timing of hydropower generation would affect the cost of both fuel and generating capacity, changing electricity prices in the region (see Section 5.23, Power).

The direct effects of each alternative were measured by the difference between the power cost under the Base Case and the cost predicted under each policy alternative. TVA performed an analysis for each alternative to assess the effect of changes in demand, timing, and amount of generation by assessing the effect of the change on the current TVA power supply plan and financial forecast.

The power supply analysis used three computer models: the Weekly Scheduling Model (WSM) of TVA's hydrological and hydroelectric system; the PROSYM power production costing model; and RELY, a generation reliability model that is used to determine the capacity needed to maintain the reliability of the power system. The data and methodology used to estimate an impact on TVA's system-wide power supply cost were the same that TVA uses for operations and planning, as discussed in Section 5.23, Power.

Changes in power cost by alternative are presented for 2004 to 2030 (Table 5.25-01) as a percentage of TVA's total revenues. The Commercial Navigation Alternative is expected to slightly reduce power costs relative to the Base Case by 0.1 percent over the 2004 through 2030 period. The Summer Hydropower Alternative is expected to result in essentially no effect on power costs relative to the Base Case. Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative are each expected to increase power costs. The greatest increase in power costs relative to the Base Case would occur under the Tailwater Habitat Alternative, which is expected to increase power costs by an average of 3.3 percent for the period from 2004 to 2030.

Table 5.25-01 Power Cost Change as a Percent of TVA Total Revenue (2004 to 2030) (percent)

Alternative	2004	2005	2006	2007	2008	2009	2010	2030
Reservoir Recreation A	0.9	0.5	0.6	0.6	0.5	0.4	0.4	0.1
Reservoir Recreation B	1.3	0.8	0.9	0.9	0.9	0.7	0.8	0.5
Summer Hydropower	-0.3	-0.1	0.0	0.0	0.0	-0.1	0.0	0.0
Equalized Summer/ Winter Flood Risk	1.5	1.2	1.5	1.2	1.3	1.2	1.3	1.1
Commercial Navigation	0.1	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Tailwater Recreation	1.2	0.8	0.9	0.8	0.9	0.7	0.8	0.5
Tailwater Habitat	3.3	3.5	3.3	3.4	3.2	3.3	3.5	2.8
Preferred	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.1

Navigation

Navigation of the reservoir system is a key component to the operating costs of industries using the system for waterborne transportation. Navigable waterways reduce the cost of shipping bulky commodities such as grain, gravel, chemicals, coal, and petroleum products that are not transported by pipeline. Changes in channel depths would alter effective delivery loads and generate changes in transportation costs.

The direct effects are shown as shipper savings. For the navigation component of the reservoir operations policy, each alternative was expressed in terms of channel depth for each section of the Tennessee River. Knowing channel depth and shipper savings per-foot depth for each section of the river allowed the estimation of total shipper savings by commodity. Under the 11-foot navigation component in the Base Case, shipper savings were forecast to increase to $597 million by 2030 (Table 5.25-02). Raising the channel depths to 13 feet was forecast to increase shipper savings by $60 million by 2030, increasing shipper savings to $657 million. Conversely, decreasing the channel depths to 10 feet would reduce shipper savings by $55 million to a new level of $542 million over the same period. Four of the policy alternatives would alter channel depths and therefore change shipper savings (Table 5.25-03). The Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative were forecast to reduce shipper savings by $17 million and $2 million by 2030, respectively, relative to the Base Case. Conversely, the Commercial Navigation Alternative and the Preferred Alternative were forecast to increase shipper savings by $24 million and $0.5 million, respectively, over the same period. Estimates of shipper savings do not include savings associated with the water-compelled rate effect. These effects are captured in the model used to estimate the total economic effects of the policy alternatives.

Table 5.25-02 Forecast Shipper Savings under the Base Case (2004 to 2030) (2002 dollars in millions)

Channel Depth	Shipper Savings	2004	2005	2006	2007	2008	2009	2010	2030
11-foot channel	Existing	$378.5	$386.1	$393.8	$401.7	$409.7	$417.9	$426.3	$597.1

Table 5.25-03 Changes in Shipper Savings by Policy Alternative (2004 to 2030) (2002 dollars in millions)

Alternative	2004	2005	2006	2007	2008	2009	2010	2030
Reservoir Recreation A	$0	$0	$0	$0	$0	$0	$0	$0
Reservoir Recreation B	$0	$0	$0	$0	$0	$0	$0	$0
Summer Hydropower	-$11.0	-$11.2	-$11.4	-$11.7	-$11.9	-$12.1	-$12.4	-$17.3
Equalized Summer/ Winter Flood Risk	-$1.2	-$1.2	-$1.2	-$1.3	-$1.3	-$1.3	-$1.3	-$1.9
Commercial Navigation	$15.3	$15.6	$15.9	$16.3	$16.6	$16.9	$17.3	$24.2
Tailwater Recreation	$0	$0	$0	$0	$0	$0	$0	$0
Tailwater Habitat	$0	$0	$0	$0	$0	$0	$0	$0
Preferred	$0.3	$0.3	$0.4	$0.4	$0.4	$0.4	$0.4	$0.5

Note: Numbers shown are for the non-utility industry. Utility shipper savings were included in the power analysis.

Water Supply

There are potentially two direct effects of changes to the reservoir operations policy within the water supply pathway. The first is the impact on intake costs. If changes in the policy reduce the minimum reservoir elevations below the level necessary for both public supply and industrial water intakes, capital expenditure would be required to alter the intakes. For each policy alternative, a hydrologic model using 100 years of historical data was used to estimate the occurrence, frequency, and duration of minimum elevation levels below the TVA-published minimum elevation levels for each reservoir where water intakes are located. The cost of restoring the existing reliability under the Base Case was then estimated for each policy alternative and was treated as an increase in the cost of local government, for input into the REMI model.

Under the Summer Hydropower Alternative (Table 5.25-04), the elevation of Cherokee Reservoir was predicted to be below the minimum elevation level of 1,020 feet for 125 weeks during the 100-year period and below 1,015 feet for 94 weeks of the 100 years. Based on the frequency and duration of these elevations, existing intakes could not be modified to provide water supply reliability. New intakes therefore would be required, estimated to cost about $5 million in capital expenditures. Four of the eight policy alternatives would require capital expenditures. The Summer Hydropower Alternative would incur the largest total intake costs of $12.5 million. The Commercial Navigation Alternative, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative would require expenditures of approximately $3.4 million, $22,500, $21,000, and $26,000, respectively.

The second potential impact would affect industries directly dependent on river flows in order to discharge wastewater. When river flow is too low or too high, affected industries would then need to curtail or shut down their operations, incurring lost production time. One TVA industry was also identified as being affected by changing reservoir operations. Hourly flow simulations were constructed for an 8-year period (1987 to 1994). The 8-year record contained dry, wet, and normal flow years and therefore represented the range of flows likely to be encountered in 100 years of flow record. According to these simulations, the annual average number of days the plant's wastewater storage capacity would be exceeded (and therefore production time would be lost) was estimated under each alternative. These estimates were transformed and entered into the REMI model as changes in output based on the number of days of production gained or lost under each policy alternative relative to the Base Case.

Water supply demands were projected into the future to identify those areas in the Valley where existing impoundments may not support future development and where water withdrawals could result in insufficient water for waste assimilation under low-flow conditions. These are discussed in the "Water Supply Inventory and Needs Analysis" report generated in support of the ROS. Areas of the Valley that are currently growth limited, or are projected to become growth limited in the future, are not expected to change as a result of modified reservoir operations.

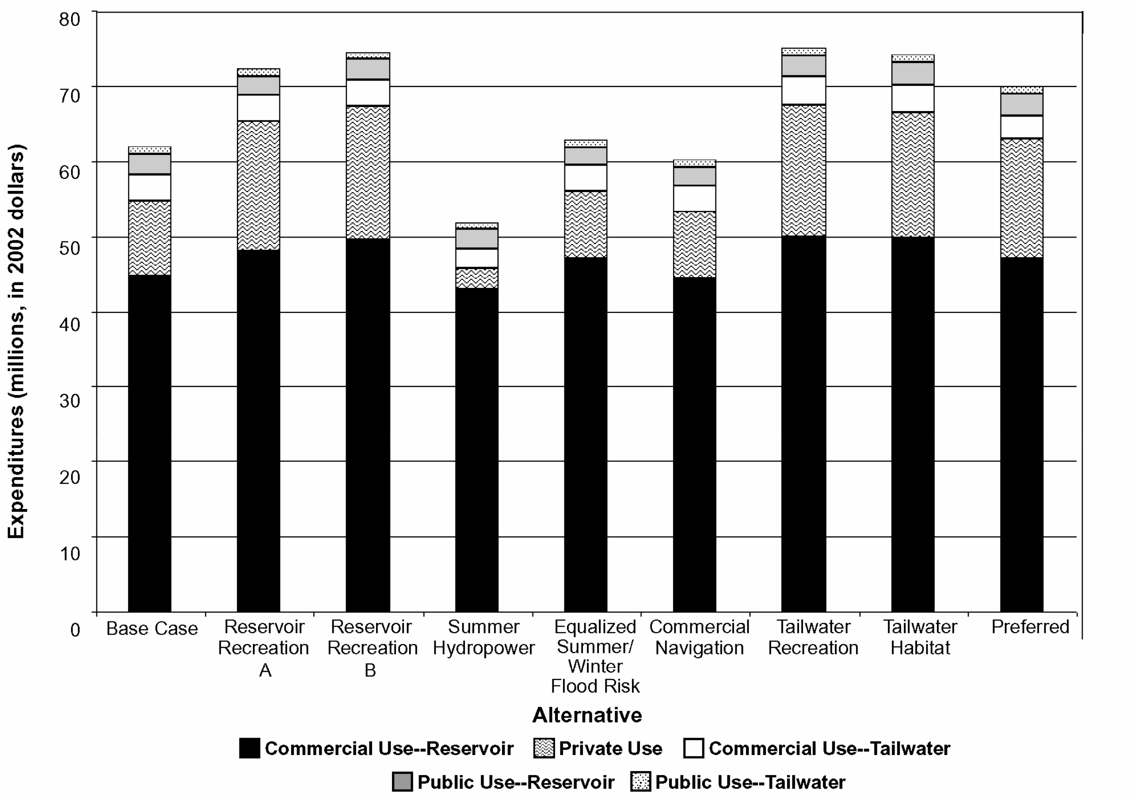
Table 5.25-04 Cost to Modify Intakes on Reservoirs with Pool Levels below TVA-Published Minimum Elevations by Policy Alternative (2002 dollars in thousands)

Reservoir	Alternative							
	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Watauga	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Cherokee	$0.0	$0.0	$5,000.0	$0.0	$1,000.0	$0.0	$0.0	$0.0
Douglas	$0.0	$0.0	$3,000.0	$0.0	$26.0	$0.0	$0.0	$26.0
Norris	$0.0	$0.0	$77.0	$0.0	$57.0	$0.0	$0.0	$0.0
Fontana	$0.0	$0.0	$4.5	$0.0	$4.5	$0.0	$0.0	$0.0
Chatuge	$0.0	$0.0	$2,200.0	$0.0	$69.5	$19.5	$19.5	$0.0
Nottely	$0.0	$0.0	$2,250.0	$0.0	$2,250.0	$1.5	$1.5	$0.0
Hiwassee	$0.0	$0.0	$1.5	$0.0	$1.5	$1.5	$0.0	$0.0
Tims Ford	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total	**$0.0**	**$0.0**	**$12,500.0**	**$0.0**	**$3,400.0**	**$22.5**	**$21.0**	**$26.0**

Note: The numbers shown in Table 5.25-04 do not directly correspond with those in Table 5.5-06. Table 5.5-06 includes changes in intake modification capital costs and pumping costs. Table 5.25-04 includes only the capital costs of intake modification. The input to the REMI model to predict economic impacts also includes lost days of production to meet wastewater discharge requirements, which is not included in Table 5.25-04.

Recreation

Changes in the reservoir operations policy are expected to alter water-based recreational use across the TVA region. Water-based recreational expenditures resulting from proposed changes in operations in the TVA reservoir system were estimated for the forecast period (see Section 5.24, Recreation). Three user groups were included in the recreation analysis: public access site users, commercial patrons, and shoreline property owners. The economic analysis is concerned with “new” or external money, either brought into the economy by individuals who live outside the TVA region or by permanent residents of the region who reallocated travel days normally spent outside the TVA region. Any transfers of spending from one use to another within the TVA region, resulting in zero net benefit to the region, were not considered in the analysis. For each alternative, changes in recreational expenditures in August through October were estimated. The changes are shown in Figure 5.25-01.



Source: TVA data 2003.

Figure 5.25-01 Projected External Recreation Expenditures by Policy Alternative (August through October 2004)

A constructed on-site survey scheme, involving mail surveys to commercial providers and shoreline property owners on 13 reservoirs, was used to estimate a baseline of recreation visitor days. Variables from these analyses were used to estimate changes in recreation visitor days based on the various alternatives. TVA’s population projections for 2003 to 2030 were then used to forecast trends in recreational use from 2003 to 2030. Estimates of percent change in the number of visitor trips or days lived at a TVA reservoir or tailwater residence in response to proposed changes in the reservoir operations policy were used to forecast changes in recreational use from 2003 to 2030. Mean expenditures per person, per user day were then applied to the projected changes in recreational use in order to calculate the projected change in expenditures from 2003 through 2030 as a result of changes in operations.

Projected changes in recreational expenditures by alternative are presented for the years 2004 to 2030 (Table 5.25-05). Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative are expected to provide greater total expenditures than under the Base Case. The Summer Hydropower Alternative and the Commercial Navigation Alternative are expected to result in reduced external recreational expenditures. The greatest increase in external expenditures is expected for the Tailwater Recreation Alternative, which would increase expenditures by $17 million by 2030. The Summer Hydropower Alternative would generate the largest decline in external recreational expenditures, reducing spending by almost $13 million by 2030.

Table 5.25-05 Changes in Recreational Expenditures from outside the TVA Region (August through October) (2002 dollars in millions)

Alternative	Spending	2004	2005	2006	2007	2008	2009	2010	2030
Base Case	Existing	$61.2	$61.9	$62.5	$63.2	$63.8	$64.5	$65.1	$79.6
Reservoir Recreation A	Change	$10.6	$10.7	$10.9	$11.0	$11.1	$11.2	$11.3	$14.0
	New level	$71.9	$72.6	$73.4	$74.1	$74.9	$75.7	$76.4	$93.6
Reservoir Recreation B	Change	$12.9	$13.1	$13.2	$13.3	$13.5	$13.6	$13.8	$17.0
	New level	$74.2	$74.9	$75.7	$76.5	$77.3	$78.1	$78.9	$96.6
Summer Hydropower	Change	-$9.8	-$9.9	-$10.0	-$10.1	-$10.2	-$10.3	-$10.4	-$12.8
	New level	$51.5	$52.0	$52.5	$53.1	$53.6	$54.2	$54.7	$66.8
Equalized Summer/ Winter Flood Risk	Change	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.4
	New level	$62.5	$63.2	$63.8	$64.4	$65.1	$65.7	$66.4	$81.1
Commercial Navigation	Change	-$1.0	-$1.0	-$1.0	-$1.0	-$1.1	-$1.1	-$1.1	-$1.3
	New level	$60.2	$60.9	$61.5	$62.1	$62.8	$63.4	$64.0	$78.3
Tailwater Recreation	Change	$13.2	$13.3	$13.4	$13.6	$13.7	$13.9	$14.0	$17.3
	New level	$74.4	$75.2	$76.0	$76.8	$77.6	$78.3	$79.2	$97.0
Tailwater Habitat	Change	$12.2	$12.4	$12.5	$12.6	$12.8	$12.9	$13.0	$16.2
	New level	$73.5	$74.2	$75.0	$75.8	$76.6	$77.4	$78.2	$95.8
Preferred	Change	$8.6	$8.7	$8.7	$8.8	$8.9	$9.0	$9.1	$11.3
	New level	$69.8	$70.5	$71.3	$72.0	$72.8	$73.5	$74.2	$90.9

Property Values

Changes in the reservoir operations policy have the potential to affect the value of waterfront properties on TVA reservoirs. Recreational and aesthetic benefits of living adjacent to the TVA reservoirs are capitalized into the values of property adjacent to the water. Changes in the existing policy that alter pool levels would alter amenities at reservoir properties and, thus, change property values. For instance, policy alternatives that would maintain summer pool levels for an additional month would increase the amenity benefits of living by the water. Adjacent property values should then rise in response.

A hedonic valuation model used to estimate the effect of reservoir levels on property values postulated that the value of residential property would be higher on lots where the winter drawdown exposes less area between the summer high pool and winter low pool elevations. In the hedonic model, the implicit price of each characteristic of the property was embedded in the market price of the property. A statistical model was used to estimate the value of the aesthetic and recreational benefits of living by the water. Changes in property values resulting from changes in reservoir elevations could then be measured.

An important relationship for the economic impact analysis concerns how changes in property values (a form of wealth) translate into changes in consumer spending. Direct economic effects in the regional economy occur via the estimate that 3 percent of the increase in household wealth is spent on "high-end" durable goods, holding constant the level of annual income. This assumption is consistent with both economic theory and empirical research. A central implication of economic theory is that people smooth consumption over their lifetime, and wealth is a key component of this consumption plan. A change in wealth will cause a rearrangement of the desired profile of consumption over time. Empirical research suggests that increases in wealth result in increases in consumer spending of between 3 and 5 percent. In this EIS, an increase in consumer spending of 3 percent of property value changes was assumed.

The results of the total change in spending for each alternative across the TVA region are presented in Table 5.25.06. Reservoir Recreation Alternative B would result in the largest increase in spending, with an estimated increase in property values leading to over $10 million annually by 2005 in additional spending on durable goods by residents in the region. Conversely, the Summer Hydropower Alternative, which would result in lower summer pool levels than under the existing policy, would cause an estimated decrease in property values, and therefore a decline in spending on durable goods of almost $12 million annually by 2005.

The REMI Model

The existing conditions and future trends through 2030 were forecast by TVA, using a system of models and forecasting processes of which the REMI model is an integral part (see Appendix C). REMI is a model widely used by federal agencies such as the USEPA and state governments such as Florida and Texas. TVA provided projections of total economic effects under the Base Case for 2004 to 2030. The direct effects within the five pathways were then used as inputs into the REMI model. Total economic effects were estimated and represented as changes in GRP, PI, employment, and population levels.

Table 5.25-06 Estimated Impacts of Changes in Property Values on Consumer Spending across the TVA Region by Policy Alternative (2004 to 2030) (2002 dollars in millions)

Alternative	2004	2005	2006	2007	2008	2009	2010	2030
Reservoir Recreation A	$3.8	$7.7	$7.7	$7.7	$7.7	$7.7	$7.7	$7.7
Reservoir Recreation B	$5.1	$10.2	$10.2	$10.2	$10.2	$10.2	$10.2	$10.2
Summer Hydropower	-$5.9	-$11.8	-$11.8	-$11.8	-$11.8	-$11.8	-$11.8	-$11.8
Equalized Summer/ Winter Flood Risk	-$2.3	-$4.5	-$4.5	-$4.5	-$4.5	-$4.5	-$4.5	-$4.5
Commercial Navigation	$2.8	$5.6	$5.6	$5.6	$5.6	$5.6	$5.6	$5.6
Tailwater Recreation	$5.0	$10.0	$10.0	$10.0	$10.0	$10.0	$10.0	$10.0
Tailwater Habitat	$4.2	$8.4	$8.4	$8.4	$8.4	$8.4	$8.4	$8.4
Preferred	$0.9	$1.8	$1.8	$1.8	$1.8	$1.8	$1.8	$1.8

Total Economic Effects of Policy Alternatives

Tables 5.25-07 through 5.25-14 show the total economic effects for the policy alternatives. The results are presented by year for the first 7 years (2004 to 2010) of the forecast period. The economic effects throughout this period show the developing trend in the regional economy as the region adjusts to the direct effects of each policy alternative. Results for 2030 are also presented; however, any results after 2020 are subject to greater uncertainty.

Direct effects ripple across the economy to differing degrees, dependent on the interactions generated within the economy and the length of time that secondary impacts affect the region. The effects of the economic drivers do not occur in isolation; they occur simultaneously due to the system-wide linkage in TVA operations. For instance, a decision to hold water in upstream reservoirs to Labor Day in order to enhance recreation in those reservoirs could also reduce water releases for hydropower generation and channel depths for navigation. The cumulative effects of the changes in each pathway are of interest due to the dynamic and interconnected nature of the economy as expressed in the REMI model.

Direct effects, in terms of their impact on the economy, are shown in Table 5.25-15. For instance, under Reservoir Recreation Alternative A, an increase in recreation spending would result in a slightly beneficial effect on the economy whereas an increase in power costs would result in a slightly adverse effect on the economy. The magnitude of the impacts on the regional economy would be very small relative to the size of the regional economy as a whole. For example, a policy alternative that reduces GRP by $10 million in a given year would represent a decrease of less than one hundredth of a percent in the value of regional output.

Table 5.25-07 Total Economic Effects under Reservoir Recreation Alternative A (2004 to 2030 in 2002 dollars)

Variable	Spending	2004	2005	2006	2007	2008	2009	2010	2030
Gross regional product	Base Case (millions)	$301,338.1	$311,985.2	$322,356.6	$333,267.3	$345,346.3	$358,597.7	$372,681.4	$694,732.7
	Change (millions)	-$7.3	$1.1	-$9.1	-$10.3	-$14.4	-$14.6	-$13.6	-$3.7
	Percent change	-0.0024%	0.0004%	-0.0028%	-0.0031%	-0.0042%	-0.0041%	-0.0036%	-0.0005%
Total personal income	Base Case (millions)	$253,806.0	$260,528.1	$268,255.1	$276,114.6	$285,081.1	$294,394.1	$303,333.6	$529,834.9
	Change (millions)	-$2.1	$0.8	-$2.8	-$3.1	-$4.7	-$4.7	-$4.4	$2.1
	Percent change	-0.0008%	0.0003%	-0.0010%	-0.0011%	-0.0016%	-0.0016%	-0.0015%	0.0004%
Employment	Base Case (thousands)	5,553.8	5,648.3	5,727.8	5,811.8	5,909.4	6,000.4	6,095.2	7,483.0
	Change (thousands)	-.073	.067	-.049	-.047	-.081	-.066	-.043	.123
	Percent change	-0.0013%	0.0012%	-0.0009%	-0.0008%	-0.0014%	-0.0011%	-0.0007%	0.0016%
Population	Base Case (thousands)	9,595.4	9,701.5	9,806.4	9,911.0	10,015.4	10,121.4	10,227.2	12,476.3
	Change (thousands)	-.139	-.180	-.251	-.314	-.365	-.392	-.408	-.200
	Percent change	-0.0014%	-0.0019%	-0.0026%	-0.0032%	-0.0036%	-0.0039%	-0.0040%	-0.0016%

Table 5.25-08 Total Economic Effects under Reservoir Recreation Alternative B (2004 to 2030 in 2002 dollars)

Variable	Spending	2004	2005	2006	2007	2008	2009	2010	2030
Gross regional product	Base Case (millions)	$301,338.1	$311,985.2	$322,356.6	$333,267.3	$345,346.3	$358,597.7	$372,681.4	$694,732.7
	Change (millions)	-$15.8	-$8.4	-$21.8	-$22.0	-$29.3	-$28.7	-$32.5	-$32.2
	Percent change	-0.0052%	-0.0027%	-0.0068%	-0.0066%	-0.0085%	-0.0080%	-0.0087%	-0.0046%
Total personal income	Base Case (millions)	$253,806.0	$260,528.1	$268,255.1	$276,114.6	$285,081.1	$294,394.1	$303,333.6	$529,834.9
	Change (millions)	-$5.1	-$2.7	-$7.6	-$7.7	-$10.4	-$10.2	-$11.5	-$5.3
	Percent change	-0.0020%	-0.0010%	-0.0028%	-0.0028%	-0.0036%	-0.0035%	-0.0038%	-0.0010%
Employment	Base Case (thousands)	5,553.8	5,648.3	5,727.8	5,811.8	5,909.4	6,000.4	6,095.2	7,483.0
	Change (thousands)	-.179	-.039	-.190	-.164	-.229	-.193	-.220	.012
	Percent change	-0.0032%	-0.0007%	-0.0033%	-0.0028%	-0.0039%	-0.0032%	-0.0036%	0.0002%
Population	Base Case (thousands)	9,595.4	9,701.5	9,806.4	9,911.0	10,015.4	10,121.4	10,227.2	12,476.3
	Change (thousands)	-.206	-.296	-.424	-.525	-.627	-.690	-.769	-.821
	Percent change	-0.0021%	-0.0031%	-0.0043%	-0.0053%	-0.0063%	-0.0068%	-0.0075%	-0.0066%

Table 5.25-09 Total Economic Effects under the Summer Hydropower Alternative (2004 to 2030 in 2002 dollars)

Variable	Spending	2004	2005	2006	2007	2008	2009	2010	2030
Gross regional product	Base Case (millions)	$301,338.1	$311,985.2	$322,356.6	$333,267.3	$345,346.3	$358,597.7	$372,681.4	$694,732.7
	Change (millions)	-$21.3	-$24.3	-$36.2	-$34.7	-$45.3	-$42.6	-$43.2	-$69.8
	Percent change	-0.0071	-0.0078%	-0.0112%	-0.0104%	-0.0131%	-0.0119%	-0.0116	-0.0100%
Total personal income	Base Case (millions)	$253,806.0	$260,528.1	$268,255.1	$276,114.6	$285,081.1	$294,394.1	$303,333.6	$529,834.9
	Change (millions)	-$4.8	-$4.3	-$10.6	-$10.4	-$14.7	-$14.1	-$14.6	-$23.7
	Percent change	-0.0019%	-0.0017%	-0.0040%	-0.0038%	-0.0052%	-0.0048%	-0.0048	-0.0045%
Employment	Base Case (thousands)	5,553.8	5,648.3	5,727.8	5,811.8	5,909.4	6,000.4	6,095.2	7,483.0
	Change (thousands)	-.186	-.171	-.376	-.346	-.460	-.417	-.413	-.496
	Percent change	-0.0033%	-0.0030%	-0.0066%	-0.0060%	-0.0078%	-0.0069%	-0.0068	-0.0025%
Population	Base Case (thousands)	9,595.4	9,701.5	9,806.4	9,911.0	10,015.4	10,121.4	10,227.2	12,476.3
	Change (thousands)	-.004	-0.34	-.111	-.178	-.251	-.307	-.372	-.922
	Percent change	0.0000%	-0.0004%	-0.0011%	-0.0018%	-0.0025%	-0.0030%	-0.0036	-0.0074%

Table 5.25-10 Total Economic Effects under the Equalized Summer/Winter Flood Risk Alternative (2004 to 2030 in 2002 dollars)

Variable	Spending	2004	2005	2006	2007	2008	2009	2010	2030
Gross regional product	Base Case (millions)	$301,338.1	$311,985.2	$322,356.6	$333,267.3	$345,346.3	$358,597.7	$372,681.4	$694,732.7
	Change (millions)	-$40.7	-$46.5	-$59.8	-$64.9	-$73.1	-$80.9	-$76.5	-$127.6
	Percent change	-0.0135%	-0.0149%	-0.0186%	-0.0195%	-0.0212%	-0.0226%	-0.0205%	-0.0184%
Total personal income	Base Case (millions)	$253,806.0	$260,528.1	$268,255.1	$276,114.6	$285,081.1	$294,394.1	$303,333.6	$529,834.9
	Change (millions)	-$14.9	-$17.8	-$23.3	-$25.7	-$29.1	-$32.5	-$31.1	-$39.8
	Percent change	-0.0059%	-0.0068%	-0.0087%	-0.0093%	-0.0102%	-0.0110%	-0.0103%	-0.0075%
Employment	Base Case (thousands)	5,553.8	5,648.3	5,727.8	5,811.8	5,909.4	6,000.4	6,095.2	7,483.0
	Change (thousands)	-.574	-.594	-.728	-.733	-.791	-.835	-.745	-.664
	Percent change	-0.0103%	-0.0105%	-0.0127%	-0.0126%	-0.0134%	-0.0139%	-0.0122%	-0.0089%
Population	Base Case (thousands)	9,595.4	9,701.5	9,806.4	9,911.0	10,015.4	10,121.4	10,227.2	12,476.3
	Change (thousands)	-.317	-.550	-.816	-1.024	-1.231	-1.409	-1.571	-2.755
	Percent change	-0.0033%	-0.0057%	-0.0083%	-0.0103%	-0.0123%	-0.0139%	-0.0154%	-0.0221%

Table 5.25-11 Total Economic Effects under the Commercial Navigation Alternative (2004 to 2030 in 2002 dollars)

Variable	Spending	2004	2005	2006	2007	2008	2009	2010	2030
Gross regional product	Base Case (millions)	$301,338.1	$311,985.2	$322,356.6	$333,267.3	$345,346.3	$358,597.7	$372,681.4	$694,732.7
	Change (millions)	$22.3	$37.7	$36.3	$42.1	$47.0	$49.2	$54.0	$87.4
	Percent change	0.0074%	0.0121%	0.0113%	0.0126%	0.0136%	0.0137%	0.0145%	0.0126%
Total personal income	Base Case (millions)	$253,806.0	$260,528.1	$268,255.1	$276,114.6	$285,081.1	$294,394.1	$303,333.6	$529,834.9
	Change (millions)	$3.2	$9.4	$8.8	$11.2	$13.0	$14.0	$15.8	$24.0
	Percent change	0.0013%	0.0036%	0.0033%	0.0041%	0.0046%	0.0048%	0.0052%	0.0045%
Employment	Base Case (thousands)	5,553.8	5,648.3	5,727.8	5,811.8	5,909.4	6,000.4	6,095.2	7,483.0
	Change (thousands)	.111	.320	.263	.320	.361	.369	.408	.466
	Percent change	0.0020%	0.0057%	0.0046%	0.0055%	0.0061%	0.0061%	0.0067%	0.0062%
Population	Base Case (thousands)	9,595.4	9,701.5	9,806.4	9,911.0	10,015.4	10,121.4	10,227.2	12,476.3
	Change (thousands)	.023	.112	.161	.220	.285	.344	.405	.974
	Percent change	0.0002%	0.0012%	0.0016%	0.0022%	0.0028%	0.0034%	0.0040%	0.0078%

Table 5.25-12 Total Economic Effects under the Tailwater Recreation Alternative (2004 to 2030 in 2002 dollars)

Variable	Spending	2004	2005	2006	2007	2008	2009	2010	2030
Gross regional product	Base Case (millions)	$301,338.1	$311,985.2	$322,356.6	$333,267.3	$345,346.3	$358,597.7	$372,681.4	$694,732.7
	Change (millions)	-$14.5	-$7.2	-$20.5	-$20.7	-$27.9	-$27.1	-$30.8	-$29.7
	Percent change	-0.0048%	-0.0023%	-0.0064%	-0.0062%	-0.0081%	-0.0076%	-0.0083%	-0.0043%
Total personal income	Base Case (millions)	$253,806.0	$260,528.1	$268,255.1	$276,114.6	$285,081.1	$294,394.1	$303,333.6	$529,834.9
	Change (millions)	-$4.6	-$2.2	-$7.0	-$7.1	-$9.7	-$9.5	-$10.9	-$4.4
	Percent change	-0.0018%	-0.0008%	-0.0026%	-0.0026%	-0.0034%	-0.0032%	-0.0036%	-0.0008%
Employment	Base Case (thousands)	5,553.8	5,648.3	5,727.8	5,811.8	5,909.4	6,000.4	6,095.2	7,483.0
	Change (thousands)	-.162	-.023	-.173	-.147	-.211	-.174	-.201	.030
	Percent change	-0.0029%	-0.0004%	-0.0030%	-0.0025%	-0.0036%	-0.0029%	-0.0033%	0.0004%
Population	Base Case (thousands)	9,595.4	9,701.5	9,806.4	9,911.0	10,015.4	10,121.4	10,227.2	12,476.3
	Change (thousands)	-.200	-.287	-.410	-.510	-.608	-.671	-.745	-.784
	Percent change	-0.0021%	-0.0030%	-0.0042%	-0.0051%	-0.0061%	-0.0066%	-0.0073%	-0.0063%

Table 5.25-13 Total Economic Effects under the Tailwater Habitat Alternative (2004 to 2030 in 2002 dollars)

Variable	Spending	2004	2005	2006	2007	2008	2009	2010	2030
Gross regional product	Base Case (millions)	$301,338.1	$311,985.2	$322,356.6	$333,267.3	$345,346.3	$358,597.7	$372,681.4	$694,732.7
	Change (millions)	-$46.3	-$78.2	-$100.3	-$115.8	-$123.8	-$141.3	-$160.8	-$335.2
	Percent change	-0.0154%	-0.0251%	-0.0311%	-0.0347%	-0.0358%	-0.0394%	-0.0431%	-0.0482%
Total personal income	Base Case (millions)	$253,806.0	$260,528.1	$268,255.1	$276,114.6	$285,081.1	$294,394.1	$303,333.6	$529,834.9
	Change (millions)	-$17.2	-$30.2	-$39.4	-$45.8	-$49.4	-$56.2	-$63.7	-$105.3
	Percent change	-0.0068%	-0.0116%	-0.0147%	-0.0166%	-0.0173%	-0.0191%	-0.0210%	-0.0199%
Employment	Base Case (thousands)	5,553.8	5,648.3	5,727.8	5,811.8	5,909.4	6,000.4	6,095.2	7,483.0
	Change (thousands)	-.700	-1.027	-1.196	-1.291	-1.277	-1.390	-1.522	-1.699
	Percent change	-0.0126%	-0.0182%	-0.0209%	-0.0222%	-0.0216%	-0.0232%	-0.0250%	-0.0227%
Population	Base Case (thousands)	9,595.4	9,701.5	9,806.4	9,911.0	10,015.4	10,121.4	10,227.2	12,476.3
	Change (thousands)	-.592	-1.168	-1.704	-2.224	-2.659	-3.086	-3.518	-7.273
	Percent change	-0.0062%	-0.0120%	-0.0174%	-0.0224%	-0.0265%	-0.0305%	-0.0344%	-0.0583%

Table 5.25-14 Total Economic Effects under the Preferred Alternative (2004 to 2030 in 2002 dollars)

Variable	Spending	2004	2005	2006	2007	2008	2009	2010	2030
Gross regional product	Base Case (millions)	$301,338.1	$311,985.2	$322,356.6	$333,267.3	$345,346.3	$358,597.7	$372,681.4	$694,732.7
	Change (millions)	-$2.2	-$5.8	-$5.6	-$8.3	-$9.0	-$7.3	-$6.0	-$4.5
	Percent change	-0.0007%	-0.0019%	-0.0018%	-0.0025%	-0.0026%	-0.0020%	-0.0016%	-0.0007%
Total personal income	Base Case (millions)	$253,806.0	$260,528.1	$268,255.1	$276,114.6	$285,081.1	$294,394.1	$303,333.6	$529,834.9
	Change (millions)	-$0.4	-$1.8	-$1.8	-$2.7	-$3.0	-$2.3	-$1.9	$0.5
	Percent change	-0.0002%	-0.0007%	-0.0007%	-0.0010%	-0.0010%	-0.0008%	-0.0006%	0.0001%
Employment	Base Case (thousands)	5,553.8	5,648.3	5,727.8	5,811.8	5,909.4	6,000.4	6,095.2	7,483.0
	Change (thousands)	0.002	-0.027	-0.016	-0.044	-0.043	-0.016	0.002	0.061
	Percent change	0.0000%	-0.0005%	-0.0003%	-0.0008%	-0.0007%	-0.0003%	0.0000%	0.0008%
Population	Base Case (thousands)	9,595.4	9,701.5	9,806.4	9,911.0	10,015.4	10,121.4	10,227.2	12,476.3
	Change (thousands)	-0.063	-0.101	-0.130	-0.163	-0.184	-0.189	-0.191	-0.116
	Percent change	-0.0007%	-0.0010%	-0.0013%	-0.0016%	-0.0018%	-0.0019%	-0.0019%	-0.0009%

Table 5.25-15 Direct Effects by Policy Alternative

Alternative	Recreation Spending	Expenditures Associated with Property Values	Water Supply	Navigation Costs	Power Costs
Reservoir Recreation A	Slightly beneficial	Slightly beneficial	Slightly adverse	No change	Slightly adverse
Reservoir Recreation B	Slightly beneficial	Slightly beneficial	No change	No change	Slightly adverse
Summer Hydropower	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Equalized Summer/ Winter Flood Risk	Slightly beneficial	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Commercial Navigation	Slightly adverse	Slightly beneficial	Slightly adverse	Slightly beneficial	Slightly beneficial
Tailwater Recreation	Slightly beneficial	Slightly beneficial	Slightly beneficial	No change	Slightly adverse
Tailwater Habitat	Slightly beneficial	Slightly beneficial	Slightly adverse	No change	Adverse
Preferred	Slightly beneficial	Slightly beneficial	Slightly adverse	Slightly beneficial	Slightly adverse

Notes:

The narrative under the Water Supply column in Table 5.25-15 is not directly comparable to the figures presented in Table 5.25-04. Table 5.25-15 takes into account the combined impact of changes in costs to modify intakes and changes in lost days of production to industries affected by low river flow. Table 5.25-04 represents only the former.

Effects are based on the year 2010.

Tables 5.25-07 through 5.25-14 present the results for all policy alternatives as forecast changes in total economic effects relative to their forecast levels under the Base Case. The percentage of changes in total economic effects is also shown.

5.25.3 Base Case

Under the Base Case, TVA would maintain the existing reservoir operations policy. Under this policy, reservoir levels are generally held up as high as possible until August, when reservoirs are drawn down for power generation and are held low through the winter to provide flood storage for spring rains. In late spring, the reservoirs are filled to reach their peak volumes for the year in April or May for the mainstem reservoirs, and in June for the tributaries. Maintaining existing operations implies no impact on the forecast trend of existing conditions.

5.25.4 Reservoir Recreation Alternative A

Reservoir Recreation Alternative A would increase recreational opportunities in the TVA region. Summer tributary reservoir levels would be maintained for an additional month through Labor Day. This alternative would increase recreation spending in the region as well as wealth-induced consumer spending by property owners on TVA reservoirs. This would positively affect the economy; however, power costs would rise, increasing the costs of production for many industries across the TVA region. Table 5.25-07 shows that the increase in power costs would more than offset the gains to the economy arising from the local areas of the reservoirs. All economic variables show an increasingly negative trend over the first 7 years of the forecast, with GRP decreasing by $14 million (0.0036 percent) by the year 2010 relative to its level under the Base Case. By 2030, GRP is forecast to have decreased by $4 million relative to the Base Case. Further, by 2030 both PI ($2 million) and employment (123 workers) would have recovered to positive levels relative to their levels under the Base Case.

5.25.5 Reservoir Recreation Alternative B

Reservoir Recreation Alternative B also would increase recreational opportunities in the region. This alternative would extend tributary and mainstem summer pool levels to Labor Day, and winter levels would be held higher. Again, recreation spending and wealth-induced spending would rise while higher power costs would result in a counteracting impact. The resulting impacts on the economy would be similar to those under Reservoir Recreation Alternative A, as there is a clear negative trend in the economic effects between 2004 and 2010; however, the magnitude of these effects under Reservoir Recreation Alternative B would be greater than under Reservoir Recreation Alternative A. GRP is forecast to decrease by $33 million by 2010 relative to its level under the Base Case (Table 5.25-08). Similarly, PI is forecast to decrease by $11.5 million, employment levels by 220 workers, and the population by 769 people. By 2030, the GRP is forecast to remain approximately $32 million below that forecast under the Base Case.

5.25.6 Summer Hydropower Alternative

The Summer Hydropower Alternative would maximize hydropower production by beginning an unrestricted drawdown of the tributary and mainstem reservoirs by June 1. This would leave summer pool levels lower than under the Base Case, and winter and spring levels would be higher. This alternative would not lower power costs measurably and would result in a neutral impact on the economy. The other direct effects would negatively affect the economy; navigation and water supply costs would rise, and spending levels would fall. Table 5.25-09 shows that forecast in economic activity measures continually decline relative to the Base Case. By 2030, the GRP and PI would have decreased by $70 million and $24 million, respectively, relative to their levels under the Base Case. Employment and population levels were also forecast to decrease under this alternative, with 496 fewer workers and 922 fewer residents.

5.25.7 Equalized Summer/Winter Flood Risk Alternative

The Equalized Summer/Winter Flood Risk Alternative would change flood guides so that tributary reservoirs would be generally higher in spring and winter but lower in summer compared to the Base Case. Power costs and selected waterborne freight costs would be raised, while reservoir recreational activity would be increased by a small amount. As a result, GRP (-$128 million) and PI (-$40 million) would show a continuing negative trend compared to their forecast levels under the Base Case (Table 5.25-10). Regional employment and population levels would also be below the forecast for the Base Case, with the level of employment shrinking by 664 workers and the population by 2,755 residents.

5.25.8 Commercial Navigation Alternative

The Commercial Navigation Alternative would enhance navigation. As expected, navigation costs would decrease as deeper channels relate to more efficient loads, providing a positive impact on the economy. Decreasing power costs would magnify this effect. Recreation spending levels would decrease but, as Table 5.25-11 shows, the economy would be positively affected by this policy alternative. All economic variables show an increasing trend over the 27-year forecast period relative to the Base Case. By 2030, the GRP and PI were forecast to increase by $87 million and $24 million, respectively, while 466 additional workers would be hired and 974 residents would migrate to the region.

5.25.9 Tailwater Recreation Alternative

The Tailwater Recreation Alternative would increase tailwater recreational opportunities by maintaining summer pool levels through Labor Day. Accordingly, recreation spending and wealth-induced spending would increase, but there are offsetting forces in the form of increasing power costs. Overall, the regional economy was forecast to contract compared to the Base Case. The GRP was forecast to decrease by $31 million by 2010 relative to the Base Case, while PI would decline by $11 million (Table 5.25-12). Employment and population levels were also forecast to be below their levels under the existing policy. Between 2010 and 2030, the economy (as measured by GRP) was forecast not to deviate further from its level under the Base Case, remaining at approximately $30 million under its forecast for the Base Case, while PI shows a recovery over this period toward its long-run growth rate.

5.25.10 Tailwater Habitat Alternative

The Tailwater Habitat Alternative would mimic natural flow conditions. The most substantial impact would result from an increase in power costs, caused by reduced peaking hydropower availability. As a result, TVA would need to replace the low-cost hydropower with higher cost purchased and generated power. The negative impact on the economy would be only partially offset by increased consumer spending driven by enhancements to recreational activities. This alternative has the most adverse implications for the regional economy. Table 5.25-13 shows the forecast trend in the economic variables being increasingly negative relative to the economic conditions under the Base Case. By 2030, relative to the forecast for the Base Case, the GRP would have declined by $335 million and PI by $105 million; there would be 1,699 fewer employees, and out-migration would lead to 7,273 fewer residents.

5.25.11 Preferred Alternative

Under the Preferred Alternative, reservoir and tailwater recreation opportunities would increase. As a result, recreation spending and wealth-induced spending would increase under this alternative. Shipper savings would also increase, but rising water supply and power costs would offset this benefit. As Table 5.25-14 shows, under this alternative, the regional economy is expected to contract slightly compared to the Base Case. By 2010, GRP and PI are forecast to decrease by $6 million and $1.9 million, respectively. Population levels are forecast to fall by 191 residents, while little impact is expected on regional levels of employment. Between 2010 and 2030, the trend in decreasing levels of economic activity would be mitigated. By 2030, GRP is forecast to decline by $4.5 million, while personal income levels are forecast to increase by $0.5 million relative to their levels under the Base Case. Population levels are expected to decrease by 116 residents, and the impact on the level of regional employment is expected to be negligible.

5.25.12 Environmental Justice

Across the TVA region as a whole, none of the policy alternatives would likely raise environmental justice issues (i.e., adverse and disproportionate environmental or human health impacts on minority or low-income populations). Population demographics rule out disproportionate impacts on minorities or low-income populations when the point of comparison is the percentage of the population comprised of minorities and low-income individuals within the seven states in which TVA operates, or the nation as a whole. It is conceivable that disproportionate impacts on minorities could occur at a sub-regional level in the Mississippi and Western sub-regions and at isolated, local locations. With regard to low-income populations, demographics also allow for the possibility of a very slight disproportionate impact across the TVA region as whole. The greatest potential for disproportionate sub-regional impacts exists in the Mississippi sub-region because of the high proportion of those living below the poverty level in that area. However, the region-wide nature of TVA's proposed action makes it unlikely that, if disproportionate impacts occurred, they would be substantial.

Although not substantial, disproportionate impacts on property values and recreation could occur. While lake-front residential property values would rise under some of the alternatives, it would unlikely adversely affect low-income populations–given that those living below the poverty level are unable to purchase lake-front property at existing prices. Minority individuals who are in the market for lake-front property would be adversely affected by increased property values; however, it is unlikely that such adverse impacts would be borne disproportionately by minorities. This would require that minorities in the market for lake-front property represent a greater percentage of the population of individuals in this market than the minority population percentage as a whole, and there is no evidence of this.

Some of the alternatives would adversely affect recreation opportunities. However, recreation survey data indicate that any such adverse impacts would not be borne disproportionately by minorities or low income populations. Those living below the poverty level likely would not be adversely affected by the loss of boating and other high-cost recreational opportunities that might occur under some of the alternatives. It is also unlikely that minorities would be disproportionately affected by the loss of such opportunities. The greatest potential for adverse and disproportionate impacts exists with regard to informal recreational opportunities, such as fishing, under some of the alternatives. The risk of such impacts under TVA's Preferred Alternative is remote because this alternative would enhance recreational opportunities.

Adverse health impacts on subsistence anglers are not anticipated, given that no increase in contaminates that accumulate in fish flesh and could potentially cause human health concerns is expected to occur under any of the alternatives (see Section 5.4.1).

5.25.13 Summary of Impacts

All of the alternatives would entail tradeoffs. None of the alternatives would be uniformly beneficial or adverse for all economic pathways or output measures.

The results of the impact analysis show that only the Commercial Navigation Alternative would produce a positive economic impact on the region. Under this alternative, more efficient waterborne transportation loads and lower electricity prices would ripple across the region, creating both lower production costs for regional industries and higher levels of disposable income for consumers. These direct effects would translate into an expanding economy; therefore, the Commercial Navigation Alternative would be the most beneficial alternative with regard to social and economic resources. Under this alternative, the positive impact on the economy would be a small change in the aggregate, raising GRP levels by only less than one-tenth of a percent in any given year.

The Tailwater Habitat Alternative represents the least beneficial alternative in terms of impacts on social and economic resources. Designed to mimic natural flows, the alternative would substantially reduce TVA's peaking hydropower availability, raising electricity prices for industry and households. This impact would overwhelm rising recreation spending and would create a contraction in the regional economy relative to the Base Case. The Equalized Summer/Winter Flood Risk Alternative also would result in adverse effects on the economy. Designed to enhance flood protection, the alternative would result in negative regional impacts associated with higher electricity and waterborne transportation costs.

Reservoir Recreation Alternative A and Reservoir Recreation Alternative B were designed to increase recreational activity, but both would create higher production costs that would offset these gains. The Summer Hydropower Alternative proposes to maximize hydropower availability but simultaneously would incur rising waterborne transportation costs and falling recreation spending. The Preferred Alternative would incur positive regional impacts of increased recreational activity, wealth-induced spending, and increased shipper savings; but these benefits would be more than offset by rising water supply and power costs. Under all these alternatives, the direct effects would contract the regional economy relative to its forecast performance under the Base Case. Of these alternatives, the Preferred Alternative would result in the smallest deviation from the Base Case.

Table 5.25-16 provides a qualitative summary of the total economic effects by policy alternative and emphasizes that impacts under all alternatives would be very small relative to the Base Case.

Different standards can be used to summarize and evaluate the total economic effects of each alternative. For instance, the impact of each alternative could be measured as an average across the whole 27-year period, by the impact at the end of the forecast period (2030), or by impacts in some representative year. After careful consideration, the economic effect in 2010 was chosen to evaluate the impact of each alternative. The year 2010 was chosen because, by then, adjustments in the economy to the effects of each alternative would have largely been made; effects in 2010 are quite similar to those taken as an average; and use of 2010 is more accurate, avoiding the uncertainties associated with long-term projection to 2030.

Concerning environmental justice, demographics suggest the possibility of a very slight disproportionate impact for low-income populations across the ROS analysis area as a whole, with the greatest potential disproportionality occurring in the Mississippi sub-region.

Table 5.25-16 Summary of Economic Effects by Policy Alternative

Alternative	Variable			
	Gross Regional Product	Personal Income	Employment[1]	Population
Base Case	No change	No change	No change	No change
Reservoir Recreation A	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Reservoir Recreation B	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Summer Hydropower	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Equalized Summer/Winter Flood Risk	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Commercial Navigation	Slightly beneficial	Slightly beneficial	Slightly beneficial	Slightly beneficial
Tailwater Recreation	Slightly adverse	Slightly adverse	Slightly adverse	Slightly adverse
Tailwater Habitat	Adverse	Adverse	Adverse	Adverse
Preferred	Slightly adverse	Slightly adverse	No change	Slightly adverse

[1] Employment is summarized as having incurred "no change" under the Preferred Alternative because by 2010 the slight increase in regional employment is considered to be negligible.

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Chapter 6

Cumulative Impacts

Tennessee Valley Authority
Reservoir Operations Study – Final Programmatic EIS

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6.1 Introduction

Cumulative impacts are defined as the effects of the proposed action when considered together with other past, present, and reasonably foreseeable future actions. Chapter 4, Description of the Affected Environment, presents information about past and present environmental conditions—including future trends, where appropriate. This chapter addresses the cumulative impacts of the reservoir operations policy alternatives and other reasonably foreseeable actions.

The ROS EIS is a programmatic evaluation of the potential consequences of changing TVA's policy for operating its integrated reservoir system. The study's broad geographic scope is the entire Tennessee River watershed and adjacent areas, including where TVA-generated electricity is consumed (TVA's Power Service Area). Consistent with the programmatic approach of this EIS and broad scale of the ROS, the cumulative impact analysis addressed cumulative impacts of the reservoir operations policy when added to future trends and future projects. Because of the time frame and geographic scope of the evaluation, predicting future resource conditions involves substantial uncertainty. Future cumulative impacts can result not only from possible actions of TVA but also from those of other agencies and the public. This increases the uncertainty. Nevertheless, existing conditions and trends provide a basis for broad assumptions for this cumulative impact analysis.

- **Future Trends.** The planning time frame of the ROS EIS is the period from 2003 to 2030. Over this three-decade period, existing conditions in many resource areas are expected to change. The amount and rate of change would vary by resource. For each resource, potential impacts were assessed for the resource conditions expected to exist over this period. The cumulative change in existing conditions between the present and 2030 was assessed as part of the resource-specific analyses in Chapter 5, Environmental Consequences of the Alternatives. This chapter summarizes the potential for cumulative impacts of each policy alternative when added to future trends, for each resource for which adverse impacts are expected to occur.

- **Future Projects.** Specific projects that would be undertaken and come into operation during the planning period were identified and evaluated. The impacts from these projects may result in regional-scale impacts when considered together with resource impacts resulting from the implementation of policy alternatives.

In addition to future trends for resources and future projects, regulatory programs—especially those that affect environmental quality—would substantially affect the occurrence of cumulative impacts. State regulatory programs, such as those implementing the Clean Air and Clean Water Acts, are designed to improve environmental conditions. While their precise effects cannot be accurately predicted, their regional or statewide application is expected to affect a positive change in the environment. Such positive environmental changes could not be fully accounted for in TVA's cumulative impact analysis. Consequently, the analysis was generally conservative; and any projected adverse cumulative impacts are likely to have been overstated.

6.2 Cumulative Impacts Associated with Future Trends

As appropriate in each resource area, relevant future trends were identified and evaluated along with the effects of policy alternatives, and were examined for potential cumulative impacts. The following sections provide a summary of these trends and their potential cumulative impacts. No material cumulative impacts are expected to result in the areas of Dam Safety, Invasive Plants and Animals, Aquatic Plants, Groundwater Resources, or Prime Farmland. The potential consequences of changes in the operations policy on Power and Navigation were determined to be primarily economic changes, and the modeling of economic changes integrated these cumulative effects. Changes in TVA's operations policy could affect Land Use, but these effects are also primarily economic and are captured in TVA's economic analyses. The cumulative effects of shoreline development are also presented in TVA's earlier programmatic EIS assessing shoreline development, the SMI (TVA 1998).

6.2.1 Air Resources/Climate

TVA evaluated potential impacts on air resources and climate based on changes in air emissions and air quality. Air quality is currently good and improving in the TVA region, as measured by EPA's national health and environmental standards for air quality, the NAAQS. Emissions of air pollutants in the region are likely to decrease in the future due to emissions reductions by TVA (see Section 4.2, Air Resources) and others. Pollution from increased motor vehicle trips and other new air pollution stationary sources (such as factories and power plants) are expected to offset some of these decreases. The overall trend, however, should be positive—with continued air quality improvements—especially as more stringent NAAQS for ozone levels and particulates are implemented by the states. On a regional basis, the Southern Appalachian Mountain Initiative has recommended an eight-state strategy designed to improve current air quality and mitigate the effects of future expected increases in cumulative air emissions from utility and other regional air emission sources. Chief among these strategies is the installation of emissions control equipment on existing and new emission sources, including energy generation facilities.

Implementation of the Tailwater Habitat Alternative or Summer Hydropower Alternative is expected to improve air quality and regional visibility because non-emitting generation either would increase or increase in summer months compared to the Base Case. These alternatives would reduce the potential for cumulative air quality effects. Reservoir Recreation Alternatives A and B, the Equalized Summer/Winter Flood Risk Alternative, and the Tailwater Recreation Alternative would adversely affect air quality because emissions from fossil-fuel electric generating units are expected to increase in order to offset the small reduction in total hydropower generation. Most alternatives also would result in a seasonal shift in emissions, resulting in increased emissions in summer, when the atmosphere is more chemically active and air quality problems like ozone levels are more severe. Overall, net annual increases in emissions under Reservoir Recreation Alternatives A and B, the Equalized Summer/Winter Flood Risk Alternative, and the Tailwater Recreation Alternative would be small and would not substantially increase the potential for cumulative impacts related to air quality. The Preferred Alternative is also expected to adversely affect the amount and timing of hydropower generation but to a lesser extent than the other action alternatives, except for the Tailwater Habitat Alternative and the Summer Hydropower Alternative.

Changes in CO_2 emissions were also evaluated as an indicator of potential climate change effects. Under four alternatives (the Preferred Alternative, Reservoir Recreation Alternative A, the Commercial Navigation Alternative, and the Tailwater Habitat Alternative), CO_2 emissions would be slightly reduced. All other alternatives would cause a potential increase in CO_2 emissions, but at very low levels—less than 1 percent of current TVA emissions. To the extent that a relationship exists between CO_2 emissions and climate change, increases or decreases in greenhouse gas emissions caused by implementation of any policy alternative would be so small that they are not likely to result in noticeable or measurable cumulative impacts.

6.2.2 Water Quality

Changes in water quality would directly affect the beneficial use of water in the Valley. Dissolved oxygen and temperature are critical to maintaining suitable habitat for aquatic organisms, including threatened and endangered species. Dissolved oxygen concentrations, the formation of toxic compounds, and the growth of algae are important to aquatic life and can affect water supply treatment costs. Water temperature is important to sport fisheries and the operation of power plants. Cumulative impacts on water quality could occur in several ways. These include the interaction of water quality changes caused by watershed development and changes in the reservoir operations policy, the potential for accumulated downstream change in water quality within the TVA system, and changes in the Valley-wide amount of reservoir or tailwater areas with anoxic conditions. Land use changes within the watershed, as well as uses of water that add nutrients and other pollutants to reservoir water, can reduce DO and increase temperature.

The interaction between future trends in water quality resulting from watershed development and changes in TVA's system-wide reservoir operations policy is difficult to predict. Future water quality throughout the Valley would depend largely on political, regulatory, and economic factors that cannot be reliably or reasonably predicted. Increased population growth would likely increase development pressure in the watershed, resulting in higher levels of nutrients and sediment loading to the TVA system. This would likely be balanced, in part, through water quality regulatory programs—including the development and implementation of targeted water quality improvement plans, such as TMDLs. These programs are expected to improve water quality in impaired segments by reducing inputs of pollutants over time.

Within reservoir systems, decreasing water quality in a downstream direction can result when releases from one dam result in worse conditions in a downstream reservoir than might otherwise occur. The following discussion focuses on the development of low concentrations of DO (anoxia) and related water quality issues, such as levels of manganese, ammonia, and nutrients, because this is the primary impact on water quality predicted by TVA's analyses.

The potential for cumulative impacts from low DO (anoxia) accumulating in a downstream direction has been considerably reduced by TVA's implementation of measures to increase oxygen in waters below hydropower dams. Starting in the 1980s, under its Reservoir Release Improvement (RRI) Program, TVA developed methods to increase oxygen in the water below hydropower dams. These methods included auto-venting turbines, surface water pumps, oxygen injection systems, aerating weirs, and blowers. In 1991, under the Lake Improvement Plan, TVA adopted efforts to increase DO concentrations in the releases from 16 dams using these techniques (see Appendix A, Table A-05). TVA also committed to provide minimum flows from a number of dams.

Water quality improvements resulting from the RRI have resulted in increases in the number and diversity of fish and aquatic insects in the tailwaters at Apalachia, Blue Ridge, Boone, Chatuge, Cherokee, Douglas, Fontana, Fort Patrick Henry, Hiwassee, Norris, Nottely, South Holston, Tims Ford, and Watauga Reservoirs. These are tributary reservoirs. TVA is committed to not reversing any of the improvements that have been made under the RRI Program and to maintaining the DO targets and minimum flows established in the Lake Improvement Plan.

The RRI Program improvements have effectively reduced and mitigated the potential for cumulative water quality problems related to anoxia accumulating or growing in a downstream direction by improving the DO balance at points along the major tributary rivers and on the upper mainstem. Under some of the alternatives, however, the potential exists for cumulative water quality impacts along the lower mainstem reservoirs. Under all of the action alternatives, except the Commercial Navigation Alternative, there is the potential for cumulative impacts related to anoxia in the waters of the mainstem reservoirs. The Commercial Navigation Alternative would maintain sufficient flow through the reservoir system to avoid such cumulative impacts. The Summer Hydropower Alternative and Preferred Alternative would also provide sufficient flows to reduce cumulative impacts on DO, except during dry years when the potential for cumulative impacts would increase during a few weeks in late July and August compared to the Base Case.

TVA's Preferred Alternative was designed in part to address the residence time of waters in the reservoirs and thereby reduce the volume of anoxia in reservoirs compared to other alternatives that would enhance recreation. The Preferred Alternative includes somewhat higher system minimum flows through mainstem reservoirs in June, July, and August than other policy alternatives that would enhance recreation in order to reduce these potential anoxic conditions. Nevertheless, water quality modeling indicated that anoxic conditions occurring seasonally in some representative mainstem reservoirs under the Preferred Alternative would worsen in the reservoirs and in some dam releases as compared to the Base Case.

For mainstem reservoirs, modeling indicates that the predicted magnitude of changes in anoxia under the Preferred Alternative was generally smaller than almost all other action alternatives. The potential does exist, however, for increased cumulative anoxic conditions in the lower mainstem reservoirs during dry years for a limited time under the Preferred Alternative.

A final potential cumulative impact on water quality is the change in the total system-wide volume of anoxic water. Such changes could affect the diversity of aquatic habitats by producing a directional change in the suitability of aquatic habitat within the system. Water quality modeling results for representative reservoirs indicate that all the policy alternatives, except for the Summer Hydropower Alternative and Commercial Navigation Alternative, would increase the total volume of anoxic water in the TVA system. The Preferred Alternative would reduce this potential cumulative impact compared to some of the action alternatives but would not eliminate it.

6.2.3 Water Supply

Although demand on water supply would increase for a variety of uses in the Valley through 2030, all of the alternatives would satisfactorily meet future water demand, and no materially adverse cumulative impacts are expected. The reservoir operations policy alternatives do differ in terms of water supply delivery costs. The Commercial Navigation Alternative and Summer Hydropower Alternative would yield adverse and substantially adverse impacts, respectively, related to water supply delivery costs. No other factors systematically affecting water supply delivery costs in the Valley were identified, and no resultant cumulative impacts on water supply delivery costs are expected under any alternative.

Some alternatives may result in increased anoxia in certain reservoirs, and water treatment costs would increase from the need to address soluble iron and manganese. The only other factor identified with a potential future impact on treatment costs was changing regulatory standards. Changing standards and their treatment cost implications could potentially interact with impacts of operational changes to produce a small cumulative impact at certain water treatment facilities under Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, the Preferred Alternative, and the Tailwater Habitat Alternative.

6.2.4 Aquatic Resources

Each action alternative would result in variable effects on aquatic resources throughout the reservoir system. Changes in water quality variables, including DO and temperature, would affect the quality and suitability of aquatic habitat in a different manner in each reservoir type. Reservoir sport fish would experience the most potential benefits under the Summer Hydropower Alternative, the Commercial Navigation Alternative, or the Tailwater Recreation Alternative. The Preferred Alternative is anticipated to benefit tributary reservoir and cool/cold tailwater sport fish. Small and variable changes are anticipated in mainstem reservoir biodiversity, warm and cool-to-warm tailwaters, and commercial fishing—resulting in little potential for cumulative effects.

Implementation of Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, or the Commercial Navigation Alternative would result in minor effects on aquatic resources and thus would have little potential for additional cumulative impact. TVA has instituted programs to improve biodiversity through selected improvements in water quality.

The primary potential cumulative impact on aquatic resources would result from alternatives that would increase water retention times in reservoirs. Increased residence time lowers water quality in summer and fall, and reduces spring flows in the mainstem reservoirs. Commercial fisheries in reservoirs would experience adverse effects under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, the Equalized Summer/Winter Flood Risk Alternative, and the Tailwater Habitat Alternative due to increased amounts of water with low DO concentrations. Generally, impacts on commercial fisheries would be concentrated on mussels, as commercial fish species are mobile and can escape decreasing water quality conditions as long as other suitable habitat is available. The long-term effect of these changes is anticipated to be variable, as water temperatures in some dam releases would limit the effectiveness of TVA programs intended to improve biodiversity.

The Preferred Alternative would reduce the potential for cumulative effects on commercial fish. Under this alternative, flows through the mainstem reservoirs would be maintained at levels slightly lower than under the Base Case during summer and early fall. Under the Preferred Alternative, no change is projected for commercial mussels. Commercial fish species in some areas would slightly benefit; in other areas, reservoir habitat conditions (DO concentrations) would decline slightly.

6.2.5 Wetlands

Wetlands are extensive in the TVA reservoir system and are experiencing a minor but continuous decline that is expected to continue under the existing reservoir operations policy. This decline is cumulative because wetland succession, a slowly evolving process, is not maintaining present wetland diversity and function. Through the SMI and its permitting authority under the TVA Act, TVA manages impacts on development of shoreline water-use facilities, and federal regulation (the Clean Water Act) requires mitigation for disturbance of jurisdictional wetlands. To some extent, both of these programs would reduce the potential for long-term cumulative impacts resulting from interactions between changes in the TVA reservoir system operations policy and other impacts on wetlands resulting from construction and development in the Valley.

The Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative would result in an overall decrease in availability of water to wetlands during the growing season, isolating these wetlands from their most prevalent source of water. This would result in negative impacts on both wetland extent and type, including substantial adverse effects on scrub/shrub and forested wetlands around tributary reservoirs. Because of the geographic extent and importance of some wetland resources, this could constitute an adverse cumulative impact on scrub/shrub and forested wetlands; but these changes may be partially offset by cumulative increases in the coverage of other wetland types.

Implementation of Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, or the Preferred Alternative would increase the availability of water to wetlands but could result in overall negative effects on wetlands. These alternatives would likely increase the formation of new wetlands but potentially would result in conversion and replacement of existing wetland types (e.g., scrub/shrub to emergent wetlands and forested wetlands to scrub/shrub), and would result in other adverse effects on existing wetland functions. Some wetland habitats would be converted in a way that would make recovery a long process or unlikely (e.g., loss of forested wetlands and loss of buttonbush swamps). Because of the geographic extent and importance of these wetland resources, this could constitute a substantial adverse cumulative impact. Under the Preferred Alternative, potential impacts on wetlands have been substantially reduced compared to the other action alternatives; but there could still be an adverse cumulative impact on wetland resources in the Tennessee Valley region. To the extent practicable, potential impacts on wetlands may be mitigated using the approaches described in Chapter 7, thereby reducing their potential for long-term cumulative impacts. The effectiveness of the mitigation measures may be limited, however, and long-term cumulative impacts could continue.

6.2.6 Terrestrial Ecology

TVA evaluated lowland and upland plant and wildlife communities in areas along TVA reservoirs and tailwaters. The analysis found that these communities have adapted to the current operations of the water control system. Long-term changes in these communities are expected as a result of natural succession and changes in wetlands (see wetland discussion above), and from other construction and development activities as well as recreational pressures. These impacts would be slow and may be offsetting; therefore, broad cumulative effects may not occur. Cumulative effects are possible, at least in the short term, on shorebirds and migratory waterfowl and the plant communities of flats habitats—in addition to the potential loss of control of gravity-maintained dewatering units on wildlife refuges on affected reservoirs. Impacts would be of greatest concern if they occurred during critical migratory periods. Cumulative effects may result from adverse impacts on managed areas and wetland habitats—both important habitats for these bird populations. The Preferred Alternative and the Commercial Navigation Alternative are expected to result in a lower level of impacts on plant and animal populations than the other action alternatives; however, impacts under both these alternatives would be greater than those observed under the Base Case. Due to the instability of reservoir levels and the projected negative changes in wetland communities, the Summer Hydropower Alternative would result in the most extensive adverse cumulative impacts on the terrestrial ecology of the region.

6.2.7 Vector Control

The annual cycle of reservoir mosquito populations is a long-term, persistent issue throughout the Valley. The mosquito is a pest species with disease-transmission potential, and management to minimize mosquito populations is ongoing in the region. Management programs and natural variation in the availability of breeding habitat are expected to control mosquito populations at existing levels, and cumulative impacts are unlikely. Implementation of any action alternative, except the Summer Hydropower Alternative or the Commercial Navigation Alternative, is expected to increase the availability of mosquito breeding habitat—allowing some potential increase in mosquito populations. These increases would be small and are not expected to be cumulative. (See Chapter 7 for potential mitigation actions.)

6.2.8 Threatened and Endangered Species

A number of federal- and state-listed threatened and endangered species inhabit areas in and adjacent to the reservoirs and stream reaches of the water control system. Most of these species are found in aquatic habitats, including warm tributary tailwaters, flowing mainstem reaches, some pooled reservoirs, and some cool-to-warm tributary tailwaters. As indicated by their classification as threatened and endangered, many of these species are in a state of long-term decline and require protection. Plans to protect their habitat and assist in their recovery have been implemented for some species and are being developed for others. Cumulative impacts on such species are usually related to further degradation of habitat from development and disturbance.

Because construction of new facilities and additional land disturbance are not proposed under any policy alternative, direct or incremental cumulative impacts on terrestrial habitat would not occur. Changes to reservoir operations under policy alternatives may alter reservoir levels, water flows, and some water quality parameters—especially temperature and DO. These changes have the potential to result in adverse impacts on federal-listed threatened and endangered species; however, the level of impact would be small and not enough to jeopardize the continued existence of these species. Potential cumulative impacts on federal-listed species should be reduced because the Endangered Species Act requires that federal agencies not take actions that would jeopardize the continued existence of listed species and prohibits the “taking” of listed species by individuals.

6.2.9 Managed Areas and Ecologically Significant Sites

Managed areas and ecologically significant sites are designated to protect and manage sensitive resources that are typically linked with wetlands, bottomland hardwood forests, and other important habitats. As protected areas, they are managed to preserve the resource value for which they were designated. TVA’s evaluation of these areas did not identify long-term trends in their condition. Implementation of either the Summer Hydropower Alternative or the Equalized Summer/Winter Flood Risk Alternative would likely cause some adverse impacts on a number of areas. Implementation of any of the other policy alternatives, including the Preferred Alternative, would result in slightly adverse to slightly beneficial impacts on managed areas. Because of the minimal nature of these changes and because these areas are affirmatively protected, future cumulative impacts are unlikely.

6.2.10 Shoreline Erosion

TVA’s evaluation found that natural erosion processes (rain, wind, runoff, and streamflow), recreational boating, fluctuating reservoir levels, and shoreline land development would continue the present trend of erosion of reservoir and tailwater shorelines. TVA management programs may reduce these rates in some areas, while increased recreational activities and land development may increase erosion in other areas. The contribution of land development to overall cumulative impacts would be limited, as the SMI is designed to limit the maximum extent of residential shoreline development to 38 percent or less. The continuing effects of shoreline erosion may include further loss of shoreline habitat, changes to water quality, and impacts on cultural resources and visual integrity. Together, these impacts could be considered cumulative.

Implementation of Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, or the Tailwater Habitat Alternative has the potential to substantially increase reservoir shoreline erosion system wide, with more extensive impacts on the tributaries than on the mainstem reservoirs. These alternatives would result in potential adverse impacts that, together with erosion of backlands and land development, may result in some cumulative erosion impacts. Shoreline erosion resulting from changes in the operations policy is expected to be a minor contribution to total land erosion. These potential impacts may be mitigated using the approaches described in Chapter 7, thereby avoiding or reducing their potential for long-term cumulative effects.

In contrast, the Summer Hydropower Alternative and Equalized Summer/Winter Flood Risk Alternative would substantially decrease shoreline erosion, resulting in cumulative beneficial effects on shoreline erosion. The Commercial Navigation Alternative is expected to have little impact on shoreline erosion. The Preferred Alternative would result in minor increases in erosion, contributing in a small way to adverse cumulative impacts.

6.2.11 Cultural Resources

The integrity of cultural resources (archaeological sites and historic structures) is affected by a number of factors directly and indirectly related to the reservoir operations policy, resulting in the potential for cumulative effects. These factors include soil erosion by rainfall, streamflow, and wave action from wind and recreational boat traffic; exposure by elevation fluctuations; development of the shoreline and back-lying lands; changes to the viewshed; and looting/vandalism or disturbance from recreational activities. TVA's evaluation of cultural resources found that ongoing shoreline land development and shoreline erosion are expected to continue long-term potentially cumulative adverse impacts on the integrity of cultural resources on shoreline and near-shore reservoir bottom areas. These impacts are anticipated to occur regardless of the reservoir operations policy alternative selected.

Implementation of Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, or the Preferred Alternative would cause additional adverse impacts—which would increase the potential for cumulative impacts compared to the Base Case. Among the preceding alternatives, the potential for cumulative impacts would be least under the Preferred Alternative. Potential adverse impacts would be reduced using the approaches described in Chapter 7, thereby reducing their potential for long-term cumulative effects.

Because they would reduce shoreline erosion, the Commercial Navigation Alternative, Summer Hydropower Alternative, and Equalized Summer/Winter Flood Risk Alternative would result in neutral to beneficial impacts on cultural resource sites and would reduce the potential for long-term adverse cumulative effects.

6.2.12 Flood Control

Requirements for storage of flood waters in TVA reservoirs to minimize flood damage during flood events were determined from evaluation of potential floodflows, based on a 99-year historical record and additional consideration of very large storm events. Except for the Base Case, detailed analyses indicated that all of the action alternatives evaluated in the DEIS would result in unacceptable increases in the risk of flooding at one or more critical locations in the Valley. A central component in formulating the Preferred Alternative was risk of flood damages. By modifying individual project flood guides and/or regulating zones, the overall potential for increased flood damage was reduced immediately downstream from each project as well as downstream at damage centers.

Extensive land development has the potential to change the volume and rate of runoff from rainfall in the Tennessee River basin. Localized areas of rapid development could result in changes to local runoff characteristics. The changes in basin-wide land use anticipated through 2030, however, are not expected to result in watershed runoff characteristics that would change the outcome of future flood events. Therefore, no cumulative impacts related to flood risk are expected under the Preferred Alternative.

6.2.13 Visual Resources

Cumulative impacts on visual resources of the TVA reservoir system could result from interaction among shoreline erosion, shoreline development, and the effects of a reservoir operations policy that may interact to degrade scenic integrity. Continued development along TVA reservoirs and tailwaters would generally affect scenic quality regardless of the policy alternative implemented. Development standards and controls may reduce such impacts, but continued development of shorelines would result in visual resource impacts that are considered unavoidable and cumulative. Scenic quality is also affected by shoreline erosion and the exposure of reservoir bottoms during periods of lower reservoir pool levels, but this is already occurring under the existing operations policy.

The interplay among these variables produces little potential for cumulative impacts on visual resources under any alternative because the directions of the impacts do not correspond. For example, the Tailwater Habitat Alternative—the alternative with the highest potential for increasing shoreline erosion and related impacts on visual integrity—also would result in a substantially beneficial effect on scenic integrity due to longer duration at higher pool levels and less fluctuation in pool levels. Except for the Summer Hydropower Alternative and the Equalized Summer/Winter Risk Alternative, all of the action alternatives, including the Preferred Alternative, were found to benefit scenic quality by reducing the size of the shoreline ring effect and amount of exposed reservoir bottoms.

The Summer Hydropower Alternative has the greatest potential to cause cumulative adverse effects on visual resources because it would generally result in the greatest exposure of reservoir bottoms, flats, and the shoreline ring throughout the reservoir system.

6.2.14 Recreation

Recreation and use of recreation resources are generally expected to increase in the future, in relation to regional population growth. All action alternatives except the Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative would result in increased recreational use, primarily as a result of higher reservoir levels or more predictable tailwater releases. Increases in recreation use under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, or the Tailwater Habitat Alternative would be greater than under the Summer Hydropower Alternative or Preferred Alternative. The Preferred Alternative is expected to enhance recreation uses but to a lesser extent than the other alternatives that would enhance recreation use. The Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative are expected to reduce recreation use due to reduced summer and fall reservoir levels and tailwater flows, and could contribute to adverse cumulative effects on recreation uses.

6.3 Cumulative Impacts Associated with Future Projects

The preceding future trends discussion addresses the cumulative impacts that could result from implementing various operations policy alternatives and activities generally occurring throughout the TVA region. At the regional level, specific projects or actions could contribute to cumulative effects.

6.3.1 Identification of Future Projects

A three-step process was used to identify future projects to be included in the cumulative impact analysis. This process included:

- **Identification of Reasonably Foreseeable Projects (Actions).** Candidate projects were identified by reviewing published notices related to the preparation of environmental documents. The USEPA clearinghouse for NEPA compliance and state agency administrative dockets for the period from 1995 to 2002 were searched for: Notices of Intent to Prepare an Environmental Review, Notices of Availability of Draft and Final Environmental Documents, Findings of No Significant Impact, and Notices of No Practical Alternative to Impacting Wetlands or Floodplains. These lists were searched to identify reasonably foreseeable projects with potential cumulative effects in the Tennessee River watershed. This search identified 161 listings, which were reviewed and evaluated for their relevance. From this review, 31 candidate projects were selected based on their location, size, and status.

- **Review of Candidate Cumulative Projects.** Abstracts for candidate projects were reviewed and evaluated to determine whether a project met criteria for potential regional cumulative impact. Projects were considered that had been approved and not yet implemented or constructed, and projects for which a notice to proceed with environmental review had been issued. Projects in construction or that had completed construction but not yet begun operation were also considered. Projects being discussed but for which no action had yet been taken were considered speculative and were not included.

- **Selection of Projects for Cumulative Analysis.** Based on the scope, status, and potential cumulative effect of those projects reviewed, TVA selected the following projects for evaluation of potential cumulative effects:

– TVA land management plans
– Other land development programs
– U. S. Forest Service land and resource management plans
– TVA hydro modernization projects
– Hydroelectric projects licensed by the Federal Energy Regulatory Commission (FERC)

The specific projects identified for cumulative impact analysis are listed in Table 6.3-01. This table also summarizes the types of impacts that may be associated with each project.

6.3.2 Cumulative Impacts Associated with TVA Land Management Plans

TVA has developed and implemented reservoir land management plans (LMPs) for the areas surrounding a number of its reservoirs. To the extent these plans have been adopted and implemented by TVA, they were considered part of the existing environment and were included in the Base Case.

As part of the review of future projects, plans for 13 TVA reservoirs were identified (see Table 6.3-01). These plans include management of areas ranging from 66,651 acres at Kentucky Reservoir and 40,236 acres at Guntersville Reservoir to 880 acres on Boone Reservoir and 2,578 acres on Melton Hill Reservoir. Generally, these are multi-use plans designating areas for resource conservation and management, and for residential and commercial/industrial access and development. In all of the LMPs, except those for Kentucky and Wheeler Reservoirs, approximately 75 percent of the TVA land evaluated by the reservoir land planning process has been allocated for resource management and conservation. Allocations for specific uses have not yet been made in the Kentucky and Wheeler Reservoir plans. To the extent that the development occurs along reservoir shorelines, it was included in the SMI assessment of maximum buildout (see Section 4.15, Land Use). In addition, adopted SMI policies, including amendments to TVA's Section 26a permitting regulations, would substantially reduce the potential for cumulative impacts. Although implementation of the LMPs would result in some loss of habitat, these plans also would provide a cumulative increase in the availability of regional recreational facilities and enhanced protection of natural resources, including sensitive resources.

Table 6.3-01 Summary of Projects Included in the Cumulative Analysis

No.	Project	Description of Location	Resources Affected
1	Guntersville Reservoir Land Management Plan	Land Management Plan for 40,236 acres on Guntersville Reservoir. The plan includes 5,079 acres for project operations, 32,584 acres for resource management and conservation, 327 acres for industrial access or commercial use, 1,704 acres for recreational uses (such as campgrounds and parks), and 543 acres for residential lake access.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion Ecological Resources – protection of species/habitat in areas designated for resource management Recreation – increased recreation access and facilities Visual Resources – protection of visual resources
2	Tellico Reservoir Land Management Plan	Land Management Plan for 12,643 acres of TVA land on Tellico Reservoir. The plan designates 635 acres for project operations, 9,320 acres for resource management and conservation, 332 acres for industrial access or commercial use, 1,804 acres for recreational uses (campgrounds, parks, and public access areas), and 552 acres for residential lake access. Also includes designation of greenway and river corridor areas for resource protection.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion Ecological Resources – protection of species/habitat in areas designated for resource management Recreation – increased recreation access and facilities Visual Resources – protection of visual resources
3	Tims Ford Reservoir Land Management Plan	Land Management Plan for 6,453 acres of state and federal lands on Tims Ford Reservoir. The plan designates 386 acres for project operations, 4,573 acres for resource management and conservation, 67 acres for industrial/commercial development, 573 acres for recreational uses (campgrounds, parks, and public access areas), and 864 acres for residential access.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion Ecological Resources – protection of species/habitat in areas designated for resource management Recreation – increased recreation access and facilities Visual Resources – protection of visual resources

Table 6.3-01 Summary of Projects Included in the Cumulative Analysis (continued)

No.	Project	Description of Location	Resources Affected
4	Boone Reservoir Land Management Plan	Land Management Plan for 880 acres of TVA land on Boone Reservoir. The plan designates 209 acres for project operations, 594 acres for resource management and conservation, 76 acres for recreational uses (campgrounds, parks, and public access areas), and 1 acre for residential access.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion Ecological Resources – protection of species/habitat in areas designated for resource management Recreation – increased recreation access and facilities Visual Resources – protection of visual resources
5	Melton Hill Reservoir Land Management Plan	Land Management Plan for 2,578 acres of TVA land on Melton Hill Reservoir. The plan designates 294 acres for project operations, 1,890 acres for resource management and conservation, 22 acres for industrial/commercial development, 221 acres for recreational uses (campgrounds, parks, and public access areas), and 151 acres for residential lake access.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion Ecological Resources – protection of species/habitat in areas designated for resource management Recreation – increased recreation access and facilities Visual Resources – protection of visual resources
6	Bear Creek Reservoirs Land Management Plan (Upper Bear Creek, Bear, Little Bear Creek, and Cedar Creek Reservoirs)	Land Management Plan for 9,178 acres of TVA land on the four Bear Creek Reservoirs. The plan designates 851 acres for project operations, 7,456 acres for resource management and conservation, 14 acres for industrial/commercial development, 616 acres for recreational uses (campgrounds, parks, and public access areas), and 241 acres for residential lake access.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion Ecological Resources – protection of species/habitat in areas designated for resource management Recreation – increased recreation access and facilities Visual Resources – protection of visual resources

Table 6.3-01 Summary of Projects Included in the Cumulative Analysis (continued)

No.	Project	Description of Location	Resources Affected
7	Norris Reservoir Land Management Plan	Land Management Plan for 27,927 acres of TVA land on Norris Reservoir. The plan designates 934 acres for project operations, 23,776 acres for resource management and conservation, 1,744 acres for recreational uses (campgrounds, parks, and public access areas), and 1,473 acres for residential lake access.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion Ecological Resources – protection of species/habitat in areas designated for resource management Recreation – increased recreation access and facilities Visual Resources – protection of visual resources
8	Cherokee Reservoir Land Management Plan	Land Management Plan for 8,026 acres of TVA land on Cherokee Reservoir. The plan designates 542 acres for project operations, 6,615 acres for resource management and conservation, 601 acres for recreational uses (campgrounds, parks, and public access areas), and 268 acres for residential lake access.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion Ecological Resources – protection of species/habitat in areas designated for resource management Recreation – increased recreation access and facilities Visual Resources – protection of visual resources
9	Pickwick Reservoir Land Management Plan	Land Management Plan for 19,238 acres of TVA land on Pickwick Reservoir. The plan designates 2,861 acres for project operations, 13,431 acres for resource management and conservation, 534 acres for industrial/commercial development, 1,327 acres for recreational uses (campgrounds, parks, and public access areas), and 1,085 acres for residential lake access.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion Ecological Resources – protection of species/habitat in areas designated for resource management Recreation – increased recreation access and facilities Visual Resources – protection of visual resources

Table 6.3-01 Summary of Projects Included in the Cumulative Analysis (continued)

No.	Project	Description of Location	Resources Affected
10	Chickamauga Reservoir Land Management Plan	Land Management Plan for 12,862 acres of TVA land on Chickamauga Reservoir. The plan designates 337 acres for project operations, 8,653 acres for resource management and conservation, 46 acres for industrial/commercial development, 899 acres for recreational uses (campgrounds, parks, and public access areas), and 2,927 acres for residential lake access.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion Ecological Resources – protection of species/habitat in areas designated for resource management Recreation – increased recreation access and facilities Visual Resources – protection of visual resources
11	Watts Bar Reservoir Land Management Plan	Land Management Plan for 11,121 acres of TVA land on Watts Bar Reservoir. The plan designates 586 acres for project operations, 7,394 acres for resource management and conservation, 142 acres for industrial/commercial development, 644 acres for recreational uses (campgrounds, parks, and public access areas), and 2,355 acres for residential lake access.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion Ecological Resources – protection of species/habitat in areas designated for resource management Recreation – increased recreation access and facilities Visual Resources – protection of visual resources
12	Kentucky Reservoir Land Management Plan	The Kentucky Reservoir Land Management Plan designated 66,651 acres for multiple uses. This reservoir has not been allocated into specific zones.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion
13	Wheeler Reservoir Land Management Plan	Wheeler Reservoir Land Management Plan designated 28,004 acres for multiple uses. This reservoir has not been allocated into specific zones.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion
14	Use of Columbia Dam Project Lands	On the Duck River, upstream of the former Columbia Dam site, approximately 13,000 acres of TVA land was transferred to the State of Tennessee for management. Up to 2,000 acres are available for residential development; 3,800 acres for a possible water supply reservoir; remaining acreage was set aside for resource protection, wildlife management, and recreation.	Ecological Resources—direct impacts on resources from development of 2,000 acres but protection of natural resources on remaining 7,200 acres and possibly 3,800 more acres if water supply reservoir not developed Visual Resources – protection of visual resources

Table 6.3-01 Summary of Projects Included in the Cumulative Analysis (continued)

No.	Project	Description of Location	Resources Affected
15	U.S. Forest Service Land and Resource Management Plans	Land and resource management plans are being revised or proposed for the six national forests that are in proximity to the Tennessee Valley. Draft plans for Cherokee and Chattahoochee-Oconee National Forests and all national forests in Alabama, including Bankhead, indicate that a greater emphasis will be placed on forest restoration, recreation, and wildlife while allowable timber harvest acreage will be decreased. The proposed forest plan for Daniel Boone reflects similar goals of improved habitat biodiversity, riparian areas, fire management, and old-growth forest stands while reducing timber harvest volumes. Revision of land management plans for Land between the Lakes and Nantahala/Pisgah are still in the planning stages.	Ecological Resources – protection of natural resources and restoration of habitat biodiversity Aquatic Resources – increased protection of watersheds, reduced sediment loads, and increased abundance of local aquatic species Recreation – increased backcountry recreation, trails and dispersed recreation areas Visual Resources – protection of scenic areas, corridors, and sensitive viewsheds
16	TVA Hydro Modernization Projects	Hydro modernization efforts were initiated in 1992 to upgrade hydropower units in the TVA power system (see Section 3.3.1). Modification projects would address several types of upgrades, including increased efficiency and electrical output, and modifications to improve DO concentrations.	Power – increased generation capacity in the region Water Quality – management of low DO levels in hydro unit discharge Ecological Resources – benefits to downstream habitat from changes in water quality
17	Hydroelectric Projects Licensed by the Federal Energy Regulatory Commission	Hydroelectric projects are now in the relicensing process in the upper Tuckaseegee, Nantahala, and Little Tennessee Rivers. Duke Power's Nantahala Area Projects include the Bryson Project (FERC No. 2601), Dillsboro Project (FERC No. 2602), Franklin Project (FERC No. 2603), Mission Project (FERC No. 2619), East Fork Project (FERC No. 2698), West Fork Project (FERC No. 2686), and Nantahala Project (FERC No. 2692). Tapoco's Tapoco Project (FERC No. 2169) is a four-development hydroelectric project located on the Little Tennessee and Cheoah Rivers in eastern Tennessee and western North Carolina that includes Santeetlah, Cheoah, Calderwood, and Chilhowee.	Land development acreage is limited by SMI policy, with reduced potential for increased erosion Ecological Resources – protection of species/habitat in areas designated for resource management Recreation – increased recreation access and facilities Visual Resources – protection of visual resources

Notes: FERC = Federal Energy Regulatory Commission. SMI = Shoreline Management Initiative. DO = Dissolved oxygen.

Because none of the action alternatives proposes development or preservation of any land areas, direct cumulative impacts of policy alternatives in concert with implementation of TVA LMPs is not expected to occur. To the extent that both implementation of policy alternatives and any of the LMPs would indirectly affect an environmental resource, cumulative effects may occur. The loss of terrestrial and shoreline habitat from development under an LMP and increased impacts on wildlife resources from implementation of a policy alternative may result in a small cumulative effect on wildlife species. Many of these potential cumulative impacts are likely to be reduced by the resource protection benefits of TVA's reservoir LMPs.

6.3.3 Cumulative Impacts Associated with Other Land Development Programs

Continuing development and urbanization throughout the Valley would occur over the planning period. Where and when these activities would occur cannot be predicted, but they are certain to occur in light of population growth trends in the Southeast. In aggregate, this development may result in regional cumulative impacts, such as reduction in habitat, changes in surface water runoff, increased water use, and increased wastewater for disposal. None of the policy alternatives proposes the development of any new facilities; therefore, no direct impacts associated with development and urbanization would occur that could be considered cumulative. In addition, new development that may be expected to occur adjacent to TVA reservoirs has been included as part of the Base Case and was considered in the impact analyses for relevant resources.

The review of future projects identified one large land development program that is located upstream of TVA 's former Columbia Dam site. This 12,800-acre site was transferred to the State of Tennessee for management. Under the State's plan, approximately 2,000 acres are planned for residential development. The remaining area would be primarily set aside for wildlife management. While implementation of this development plan would remove as much as 2,000 acres of natural habitat, it would preserve other natural areas that are very important habitats for a number of sensitive resources, including species listed as threatened or endangered. No materially adverse cumulative impacts are expected to occur from implementation of any policy alternative in concert with this land development program.

6.3.4 Cumulative Impacts Associated with U.S. Forest Service Land Management Plans

Because national forest lands comprise large blocks of undeveloped acreage proximate to the Tennessee Valley region, management plans for nearby forests were reviewed for potential cumulative impacts. These federally managed lands include Cherokee National Forest in Tennessee, Nantahala/Pisgah National Forests in North Carolina, Chattahoochee-Oconee National Forests in Georgia, Bankhead National Forest in Alabama, Daniel Boone National Forest in Kentucky, and Land between the Lakes National Recreation Area in Tennessee and Kentucky.

The National Forest Management Act (NFMA) requires national forests to be managed under forest or land management plans that must be periodically revised. Three of the above national forests (Cherokee; Chattahoochee-Oconee; and all national forests in Alabama, including

Bankhead) are currently undergoing land management plan revisions. This is part of a collaborative effort among five forests to develop a more consistent management approach to improving forest health, productivity, and public enjoyment of national forests in the Southern Appalachians. This new approach to developing forest plans will use the findings of the Southern Appalachian Assessment (USDA Forest Service 1996) to identify common issues and management prescriptions across all Southern Appalachian forests. These common goals will be incorporated into each proposed management plan, along with any unique issues specific to individual forests. Drafts of management plans and DEIS documents for these three forests were released in March 2003; maintaining and restoring healthy forests was identified as the most significant goal of the revised plans (USDA Forest Service 2003a). Although these management documents are still being developed, they include such changes as more focus on ecological habitat protection and restoration, protection of old-growth forests, watershed health, and wilderness benefits while decreasing annual timber harvests. The proposed changes represent a shift from balanced-age timber management to an emphasis on the health of existing forest stands and restoration of forest ecosystems (USDA Forest Service 2003b, 2003c, 2003d).

The Daniel Boone DEIS and Proposed Revised Land and Resource Management Plan that was released in April 2003 reflects a similar shift in goals and management direction, including new prescriptions for habitat biodiversity and riparian areas, reduction in timber harvest volume, better understanding of fire habitat needs, and increased progression to old-growth stands (USDA Forest Service 2003e). New land and resource management plans are proposed to be released in 2004 for Land between the Lakes and in 2008/2009 for Nantahala/Pisgah National Forests. Current trends indicate a positive impact on regional land and water resources from U.S. Forest Service management activities, and no substantial adverse cumulative impacts relating to TVA's proposed action are anticipated.

6.3.5 Cumulative Impacts Associated with Hydro Modernization Projects

TVA is in the process of modernizing its hydropower facilities throughout the water control system. The potential impacts of these activities were addressed in TVA's Energy Vision 2020 EIS (1995). HMOD projects that were designed and funded, implemented, or completed on or before October 2001 are considered in this EIS as part of the Base Case (see Appendix A, Table A-09). The projects considered but not designed or implemented as of October 2001 are considered in the cumulative impacts analysis. These projects are listed in Table 6.3-02. The purpose of the HMOD projects is to increase the effective output and operational flexibility of these units; nevertheless, in most circumstances, an increase in discharge flow rate would occur during operations (as noted in Table 6.3-02).

The direct impact of modernized units would be increased flows. This may cause changes in river hydrology at run-of-river projects during operation of upstream hydropower units. These projects would include the reaches below Wheeler, Ocoee #3, Watauga, Blue Ridge, and Wilbur Reservoirs. The increased flows are not expected to be outside the range of flows that would otherwise occur at these projects; therefore, the direct impacts related to flows would not cumulatively be greater than impacts already assessed in each relevant resource area under the Base Case.

Table 6.3-02 Hydro Modernization Projects Considered in Cumulative Impact Analysis

Power Plant	Status in October 2001	Receiving Water	Planned Changes	Flow Increase
Cherokee (Units 1–4)	Phase 1	Mainstem storage	High efficiency, low flow	Yes
Wheeler (Units 1–8)	Phase 1	Mainstem run-of-river	High efficiency, low flow	Not expected
Wilson (Units 19–21)	Phase 1	Mainstem storage	Increased efficiency/capacity	Expected
Fort Loudoun (Units 1–2)	Not started	Mainstem storage	Increased efficiency/capacity	Mix
Wilson (Units 1–4)	Not started	Mainstem storage	High efficiency	Yes
Wilson (Units 5–8)	Not started	Mainstem storage	High efficiency	Yes
Ocoee #3 (Unit 1)	Not started	Tributary run-of-river	Increased efficiency/capacity	Yes
Nickajack (Units 3–4)	Not started	Mainstem storage	Increased efficiency/capacity	Yes
South Holston (Unit 1)	Not started	Tributary storage	Increased efficiency/capacity	No
Melton Hill (Units 1–2)	Not started	Mainstem storage	Increased efficiency/capacity	No
Watauga (Units 1–2)	Not started	Tributary run-of-river	Increased efficiency/capacity	Yes
Blue Ridge (Unit 1)	Not started	Tributary run-of-river	Increased efficiency/capacity	Yes
Wilbur (Units 1–4)	Not started	Tributary run-of-river	Increased efficiency/capacity	Insignificant

Increased flows for modernized hydropower units discharging to mainstem and tributary storage reservoirs could affect water quality (principally by changes in temperature in the receiving waters). The incremental increase in discharge volume from modernized units would be small when compared to overall discharge volume and would be within the normal range of variation for release volumes, such that water quality is unlikely to be changed and no cumulative impact is likely to result.

Increased power generation capacity would allow production of additional electrical energy with the same amount of water. The TVA reservoir system currently has approximately 3,842 MW of hydropower capacity (not including Raccoon Mountain). Although this capacity would be increased through modernization efforts; actual hydrologic conditions and operations of the water control system in any given year would determine the cumulative increase in electrical production. Because TVA hydropower units are often operated during periods of peak demand, increased electrical output from hydropower production could reduce the requirements for energy from fossil-fired peaking units on the TVA power system. The cumulative effects of this offset could be to displace some peak fossil production. Displacing peak fossil production with incremental hydropower production could reduce air emissions from power production. The incremental offset of fossil generation is likely to be small, however, and would occur only if no long-term increase in overall peak energy growth occurs. It is unlikely that a cumulative reduction in air emissions from incremental hydropower production as a result of modernization would occur.

6.3.6 Cumulative Impacts Associated with Hydroelectric Projects Licensed by the FERC

A number of hydroelectric projects in the Tennessee Valley are operating under licenses authorized by the FERC. Some of these projects are now in the process of being relicensed, a multi-year process that includes engineering and operations review of the project; consultation with relevant federal and state natural resources agencies, Indian tribes, and state water quality agencies; resource studies; and environmental and economic analyses. The process culminates with the submittal of a license application to the FERC, development of a NEPA compliance document (EA or EIS), and a decision by the Commission as to the term and operating conditions of the license. The relicensing process typically results in the issuance of a new license for operation of the project for the next 30 to 50 years under new operating conditions and with new operations and other measures for the protection, mitigation, and enhancement of environmental resources.

Several hydroelectric projects are now in the relicensing process in the upper Tuckaseegee and Nantahala Rivers, two major tributaries of Fontana Reservoir, and in the Little Tennessee River downstream of Fontana Reservoir.

- **Nantahala Area Projects.** Duke Power is relicensing its Nantahala Area projects, including 10 hydroelectric stations and 12 reservoirs on the Hiwassee, Nantahala, Oconaluftee, and Tuckasegee Rivers in western North Carolina. These include the Bryson Project (FERC No. 2601), Dillsboro Project (FERC No. 2602), Franklin Project (FERC No. 2603), Mission Project (FERC No. 2619), East Fork Project (FERC No. 2698), West Fork Project (FERC No. 2686), and Nantahala Project (FERC No. 2692).

- **Tapoco Project.** Tapoco, a division of the Alcoa Power Generating Inc (APGI), is relicensing its Tapoco Project (FERC No. 2169), a four-development hydroelectric project located below Fontana Reservoir on the Little Tennessee and Cheoah Rivers in eastern Tennessee and western North Carolina. The four developments that comprise the project are Santeetlah, Cheoah, Calderwood, and Chilhowee.

These hydroelectric projects are well along in the licensing process, and the licensing process for these projects has included the development of draft settlement agreements with the resource agencies and other participants. These settlement agreements are not yet finalized, and the FERC must make its own independent analysis and issue the licenses. Based on the draft settlement agreements to date and the history of recent relicensing process at other hydroelectric projects, the new licenses for the Nantahala Area and Tapoco Projects would likely contain protection, mitigation, and enhancement measures. These would include such measures as improvement and enhancement of recreational access and opportunity, new minimum flows that would improve aquatic habitat and benefit fish and wildlife, protection of historical and cultural resources, and other environmental enhancements. Consequently, the relicensing of these projects would contribute in a positive way to beneficial cumulative impacts.

Duke Power and Tapoco projects are both located in the headwaters of the TVA region, and their total water storage volume is very small relative to the TVA reservoir system. Due to their size and location, there is limited potential for adverse cumulative effects on TVA's operations or flood risk.

Chapter 7

Potential Mitigation Measures

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7.1. Introduction

The National Environmental Policy Act and its implementing regulations require that an EIS identify appropriate mitigation measures for the adverse impacts potentially resulting from a proposed action. Mitigation measures are actions that could be taken to avoid, offset, reduce, or compensate for adverse effects to the environment.

The purpose of this chapter is to describe the programmatic framework within which mitigation measures would be implemented and to identify and describe the mitigation measures that TVA may implement if the Preferred Alternative is implemented. After issuance of the FEIS, reviewing public comments on the FEIS, and a decision from the TVA Board, TVA will identify those mitigation measures to be implemented in its Record of Decision for this action.

> **MITIGATION**
>
> NEPA defines mitigation as actions taken to avoid, reduce the severity of, or eliminate an adverse impact. Mitigation can include:
>
> - Avoiding impacts;
> - Minimizing impacts by limiting the degree or magnitude of the action;
> - Restoring or rehabilitating the affected environment;
> - Reducing or eliminating impacts over time; and,
> - Compensating by providing offsetting resources or environments.

Because the ROS is a programmatic action that takes place over a multi-state region covering the entire integrated reservoir system, TVA's mitigation approach also is appropriately scaled to a programmatic, reservoir-system level. TVA will rely heavily on its existing resource management programs to detect and track environmental changes that may occur and to implement identified mitigation measures.

This chapter is organized into three parts. Section 7.2 describes the need and context for a programmatic approach to mitigation. Section 7.3 presents an overview of TVA's management programs, which provide a framework for mitigation, monitoring, reporting, and enforcement. Section 7.4 describes the steps that TVA has taken during development of the Preferred Alternative to avoid and minimize environmental effects. That section also outlines the actions TVA may take to detect and track environmental changes and to mitigate adverse resource impacts if the Preferred Alternative is implemented.

7.2. Programmatic Approach to Mitigation

Mitigation for a policy action differs considerably from mitigation for a specific project. This is especially true for an operations policy that affects a large geographic area and the large number of waterbodies in the TVA reservoir system. In contrast with project-specific impacts, which may be readily delineated and quantified, some policy impacts can be diffuse, difficult to predict, may or may not occur as anticipated, and may develop over a long period of time. The prediction of environmental impacts, always an inexact science, is even more difficult for large-scale actions such as reservoir operations. Consequently, monitoring and an adaptive response can be important components of a programmatic mitigation plan.

TVA's reservoir operations policy permits an adaptive response that has included substantial monitoring of environmental parameters, evaluation of ongoing environmental impacts, and mitigation of impacts. Under the Reservoir Release Improvement (RRI) Program, TVA has restored concentrations of DO in over 300 miles downstream of 16 projects. TVA has also established minimum flow requirements at 25 sites. Required structural modifications were completed in 1996, but ongoing operational aspects of the program could be modified to help mitigate low DO concentrations and flow problems in project releases.

In addition, the numerous statutes and implementing regulations that are presented in Chapter 4, Description of Affected Environment, can substantially affect the impacts relating to alternative reservoir operations policies. Chapter 5, Environmental Consequences of the Alternatives, provides the impact analysis and conclusions concerning compliance with these regulations and statutes; these are summarized in this chapter, as appropriate.

7.3. TVA Management Programs—Providing a Framework for Mitigation

TVA has developed numerous policies and programs to protect and enhance natural resources; these programs are the logical institutional framework for implementing mitigation actions. TVA presently manages and administers a wide variety of programs, initiatives, public outreach, and other individual measures designed to monitor, protect, maintain, and enhance the quality of the environment within the TVA reservoir system (Table 7.3-01). These activities range from monitoring programs such as the Vital Signs Reservoir Ecological Health Monitoring Program, to the development of reservoir land management plans and implementation of the Clean Water Initiative. As impacts are identified, existing TVA programs can be changed to better address substantive adverse impacts. Table 7.3-01 outlines a number of TVA program elements and activities relevant to monitoring and mitigation activities. These programs and activities were considered in the development of mitigation measures for the Preferred Alternative.

Table 7.3-01 TVA Program Elements and Activities Relevant to Mitigation

TVA Program or Activity	TVA Programs and Activities Relevant to Mitigation Strategies
Section 26a permitting process – Requires obtaining TVA approval before putting obstructions on or along Tennessee River system	• This process addresses construction, maintenance, and operation of facilities and activities on, over, or along the Tennessee River and its tributaries. This includes residential shoreline structures, non-navigable houseboats, and intakes and outfalls. • TVA Watershed Teams are responsible for implementation of Section 26a. • Permit recipients are required to follow the construction procedures and environmental protection measures specified. • For non-routine projects or actions, Environmental Assessments (EAs) or Environmental Impact Statements (EISs) are completed in addition to the Section 26a permitting process.
Reservoir Land Management Planning – Defines allowable areas for residential, commercial, and industrial shoreline development on TVA property	• Land Management Plans (LMPs) are approved by the TVA Board of Directors and implemented by the Watershed Teams. • Each LMP includes provisions for shoreline management, land use, protection, and monitoring. The whole reservoir is considered in the plan. • Each LMP is developed with extensive interagency and public review.
Reservoir Release Improvement Program – TVA's Program, completed in 1996, to improve dissolved oxygen (DO) and increase water levels in tailwaters from minimum flows	• TVA uses a wide range of methods to improve DO concentrations. In some cases, more than one approach is necessary to reach oxygen targets (6 milligrams per liter of water in cold-water tailwaters, and 4 milligrams per liter in warm-water tailwaters), which include turbine venting, surface water pumps, oxygen injection systems, aerating weirs, and air compressors and blowers. • TVA uses three different technologies to maintain minimum water level in the riverbed below tributary dams, including turbine pulsing, weirs, and small hydroelectric units.

Table 7.3-01 TVA Program Elements and Activities Relevant to Mitigation (continued)

TVA Program or Activity	TVA Programs and Activities Relevant to Mitigation Strategies
Vital Signs Reservoir Ecological Health Monitoring Program – TVA's program to systematically monitor the ecological condition of its reservoirs	• This monitoring program provides the necessary information from five key indicators (chlorophyll-a, DO, fish assemblage, benthic macroinvertebrates, and sediment contaminants) to evaluate conditions in reservoirs and to target detailed assessment studies if significant problems are found. In addition, this information establishes a baseline for comparing future water quality conditions in TVA's reservoirs. • TVA monitors ecological conditions at 69 sites on 31 reservoirs. Each site was monitored initially for 4 to 5 consecutive years to establish baseline data. Monitoring continues on an every-other-year basis unless a substantial change in the ecological health score occurs during a 2-year cycle. If that occurs, the site is monitored the next year to confirm that the change was not temporary. Roughly half the sites are sampled each year on an alternating basis. • In 1999, TVA began physical and chemical water quality monitoring annually on 32 reservoirs at 59 locations. Physical and chemical water quality monitoring is conducted monthly from April through September on mainstem reservoirs and from April through October on tributary reservoirs. Sampling includes temperature, DO, pH, and conductivity profiles; and photic zone composite samples for chlorophyll and nutrients (Total P, NH3, NOx, organic N, TKN, TSS, and TOC). • TVA performs biological sampling (fish and/or benthic macroinvertebrates) of tailwaters for 18 tailwaters at 47 sites. Reservoir fish and benthic assemblages are sampled once in late fall/early winter. The condition of these biological communities is evaluated using multi-metric indices. Sediment samples are collected in July or August of each year and analyzed for PCBs, pesticides, and metal contaminants. The monitoring program is based on sampling protocols following EPA Level III fish and Level III benthic bioassessment protocols.
Shoreline Management Policy – A comprehensive management policy developed out of the Shoreline Management Initiative that controls residential development along TVA reservoir shorelines	• TVA Watershed Teams are responsible for implementation of the Shoreline Management Policy. • The goal is to balance shoreline development, recreation use, and resource conservation needs. • Under this policy, a Residential Access Shoreland Inventory is being conducted, which includes an ongoing baseline inventory of resource conditions along TVA-owned residential access shoreland and flowage easement shoreland. Residential shoreline is placed into at least three categories: shoreline protection, residential mitigation, and managed residential. • New construction of residential water use facilities on waterbodies is limited to 1,000 square feet. • Shorelands not open for residential development can be opened only if offset by closing other shorelands that are open to residential development (a maintain-and-gain policy). • A 50-foot shoreline management zone (or greenbelt) is retained on TVA land that adjoins newly developed residential areas where practicable.

Table 7.3-01 TVA Program Elements and Activities Relevant to Mitigation (continued)

TVA Program or Activity	TVA Programs and Activities Relevant to Mitigation Strategies
Shoreline Management Policy (continued)	• Vegetation Management Plans are required for new developments under this policy and are designed to improve or enhance the vegetative cover of the property. Use of native vegetation is encouraged. • Best management practices for the construction of docks, management of vegetation, stabilization of shoreline erosion, and other shoreline alterations are promoted to protect water quality.
Shoreline Treatment Program – A program for rating the condition of shorelines within TVA reservoirs and identifying those to be restored through stabilization and revegetation	• TVA has conducted Shoreline Condition Assessments on all TVA reservoir shorelines. These assessments rate the shoreline conditions based on two parameters: erosion condition and vegetation condition. Shorelines are rated as good, fair, or poor based on the combined score for the two parameters. Each year, TVA selects 35 to 40 sites (approximately 8 miles of reservoir shoreline) that are rated as poor to be restored through stabilization and revegetation. The shoreline rating criteria, used to rank potential sites in order of treatment priority, provides a higher rating to those sites where archaeological resources are threatened, all other criteria being equal.
Hydro Automation Program – A TVA Program to automate the control of TVA's hydropower generating units	• The Hydro Automation Program will link a majority of all 109 units to a centralized computer system so turbines can be managed individually on a system-wide scale.
TVA's Natural Areas Programs – TVA's cooperative management of publicly owned lands with significant natural features.	• In managing the publicly owned land in and around its facilities and reservoirs, TVA has developed a land use designation system under which 82 sites on 10,700 acres have been classified as TVA natural areas. The sites are identified as habitat protection areas, small wild areas, ecological study areas, or wildlife observation areas. Their management includes restrictions on activities that might endanger significant natural features.
Natural Heritage Project – TVA's project to inventory and monitor sensitive natural resources, including protected species, geological features, natural areas, and other sensitive natural resources	• In cooperation with other federal, state, and non-governmental organizations, TVA identifies, monitors, and assists in protecting threatened and endangered species and environmentally sensitive sites. In addition, it maintains databases of these protected species, geological features, natural areas, and other sensitive natural resources. The Natural Heritage Project staff also uses this information to provide environmental input on TVA activities that range from transmission line construction to economic development. TVA and the U.S. Fish and Wildlife Service routinely share information on the location of listed species.
Riparian Restoration – Activities to protect and restore riparian vegetation	• Riparian restoration is designed to help owners of streambank or shoreline properties create landscaping plans that not only enhance their property but also protect water resources. The program identifies ways of using trees and other vegetation to help reduce erosion by holding soil in place, protect water quality by filtering sediments and pollutants, provide wildlife habitat and cover for fish, and enhance scenic beauty along the water's edge.

Table 7.3-01 TVA Program Elements and Activities Relevant to Mitigation (continued)

TVA Program or Activity	TVA Programs and Activities Relevant to Mitigation Strategies
Cultural Resources Management – TVA's program to manage cultural and archaeological resources	• Cultural resources management includes various actions to address requirements of the National Historic Preservation Act and the Archaeological Resource Protection Act. • Archaeological resources in need of treatment/protection are identified from data obtained during archaeological surveys of reservoir shorelines and TVA reservoir lands, and through additional field evaluations of site conditions. The most critically impaired sites are submitted to the Shoreline Treatment Program for consideration in that program's rating process. For each site selected for treatment, consultation is conducted with the appropriate State Historic Preservation Office and other stakeholders, such as Indian tribes.
Clean Water Initiative – A program started in 1992 as a result of the Lake Improvement Plan; TVA partnerships with community residents, businesses, and government agencies to promote watershed protection	• TVA's Watershed Teams are responsible for carrying out the program. They focus on improving water quality and shoreline conditions. Among other accomplishments, these community coalitions: —Monitor stream and aquatic community conditions; —Institute agricultural and urban management practices that reduce water pollution; —Treat eroded land and stabilized streambanks; —Plant vegetation and installed structures intended to improve aquatic habitat; and, —Collect waste and litter from streambanks and shores.

7.4. Potential Impacts and Mitigation for the Preferred Alternative

Mitigation follows a sequence of avoiding impacts; minimizing impacts by limiting the degree or magnitude of the action; and then, if needed, restoring or rehabilitating the affected environment, reducing or eliminating impacts over time, or compensating by providing offsetting resources or environments. Monitoring is often included to verify anticipated outcomes or identify unanticipated impacts. TVA has implemented the first steps of this mitigation process by avoiding and minimizing potential impacts in the design of its reservoir operations policy alternatives and especially in the formulation of the Preferred Alternative.

In developing the Preferred Alternative, TVA combined the desirable features of the alternatives identified in the DEIS to create a more feasible, publicly responsive preferred alternative. Through detailed analysis in this FEIS, TVA has determined that most changes under the Preferred Alternative would result in beneficial to slightly adverse impacts. The Preferred Alternative would result in a few types of effects, however, that would cause adverse impacts on the environment.

7.4.1 Avoidance and Minimization in the Preferred Alternative

The Preferred Alternative was formulated purposefully to avoid or reduce the adverse impacts associated with the action alternatives presented in the DEIS, especially the substantially adverse impacts related to flood damages, water quality, power costs, aquatic resources, wetlands, and migratory waterfowl and shorebirds. The elements of the Preferred Alternative that were added or modified specifically to avoid or minimize potential adverse impacts include the following:

- Except for the Base Case, detailed analyses indicated that all of the alternatives evaluated in the DEIS would result in unacceptable increases in the risk of flooding at critical locations in the Tennessee Valley. To address this issue, operating guides and regulating zones for individual projects were modified so that there would be no increase in flood damages for flood events with a frequency of 500 years or less.

- Most of the alternatives that included extension of summer pools further into summer and fall than under the Base Case would result in longer residence time of water in the reservoirs and consequent adverse or substantially adverse impacts on water quality. The Preferred Alternative focuses on achieving certain flows from the reservoirs from June 1 through Labor Day. Consequently, impacts on water quality would be only slightly adverse and variable among the reservoirs under the Preferred Alternative. However, some of these variable impacts could be adverse and may justify mitigation. This balancing of additional recreation benefits with water quality impacts is also important for aquatic resources, because water quality is a major factor that influences the health of fisheries and the quality of aquatic habitat.

- Habitat quality in many tailwaters would be maintained by ensuring that minimum flow commitments and DO targets in the Lake Improvement Plan would continue to be met. In addition, TVA would provide seasonal releases into the Apalachia Bypass to enhance aquatic habitat in that river reach.

- Most of the alternatives that extended summer pool levels could result in substantial adverse effects on wetlands. Under the Preferred Alternative, pools would be maintained at levels more similar to the Base Case than other policy alternatives. Although adverse impacts on wetland extent, distribution, and habitat connectivity would be reduced compared to most other policy alternatives, adverse impacts may still occur.

- No changes would be made in the operating guide curves for Kentucky Reservoir. This would substantially reduce the potential for adverse effects on flats habitats, interference with the operation and integrity of managed areas, and impacts on adjacent forested wetlands that could occur under alternatives that extend summer pool levels further into summer and fall.

7.4.2 Mitigation for the Preferred Alternative

The Preferred Alternative does not avoid all potential impacts on environmental resources; some adverse impacts could still occur. In particular, implementation of the Preferred Alternative could result in slightly adverse to adverse impacts on certain wetland types and locations, water quality and aquatic resources in some reservoirs, and other resource areas. In some cases, the extent of the impacts may vary from year to year—depending on the reservoir, annual rainfall conditions, and other factors.

Potential mitigation measures for TVA's Preferred Alternative are identified in Table 7.4-01 for adverse impacts on water quality, aquatic resources, and vector (mosquito) control. These mitigation measures are based on incremental impacts compared to the Base Case and are scaled to resource importance and extent as well as to the severity of the potential impact. For each mitigation measure proposed, TVA has provided a description of the need for the mitigation; the mitigation measure or monitoring activity; and the anticipated result in terms of follow-up activities for resource management, protection, enhancement, or replacement.

Table 7.4-01 Mitigation for Potential Adverse Impacts Associated with the Preferred Alternative

Need	Description	Results and Follow-Up Activities
Water quality and aquatic resources could be adversely affected at some locations. If analysis or monitoring indicates that dissolved oxygen (DO) concentrations are declining below DO target levels, increase TVA aeration efforts (see Table 7.4-02).	Upgrade aeration equipment and operations at appropriate locations as necessary to meet the DO target levels established by the Lake Improvement Plan (see Appendix A, Table A-05.) This could include increased oxygenation, upgrading existing equipment, or installing additional equipment. Such measures shall be initiated and completed within 1 year at Watts Bar, and within 3 years at other locations where established targets are not being met.	Share information about enhanced aeration efforts with interested agencies. Continue monitoring to determine whether efforts are successful. If DO targets cannot be maintained, investigate additional mitigation approaches with interested agencies.
Holding mainstem reservoir levels up longer could increase the number of days that reservoir mosquito breeding habitat exists. Mitigate if this is confirmed through monitoring (see Table 7.4-02).	Extend the duration of reservoir level fluctuations for mosquito control, consistent with holding mainstem reservoir levels up longer.	Continue to monitor mosquito levels. If extending the duration of the fluctuations does not offset the increase in reservoir mosquitoes, investigate other mitigation methods—including additional changes in fluctuation efforts.

7.4.3 Mitigation and Monitoring

Given the inherent uncertainties with any environmental analyses, monitoring should be conducted before a substantial investment is made in mitigation—not only to avoid wasting money but also to ensure that the appropriate mitigation is used at the most important locations. A mix of monitoring and adaptive response is an important component of TVA's programmatic mitigation plan. Tables 7.4-02 and 7.4-03 describe the activities that could be taken to verify TVA's projection of impacts for a number of important resource areas.

Tables 7.4-02 and 7.4-03 identify those activities that could be undertaken to mitigate adverse impacts that could not be avoided in the formulation of the Preferred Alternative. Activities that could be taken to address other resource areas are also identified.

Table 7.4-02 Monitoring for Potential Adverse Impacts Associated with the Preferred Alternative

Need	Description	Results and Follow-Up Activities
Decreases in concentrations of dissolved oxygen (DO) are predicted in water released from some mainstem and tributary dams due to increase in volumes of water with low DO concentrations in the reservoirs. This could adversely affect water quality and aquatic resources.	Continue existing monitoring activities under the Reservoir Release Improvement and Vital Signs Reservoir Ecological Health monitoring programs to look for water quality and ecological changes. Conduct additional DO and temperature sampling at selected tailwater locations as determined by Vital Signs monitoring.	Share data with other interested agencies. If DO concentrations lower than the established targets are observed, mitigate appropriately (see Table 7.4-01).
Holding mainstem reservoir levels up longer could increase the number of days that reservoir mosquito breeding habitat exists.	Continue existing monitoring activities throughout the extended time the mainstem reservoir levels are held up.	Share data with interested agencies. If reservoir mosquito nuisance levels increase, mitigate appropriately (see Table 7.4-01).

Table 7.4-03 Monitoring for Other Resource Areas

Need	Description	Results and Follow-Up Activities
The rate of erosion on reservoir shorelines could increase, further affecting sensitive cultural resource sites.	Continue monitoring sensitive cultural resource sites along the shoreline.	If the rate of shoreline erosion at sensitive cultural resource sites increases, increase stabilization efforts commensurate with the rate of increase.
One population of the endangered green pitcher plant on Chatuge Reservoir could be affected by changes in the local hydrology. Detailed hydrologic studies have not been conducted at this site.	Work with the landowner, the U.S. Fish and Wildlife Service, and other interested agencies to conduct a hydrologic study to determine whether the changes in reservoir levels would affect this population. The study and results are to be completed within 1 year. Then, periodically monitor the status of green pitcher plant populations around Chatuge Reservoir and share data with interested agencies.	If results of the study indicate that changes resulting from implementation of the Preferred Alternative are likely to adversely affect the green pitcher plant, take appropriate action to avoid or mitigate those adverse effects.
The results of the Reservoir Operations Study indicate that there is a need to develop a Drought Management Plan for the Tennessee River system.	Work with state and federal agencies in a cooperative manner to develop a Drought Management Plan within a reasonable period of time. This plan would be implemented during extreme drought conditions.	Suspend the reservoir operations policy during severe drought to allow implementation of the Drought Management Plan.
The availability of water would generally increase during the growing season. This could cause slight shifts in the extents and distributions of wetlands and wetland types. The changes in the timing of the presence of water could adversely affect flats, scrub/shrub, and forested wetlands. There could be a slight decrease in wetland functions overall.	Develop a monitoring program to determine whether extended pool levels cause shifts of wetland plant communities. Perform monitoring activities on a 3- to 5-year basis for 15 years to establish effects.	If substantial shifts of wetland plant communities occur, take appropriate action to mitigate adverse effects.

Table 7.4-03 Monitoring for Other Resource Areas (continued)

Need	Description	Results and Follow-Up Activities
The results of the Reservoir Operations Study indicate that there is a need for more cooperative efforts to determine habitat requirements and potential enhancements for shorebirds.	Work with state and federal agencies in a cooperative manner to determine habitat requirements and opportunities for enhancements to shorebirds. This will include better identification of information gaps and cataloguing the federal and state programs that address these habitats and species.	Share data with other interested agencies and investigate with other agencies actions that could be taken to enhance these habitats and species.
The results of the Reservoir Operations Study indicate that there is a need for more cooperative efforts to determine habitat requirements and potential enhancements for important sport fish.	Work with state and federal agencies in a cooperative manner to determine habitat requirements and opportunities for enhancements to sports fish. This will include better identification of information gaps and cataloguing the federal and state programs that address these habitats and species.	Share data with other interested agencies and investigate with other agencies actions that could be taken to enhance these habitats and species.

Chapter 8

List of Preparers

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8.1 TVA Staff

D. Jane Awl

Position: Wetlands Biologist, Tennessee Valley Authority
Education: M.S., Ecology; B.S., Biology and Environmental Science
Background: 12 years of experience in wetlands assessment and delineation

Barry L. Barnard

Position: Specialist, Environmental Compliance Projects, Tennessee Valley Authority
Education: B.S., Chemical Engineering
Background: 32 years of experience in air pollution compliance engineering, permitting, and emissions monitoring

John T. Baxter, Jr.

Position: Aquatic Biologist, Tennessee Valley Authority
Education: M.S. and B.S., Zoology
Background: 12 years of experience in aquatic biology, 4 years of experience in environmental review

J. Mark Boggs

Position: Hydrologist, Tennessee Valley Authority
Education: M.S., Hydrology; B.S., Geophysics
Background: 29 years of experience in hydrologic investigation/analysis for environmental and engineering applications

Charles E. Bohac

Position: Water Supply Specialist, Tennessee Valley Authority
Education: Ph.D., M.S., and B.S., Civil Engineering
Background: 28 years of experience in water resource investigations, water quality analysis, waste treatment and disposal system design, groundwater supply and contamination analysis, and hydro and fossil power plant engineering

Larry G. Bray

Position: Specialist, Navigation Economics, Tennessee Valley Authority
Education: M.A., Ph.D., Economics
Background: 27 years of experience as Economist with TVA, currently with the Navigation Program in River Operations

Gerald E. Brooks

Position: Production Cost Studies Specialist, Tennessee Valley Authority
Education: M.A.T., Physics; B.S., Mathematics
Background: 24 years of experience in TVA power resource planning (reliability and production cost studies); meteorologist in U.S. Air Force and TVA air quality program

David W. Burch

Position: Economist, Tennessee Valley Authority
Education: Ph.D., Food and Resource Economics; M.A. and B.A., Economics and Political Science
Background: 29 years of experience in economic analysis, financial feasibility analysis, modeling, forecasting, and teaching

Edward E. C. Clebsch

Position: Contract Botanist, Tennessee Valley Authority
Education: Ph.D., Botany and Soil Science; M.S., Botany and Zoology; A.B., Botany and Geology
Background: 40 years of experience in teaching and research, and serving as a consulting botanist and ecologist in the Southeastern United States

8 List of Preparers

Joseph L. Collins

Position: Senior Heritage Botanist, Tennessee Valley Authority

Education: Ph.D., Plant Taxonomy; B.S., General Biology

Background: 26 years of experience in environmental assessment and NEPA compliance

Evan Robertson Crews

Position: Watershed Representative, Resource Stewardship, Tennessee Valley Authority

Education: M.S. and B.S., Environmental Science; B.S., Geology

Background: 3 years of experience as aquatic monitoring contractor to TVA; 3 years of experience in land management and watershed/water quality improvement projects

Robert L Curtis, Jr.

Position: Shoreline Process Manager, Tennessee Valley Authority

Education: M.S., Wildlife Science; B.S., Biology

Background: 30 years of experience in wildlife management, reservoir land planning, and reservoir shoreline permitting

Chrisman A. Dager

Position: Navigation Economist, Tennessee Valley Authority

Education: B.S. Business Administration, M.B.A. Transportation

Background: 30 years of experience in transportation planning and operations, with the past 9 years at TVA in Navigation Economic Analysis

Melvin B. Dean

Position: Computer Technician–GIS, Tennessee Valley Authority

Education: A.S., Civil Engineering Technology

Background: 23 years of experience in mapping and GIS work

Bridget Donaldson

Position: Terrestrial Zoologist Contractor, Resource Stewardship, Tennessee Valley Authority

Education: M.S., Ecology and Evolutionary Biology; B.A., Ecological, Populational, and Organismic Biology

Background: 8 years of experience in field biology; 2 years of experience in writing terrestrial zoology input for environmental reviews

Laura M. Duncan

Position: Watershed Representative, Tennessee Valley Authority

Education: M.S., Urban and Regional Planning (minor in Environmental Policy); B.S., Biology and Marine Science (double major)

Background: 10 years of experience in water resources field, with 5 years focused on watershed planning

Don L. Dycus

Position: Program Manager, Environmental Policy and Strategy, Tennessee Valley Authority

Education: M.S. and B.S., Zoology

Background: Over 30 years of experience in monitoring and evaluating water quality and aquatic biological conditions on TVA reservoirs.

Michael Eiffe

Position: Civil Engineer, Tennessee Valley Authority

Education: M.E. and B.S., Civil and Environmental Engineering

Background: 23 years of experience in hydrologic, hydraulic, and environmental engineering

Charles B. Feagans, P.E.

Position: Senior Manager, Operations Management, Electric Systems Operation, Tennessee Valley Authority
Education: M.S., M.B.A., and B.S., Civil Engineering
Background: 23 years of experience in hydrogeneration studies and power operations

Nancy D. Fraley

Position: Natural Areas Coordinator, Resource Stewardship, Tennessee Valley Authority
Education: M.S., Botany
Background: 12 years of experience in terrestrial vegetation assessment, rare plant inventory, and environmental education; 6 years of experience in management of invasive exotic plants

R. Lee Fuller

Position: Risk Management Specialist, Tennessee Valley Authority
Education: M.S., Engineering; B.S., Biological Sciences; A.A., Engineering
Background: 7 years of experience in power plant operations; 6 years of experience in computer system design and maintenance for power system applications; 10 years of experience in industrial and power plant environmental regulations and control technologies; 3 years of experience in power system analysis and risk management

Kenneth D. Gardner

Position: Aquatic Biologist, Tennessee Valley Authority
Education: M.S., Wildlife and Fisheries Science; B.S., Wildlife and Fisheries Science
Background: 13 years of experience in environmental assessment

Sidney Eugene Gibson

Position: Manager, Water Supply and Special Projects, Tennessee Valley Authority
Education: B.S., Engineering Science and Mechanics
Background: 30 years of experience in engineering and integrated resource management

Juan E. Gonzalez

Position: Economic Forecasting Manager, Tennessee Valley Authority
Education: A.B.D. and M.A., Economics; B.A., Economics, Political Science, and Mathematics
Background: 30 years of experience in economic modeling, forecasting, and analysis relating to economic development, corporate and power resource planning, water resources and associated commerce, and environmental assessment

H. Morgan Goranflo, Jr., P.E.

Position: Manager, River Operations, Tennessee Valley Authority
Education: M.S. and B.S., Civil Engineering
Background: 30 years of experience in hydropower and reservoir system planning and operations

Ella Christina Guinn

Position: Natural Areas Contractor, Resource Stewardship, Tennessee Valley Authority
Education: M.S., Geography; B.A., Geography
Background: 9 years of experience in land use analysis, interpretation, and planning

James Hagerman

Position: Environmental Engineer, Tennessee Valley Authority
Education: B.S. and M.S., Agricultural Engineering; registered professional engineer
Background: 13 years of experience in nonpoint source pollution and water quality

8 List of Preparers

J. Hollis Hart, Jr.

Position: Risk Management Specialist, Tennessee Valley Authority
Education: M.B.A., Finance; B.S., Electrical Engineering
Background: 8 years of experience in electric utility industry (electric system operations, distribution project management, commercial marketing, and generation resource planning)

Jason C. Hartsell

Position: Chemical Engineer, Tennessee Valley Authority
Education: B.S., Chemical Engineering
Background: 2 years of experience in air quality compliance, emissions inventories, and power plant permit applications

Travis Hill Henry

Position: Senior Terrestrial Zoologist, Tennessee Valley Authority
Education: M.S., Zoology; B.S., Wildlife Biology
Background: 12 years of experience in environmental review and zoological investigations

Gary D. Hickman

Position: Manager, Projects and Services, Tennessee Valley Authority
Education: M.S. and B.S., Zoology
Background: 30 years of experience in aquatic ecology, with emphasis on fish community assessment and development of indices to measure environmental quality

Mark K. Hill

Position: Specialist, Production Technology, Tennessee Valley Authority
Education: B.S., Mechanical Engineering
Background: 20 years of experience in electrical power generation technology evaluation

John J. Jenkinson

Position: Senior Mollusk Biologist, Tennessee Valley Authority
Education: Ph.D., M.S., and B.S., Zoology
Background: 24 years of experience in aquatic life and aquatic endangered species impact assessment

Donald L. Kachelman

Position: Chemical Engineer, Tennessee Valley Authority
Education: B.S., Chemical Engineering
Background: 22 years of experience, including 10 years in air quality compliance, emissions inventories, and permit applications

Jimmie J. Kelsoe

Position: Environmental Scientist, Tennessee Valley Authority
Education: B.S., Chemistry and Mathematics
Background: 25 years of experience in agronomic research, including 6 years of experience in NEPA reviews

Robin E. Kirsch

Position: Project Manager, Special Studies
Education: B.S. Mechanical Engineering
Background: 8 years of experience in nuclear power plant engineering and 12 years of experience in reservoir operations

M. Carolyn Koroa

Position: Geographic Analyst, Tennessee Valley Authority
Education: B.A., M.S., Geography
Background: 13 years of experience as Geographer and Spatial Analyst, 7 years at TVA with the Navigation Program

Susan Lauver

Position: Senior Manager, Strategic Communications, Tennessee Valley Authority
Education: M.P.A., Public Administration; B.S., Communications
Background: 24 years of experience in public relations and public participation

Katherine F. Lindquist, P. E.

Position: Manager, Hydrothermal Team, River Scheduling, Tennessee Valley Authority
Education: M.S., Civil Engineering/ Environmental Hydraulics; B.S., Civil Engineering
Background: 24 years of experience in water quality

Jack Don Lokey

Position: Environmental Engineer, Tennessee Valley Authority
Education: M.S. and B.S., Chemical Engineering
Background: 27 years of experience in environmental engineering, focused on air quality compliance, emissions inventories, and permit applications

Jason Michael Mitchell

Position: Contract Terrestrial Zoologist, Resource Stewardship, Tennessee Valley Authority
Education: M.P.A., Environmental Policy; B.S., Wildlife and Fisheries Science
Background: Natural resource management with emphasis on endangered species, including 3 years with state wildlife agency and 6 years performing zoological assessment for federal land management organizations

Jeffrey Wayne Munsey

Position: Civil Engineer (Dam Safety), Tennessee Valley Authority
Education: M.S. and B.S., Geophysics
Background: 18 years of experience in geophysical and geological studies and investigations, including applications to environmental assessments

C. Michael Murphree

Position: Economist/Statistician, Tennessee Valley Authority
Education: B.S. Statistics, M.A. Economics
Background: 34 years of experience with TVA as Economist/Information Systems Analyst/Programmer

Norris A. Nielsen

Position: Project Manager, Environmental Technology, Tennessee Valley Authority
Education: M.S. and B.S., Meteorology
Background: 30 years of experience in applied meteorology, including input to and review of NEPA documents

David T. Nye

Position: Project Manager, Reservoir Operations Study
Education: B.S., Civil Engineering
Background: 30 years of experience in nuclear, fossil, and hydropower design, maintenance, and operations

William Oldland

Position: Medical Entomologist, Tennessee Valley Authority
Education: M.S., Entomology; B.S., Wildlife Biology
Background: 12 years of experience in entomology

Esther Sullivan Parish

Position: Geographic Analyst, Tennessee Valley Authority
Education: M.S., Geography; B.S., Geology and Geophysics
Background: 8 years of experience in geographic and environmental data analysis

William J. Parkhurst

Position: Senior Specialist, Tennessee Valley Authority
Education: M.S., Environmental Health; B.S., Biology/Earth Sciences
Background: 29 years of experience in air quality monitoring, data analysis, and air quality research

8 List of Preparers

Ralph M. Perhac, Jr.

Position: Economist, Tennessee Valley Authority
Education: Ph.D., Philosophy; M.B.A. and B.S., Economics
Background: 7 years of experience as an economist, 10 years of experience in environmental research and review

Ralph L. Porter, Jr.

Position: Landscape Architect–Principal, Tennessee Valley Authority
Education: B.L.A., Landscape Architecture
Background: 34 years of experience in land planning and site design for institutional, recreational, and industrial development, including 7 years in environmental review of visual and aesthetic resources

William H. Redmond

Position: Manager, Resource Services, Tennessee Valley Authority
Education: Ph.D., M.S., and B.S., Zoology
Background: 28 years of experience as a professional zoologist; 23 years of experience in supervision and management

Andrew J. Sanislo

Position: Risk Management Specialist, Tennessee Valley Authority
Education: M.B.A., Finance; M.E. and B.S., Nuclear Engineering
Background: 2 years of experience in power generation planning, financial analysis, and forecasting; 20 years of power industry experience in project management, nuclear core design, fuel engineering and manufacturing, and operations support; 6 years in the U.S. Air Force

Linda B. Shipp

Position: Senior NEPA Specialist, River Operations
Education: Ph.D., Botany; M.S., Ecology
Background: 25 years of experience in environmental and integrated regional resources management training and environmental impact assessment

Peggy W. Shute

Position: Manager, Heritage Resources, Tennessee Valley Authority
Education: M.S., Zoology; B. A., Biology
Background: 16 years of experience in environmental review

Shandon N. Smith

Position: Atmospheric Analyst, Tennessee Valley Authority
Education: B.S., Professional Geography
Background: 1 year of experience in GIS mapping and processing involving spatial air quality information

Ramona C. Sumner

Position: Risk Management Specialist, Tennessee Valley Authority
Education: M.B.A., and B.S., Mathematics
Background: 8 years of experience in risk management

Roger Tankersley, Jr.

Position: Senior Scientist/Geographer, Tennessee Valley Authority
Education: Ph.D., M.S., and B.S., Geography
Background: 11 years of experience in spatial environmental analyses, particularly biogeographic analyses

Ken Tennessen

Position: Medical Entomologist, Tennessee Valley Authority (retired)
Education: Ph.D., M.S., and B.S, Entomology
Background: 27 years of experience in entomology, 17 years of experience in medical entomology

Lois I. Threlkeld

Position: Manager, Business Process Analysis, Tennessee Valley Authority
Education: M.S., Industrial Engineering; B.S., Civil Engineering; A.B., Chemistry
Background: 26 years of experience in engineering and business positions at TVA

Charles R. Tichy

Position: Historic Architect, Resource Stewardship, Tennessee Valley Authority
Education: B.S., Architecture; M.A., Historic Preservation
Background: 34 years of experience in historic preservation and restoration, and historic structures review under the National Historic Preservation Act

Christopher D. Ungate

Position: Manager, Generation Resource Planning, Tennessee Valley Authority
Education: M.B.A.; M.S. and B.S., Civil Engineering
Background: 4 years of experience in generation planning; 2 years of experience in hydro operations; 4 years of experience in reservoir operations planning; 5 years of experience in watershed management; 3 years of experience in corporate planning; and 10 years of experience in engineering testing and modeling

David H. Webb

Position: Biologist - Aquatic Plants, Tennessee Valley Authority
Education: Ph.D., Botany; M.S., Zoology; B.S., Biology
Background: 25 years of experience with TVA in aquatic plant management and support studies

Carolyn Leigh Wells

Position: Biologist/Botanist, Tennessee Valley Authority
Education: Ph.D., Botany; B.A., Biology
Background: 4 years of experience in managing sensitive botanical resources and preparing technical input to environmental review documents

Lucritia D. White

Position: Risk Management Specialist, Tennessee Valley Authority
Education: M.S., Engineering Management; B.S., Mechanical Engineering
Background: 12 years of experience in electric utility operations, including system dispatching, generation plan development, coal-fired operation, and maintenance processes

Joel E. Williams

Position: Assistant Project Manager, Reservoir Operations Study
Education: M.P.A., Public Administration; B.S., Geology
Background: 20 years of experience in remote sensing, land and shoreline management, and watershed restoration

Cassandra L. Wylie

Position: Project Manager, Environmental Technology, Tennessee Valley Authority
Education: M.S., Forestry and Statistics; B.S., Forestry
Background: 16 years of experience in atmospheric modeling and air quality analysis

8.2 TVA Consultants

Todd M. Ahlman

Position: Archaeologist, The Louis Berger Group, River System Operations & Environment, Inc.
Education: Ph.D., M.A., and B.A., Anthropology
Background: 13 years of experience in archaeological resource management

Karen Argonza

Position: Production Manager/Technical Editor, ENTRIX, Inc.
Education: B.A., Journalism
Background: 16 years of experience in project coordination, technical writing, and project management

Robert Mathew Baumgartner

Position: Managing Consultant, PA Government Services, Inc.
Education: Ph.D., M.S., and B.S., Sociology
Background: 21 years of experience in social science research in the consulting industry

John C. Bergstrom

Position: Professor, The University of Georgia, Athens
Education: Ph.D. and M.S., Agricultural Economics; B.S., Resource Management
Background: 20 years of experience in applied research related to the economics of natural resource and environmental policy and management

David B. Blankenhorn, R.G.

Position: Senior Project Geologist/Engineer, ENTRIX, Inc.
Education: M.S., Civil Engineering; B.S., Applied Earth Science
Background: 8 years of experience in hydrogeology/hydrology

C. Shane Boring

Position: Environmental Scientist, Kleinschmidt Associates
Education: M.S., Ecology; B.S., Biology
Background: 5 years of experience at the academic research level on a wide range of wildlife and fisheries resource-related issues; 1 year of experience at the state regulatory level

Heather Ann Cabral

Position: GIS Analyst, Applied Geographics, Inc.
Education: B.S., Geography
Background: 3 years of experience using GIS, providing data analysis, data conversion, data development, and mapping for municipal services, environmental management issues, and transportation services

Lee E. Carbonneau

Position: Senior Scientist, Normandeau Associates, Inc.
Education: M.S., Wildlife Ecology; B.S., Forest Biology
Background: 21 years of experience in terrestrial and wetland inventory, assessment, and habitat restoration

Matthew D. Chan

Position: Senior Scientist, Normandeau Associates, Inc.
Education: Ph.D., Fisheries Science; M.S. and B.A., Biology
Background: 1 year of experience as fisheries biologist; 1 year of experience as senior scientist for aquatic resource studies, specializing in instream flow issues

Jon M. Christensen

Position: Senior Licensing Coordinator and Economist, Kleinschmidt Associates
Education: B.A., Economics
Background: 16 years of experience in economic and recreation studies and environmental assessments

Eileen F. Dessaso

Position: Senior Project Coordinator, ENTRIX, Inc.
Education: IPM Certification (in progress); CEQA, NEPA Workshops; Partial Degree, Library Science
Background: 10 years of experience in coordinating reservoir and hydroelectric facilities, transmission lines, natural gas pipelines, and power plant projects

Bruce A. DiGennaro

Position: Senior Planner, Kleinschmidt Associates
Education: B.S., Environmental Planning and Management
Background: 18 years of experience in recreation studies and analyses for water and energy projects

Erik Dilts

Position: Senior Staff Scientist, ENTRIX, Inc.
Education: M.S., Forest Resources (Fisheries Biology); B.S., Biology
Background: 3 years of experience in environmental resource reporting and NEPA documentation

Jennifer Q. Dow

Position: Licensing Coordinator, Kleinschmidt Associates
Education: B.S., Business Management; A.S., Legal Secretarial
Background: General administrative and legislative research

Patrick Fairbairn

Position: Natural Resources Planner, Normandeau Associates, Inc.
Education: Ph.D., Wildlife/Natural Resource Planning; M.A., English; B.A., General Studies
Background: 31 years of experience in natural resource planning and studies of the ecology of North American biota

Albert S. Garlo

Position: Senior Wetland Scientist, Normandeau Associates, Inc.
Education: M.S., Forestry Genetics; B.S., Forestry
Background: 25 years of experience in forestry, wetlands, and environmental assessment projects

Jimmy Groton

Position: Environmental Scientist, Science Applications International Corporation
Education: M.S., Forestry; B.S., Natural Resources
Background: 23 years of experience in natural resource management and environmental impact assessment; 13 years of experience in NEPA compliance and wetlands ecology, management, and restoration

Richard K. Grady

Position: Executive Vice President, Applied Geographics, Inc.
Education: M.B.A., Management; B.S., Resource Economics
Background: 25 years of experience in computer mapping, systems integration, and GIS

Ernest B. Griggs

Position: Assistant Project Manager, PB Power, Inc.
Education: B.S., Management
Background: 30 years of experience in bulk power (hydro) generation and transmission

8 List of Preparers

Amy H. Haas

Position: GIS Analyst, Applied Geographics, Inc.
Education: B.S., Earth Sciences
Background: 4 years of experience in environmental sciences and GIS

Melissa Hetrick

Position: Assistant Staff Environmental Scientist, ENTRIX, Inc.
Education: B.S., Integrative Biology
Background: 3 years of experience in environmental impact assessment and environmental policy and permitting

Gale Hoffnagle

Position: Senior Vice President and Technical Director, TRC Environmental Corporation
Education: M.S. and B.S., Meteorology
Background: 34 years of experience in air quality consulting

Paul M. Jakus

Position: Associate Professor, Utah State University
Education: Ph.D., Economics; M.Sc. and B.Sc., Agricultural and Natural Resource Economics
Background: Faculty member at University of Tennessee with extensive experience in trip response modeling in the TVA region

Angela Johnson

Position: Biologist, Science Applications International Corporation
Education: B.S., Biology
Background: 5 years of experience in ecological risk assessment and wildlife biology

Margaret W. (Peg) Johnson

Position: Supervising Planner, Associate Vice President, Parsons Brinckerhoff, Inc.
Education: M.S., Economics; B.A., English
Background: 24 years of experience in ports and waterway planning and economic analysis

Deborah Joy

Position: Archaeologist, Legacy Research Associates, Inc.
Education: M.A., Native American History; B.A., Anthropology
Background: 22 years of experience in archaeology; 18 years of experience in cultural resource management

Nancy Ellen Keene

Position: Wetlands Biologist, ADECCO Technical
Education: Ph.D., Ecology; M.Ed., Outdoor Education; B.S., Biology
Background: 11 years of experience in teaching, researching, and performing environmental assessments

Carrie Koenig

Position: Consultant Analyst, PA Government Services, Inc.
Education: B.B.A., Business Management and Marketing
Background: 5 years of experience in survey research

Thomas Kokx

Position: Principal, Thomas Kokx Associates
Education: B.S., Landscape Architecture
Background: 30 years of experience in visual resource inventory, assessment, and management

Karl Krcma

Position: Supervising Engineer, Parson Brinckerhoff, Inc.
Education: B.S., Agricultural Engineering
Background: 23 years of experience in ports, waterways, and marine facilities

Donald Kretchmer

Position: Senior Water Resources Scientist, Normandeau Associates, Inc.
Education: M.S., Water Resources Management; B.S., Natural Resources
Background: 22 years of experience in water resources planning and management

Gabriela Landau-Gabbai

Position: GIS Analyst, Applied Geographics, Inc.
Education: M.S., Urban and Regional Planning; B.A., Geography
Background: 1 year of experience in urban planning; 2 years of experience in GIS

Paul Leonard

Position: Senior Project Manager, ENTRIX, Inc.
Education: M.S., Fisheries Science/Statistics; B.S., Aquatic Science/Biology
Background: 20 years of experience in managing and performing environmental assessments related to hydroelectric power and other water resource development projects

Elisa Aylin Lewallen

Position: Project Scientist, ENTRIX, Inc.
Education: M.S., Environmental Science; M.P.A., Public Affairs; B.S., Natural Resources
Background: 6 years of experience in watershed assessments, water quality monitoring, stream assessments, endangered species surveys, and environmental permitting

Joan Lynn

Position: President, egret, inc.
Education: 6 years of undergraduate studies in Latin and Greek
Background: 20 years of experience in writing and editing environmental documents

Dennis Magee

Position: Vice President, Normandeau Associates, Inc.
Education: M.S., Botany/Forestry; B.S., Zoology/Wildlife
Background: 31 years of experience in managing a wide range of environmental assessment projects

Richard Masters, P.E.

Position: Director of Engineering, Normandeau Associates, Inc.
Education: M.A., Environmental Planning; B.S., Civil Engineering
Background: 22 years of experience in environmental planning and water resources engineering

Ian K. McDonough

Position: Economics Graduate Student, Utah State University
Education: B.Sc., Information Systems
Background: Expertise in developing and maintaining electronic databases

Bryce Mochrie

Position: Senior Principal Engineer, PB Power, Inc.
Education: M.S. and B.S., Civil Engineering
Background: 25 years of experience in addressing the structural aspects of dam design, stability, and safety

April Montgomery

Position: Preservation Planner, Legacy Research Associates, Inc.
Education: M.A., Urban and Regional Planning; B.A., History
Background: 5 years of experience in historic preservation planning

Marcia B. Montgomery

Position: Project Historian, ENTRIX, Inc.
Education: M.A. and B.A., History
Background: 12 years of experience in historic research for environmental compliance

8 List of Preparers

Ash Morgan

Position: Senior Staff Scientist, ENTRIX, Inc.
Education: Ph.D. and M.A., Economics; B.A., Accounting and Finance
Background: 5 years of experience in economic modeling and analysis

Nicholas Nitka

Position: Consultant Analyst, PA Government Services, Inc.
Education: B.S., Marketing
Background: 5 years of experience in managing large-scale surveys for government and private clients

Kelly O'Brien

Position: Staff Recreation Analyst/Planner, Kleinschmidt Associates
Education: M.S., Resource Economics; B.S.S., Environmental Policy
Background: 3 years of experience in survey research and statistical applications; 8 years of experience in the recreation industry

Kimberly R. Peace

Position: Wetlands Scientist, Normandeau Associates, Inc.
Education: M.S. and B.S., Marine Science
Background: 8 years of experience in the field of environmental consulting, including wetlands delineation and mitigation, endangered species surveys, NEPA compliance and EIS preparation

Marcia L. (Marty) Phillips

Position: Senior Resource Economist, Kleinschmidt Associates
Education: M.S., Agricultural and Resource Economics; B.S., Natural Resources; A.A., Liberal Arts
Background: 15 years of experience in resource economics and survey research in the field of outdoor recreation

Cindy Potter

Position: Document Coordinator, ENTRIX, Inc.
Education: B.A., Liberal Arts
Background: 6 years of experience in public outreach and coordinating production of environmental documents

Paul W. Rasmussen

Position: Statistician, Wisconsin Department of Natural Resources
Education: M.S., Statistics; M.S. and B.A., Biology
Background: 22 years of experience in environmental and biomedical statistics

Pamela R. Rathbun

Position: Principal Consultant, PA Government Services, Inc.
Education: M.S., Sociology (Research and Analysis); B.S., Rural Sociology
Background: 20 years of experience in designing and conducting survey research for clients in the public and private sectors

John Robinson

Position: Senior Project Manager, ENTRIX, Inc.
Education: Masters Studies in Urban Design and Economics; B. Arch., Architecture
Background: 33 years of experience in energy facility development, permitting, and environmental performance evaluation (NEPA compliance) for thermal, nuclear, combustion turbine, pipeline, transmission line, and alternative energy facilities

Barbara Rosensteel

Position: Wetlands Biologist, ADECCO Technical
Education: M.S. and B.S., Environmental Science
Background: 14 years of experience in wetlands assessment and delineation

Jeffrey G. Royal

Position: Archaeologist, Legacy Research Associates, Inc.
Education: Ph.D., M.A., and B.A., Anthropology; B.A., Economics
Background: 12 years of experience in archaeological research, analysis, and publication

Cynthia Audrey Saine

Position: Senior GIS Analyst, Applied Geographics, Inc.
Education: B.A., Economics and Environmental Science
Background: 8 years of experience in GIS

John Shuman

Position: Senior Water Resources Planner, Kleinschmidt Associates
Education: Ph.D., Environmental Science; B.A., Biology
Background: 20 years of experience in fisheries, aquatic ecology, reservoir limnology, environmental science, and watershed planning

Heidi K. Singletary

Position: Senior GIS Analyst/Project Manager, Applied Geographics, Inc.
Education: M.S. and B.S., Environmental Science
Background: 5 years of experience in data development and mapping with GIS

Theresa Tennant

Position: Administrative Assistant, PA Government Services, Inc.
Background: 1 year of experience in administration in a survey research firm

Daniel R. Tormey

Position: Senior Management Consultant, ENTRIX, Inc.
Education: Ph.D., Geology and Geochemistry; B.S., Civil Engineering; B.S., Geology
Background: 14 years of experience as a hydrologist, geologist, geochemist, civil engineer, environmental scientist, environmental engineer, and project manager

William W. Wade

Position: President, Energy and Water Economics
Education: Ph.D., Agricultural and Resource Economics; M.S., Agricultural and Resource Economics; B.S., English
Background: 30 years of experience in conducting regional economic impact analyses and resource economic analyses

Calvin Wenzel

Position: Wildlife Ecologist, Science Applications International Corporation
Education: B.S., Biology
Background: 28 years of experience in NEPA compliance, natural resource management, and environmental impact assessment

Jennifer West

Position: Soil Scientist, Normandeau Associates, Inc.
Education: M.S., Plant Science; B.S., Natural Resource Management
Background: 17 years of experience in environmental consulting, including permitting, site review, and mapping of soils and wetlands

Shirley Marie Williamson

Position: Project Manager, PB Power, Inc.
Education: M.S., Civil Engineering; B.S., Civil Engineering
Background: 22 years of experience in water resources projects and hydrologic analyses

8 List of Preparers

Roberta Willis

Position: Senior Consultant, ENTRIX, Inc.
Education: M.S., Ecology/Forestry; B.S., Landscape Design/Biology
Background: 25 years managing and performing environmental assessments related to environmental planning and natural resource programs and projects

Michael W. Wright

Position: Senior Management Consultant, Water Resources, ENTRIX, Inc.
Education: M.A. and B.A., Geography
Background: 32 years of experience in NEPA assessments for major water resource management and infrastructure projects

Bryan Zent

Position: Consultant, PA Government Services, Inc.
Education: M.A., Industrial/Organizational Psychology; B.S., Psychology
Background: 8 years of experience in survey design, data collection, data management, and data analysis

Chapter 9

Distribution List

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9.1 Federal Agencies

Bureau of Indian Affairs, Franklin Keel, Eastern Agency
Bureau of Indian Affairs, Ross Mooney, Washington, DC
Bureau of Indian Affairs, Mike Smith (Acting)
Bureau of Indian Affairs, J. Mannis, Regional Director, Eastern Oklahoma Regional Office
Economic Development Administration, William J. Day, Jr., Regional Director, Atlanta Region
Economic Development Administration, John Ogden, Atlanta Region
Economic Development Administration, Paul M. Raetsch, Regional Director, Philadelphia Region
Environmental Protection Agency, Heinz J. Mueller, Chief, Office of Environmental Assessment
Environmental Protection Agency, Thomas Welborn, Region 4
Federal Emergency Management Agency, Mark A. Viera, Atlanta, GA
Federal Emergency Management Agency, Mohammad Waliullah, Atlanta, GA
National Park Service, John Conoboy, Trail of Tears National Historic Trail, Long Distance Trails Group Office
National Park Service, Jeff Duncan, Hydropower Assistance
National Park Service, Phil Francis, Superintendent (Acting), Great Smoky Mountain National Park
National Park Service, Woody Harrell, Superintendent, Shiloh National Military Park
National Park Service, Patrick Reed, Superintendent, Chickamauga-Chattanooga National Military Park
National Park Service, Wendell Simpson, Superintendent, Natchez Trace National Scenic Trail
National Park Service, Rich Sussman, Planning and Compliance Division
National Weather Service, Jerry McDuffie, Weather Forecast Office, Morristown, TN
National Weather Service, Dave Reed, Lower Mississippi River Forecast Center
National Weather Service, Ben Weiger, Southern Regions
U.S. Army Corps of Engineers, Larry Banks, Mississippi Valley Division
U.S. Army Corps of Engineers, Bill Barron, Nashville District
U.S. Army Corps of Engineers, Dave Buelow, Great Lakes and Ohio River Division
U.S. Army Corps of Engineers, David K. Baker, Asheville Regulatory Field Office
U.S. Army Corps of Engineers, Col. Frederick L. Clapp, Jr., Commander, Vicksburg District
U.S. Army Corps of Engineers, Patty Coffey, Nashville District
U.S. Army Corps of Engineers, Gary Craig, North Area Section
U.S. Army Corps of Engineers, Col. James W. DeLony, Commander, Wilmington District
U.S. Army Corps of Engineers, Brigadier General Edwin J. Arnold, Jr., Mississippi Valley Division
U.S. Army Corps of Engineers, Ron Gatlin, Regulatory Branch
U.S. Army Corps of Engineers, Lt. Col. Steve Gay, Commander, Nashville District
U.S. Army Corps of Engineers, Col. Roger A. Gerber, Commander, Savannah District
U.S. Army Corps of Engineers, W. Chris Hinton-Lee, Director, Military and Technical Directorate
U.S. Army Corps of Engineers, Brigadier General Robert Griffin, Director of Civil Works
U.S. Army Corps of Engineers, Elizabeth S. Guynes, Chief, Regulatory Branch, Vicksburg District
U.S. Army Corps of Engineers, Col. David I. Hansen, PE, Commander, Norfolk District
U.S. Army Corps of Engineers, Brigadier General Steven R. Hawkins, Commander, Great Lakes and Ohio River Division
U.S. Army Corps of Engineers, Robert Johnson
U.S. Army Corps of Engineers, Col. Robert B. Keyser, Commander, Mobile District
U.S. Army Corps of Engineers, Ron Krizman, Chief, Regulatory Branch, Mobile District

U.S. Army Corps of Engineers, Brigadier General Peter T. Madsen, Commander, South Atlantic Division
U.S. Army Corps of Engineers, Brigadier General M. Stephen Rhoades, Commander, Atlantic Division
U.S. Army of Engineers, Brigadier General Don T. Riley, President Designee, Mississippi River Commission
U.S. Army Corps of Engineers, Col. Jack V. Scherer, Commander, Memphis District
U.S. Army Corps of Engineers, Col. Robert E. Slockbower, Commander, Louisville District
U.S. Army Corps of Engineers, Tom Swor, Nashville District
U.S. Army Corps of Engineers, Dennis Williams, Nashville District
U.S. Coast Guard, Commander Patrick T. Keane, Marine Safety Office
U.S. Coast Guard, Josh McTaggart, Marine Safety Office
U.S. Coast Guard, Lt. Commander Paul Thorne, Marine Safety Detachment
U.S. Department of Agriculture - National Resources Conservation Service, Mary K. Combs, State Conservationist
U.S. Department of Agriculture - National Resources Conservation Service, Denise Doetzer, State Conservationist
U.S. Department of Agriculture - National Resources Conservation Service, John Dondero, Regional Strategic Planner
U.S. Department of Agriculture - National Resources Conservation Service, James W. Ford, State Conservationist
U.S. Department of Agriculture - National Resources Conservation Service, Robert N. Jones, State Conservationist
U.S. Department of Agriculture - National Resources Conservation Service, Leonard Jordan, State Conservationist
U.S. Department of Agriculture - National Resources Conservation Service, David G. Sawyer, State Conservationist
U.S. Department of Agriculture - National Resources Conservation Service, Vic Simpson, Regional Technology Specialist
U.S. Department of Agriculture - National Resources Conservation Service, David Thackeray, Director, Water Management Center
U.S. Department of Agriculture - National Resources Conservation Service, Homer L. Wilkes, State Conservationist
U.S. Department of the Interior, Office of Environmental Policy and Compliance, Stephen R. Spencer
U.S. Department of the Interior, Office of Environmental Policy and Compliance, Gregory Hogue, Regional Environmental Officer
U.S. Department of the Interior, Office of Environmental Policy and Compliance, Willie R. Taylor, Director
U.S. Forest Service, Terry Bowerman, District Ranger, Nolichucky/Unaka District
U.S. Forest Service, Cassius Cash, Toccoa Ranger District
U.S. Forest Service, Jack Holcomb
U.S. Forest Service, Bob Jacobs, Regional Forester, Region 8
U.S. Forest Service, Ray Johnston
U.S. Forest Service, Don Kinnerson, Ocoee/Hiwassee District
U.S. Forest Service, Bill Lisowsky, Area Supervisor, Land between the Lakes
U.S. Forest Service, John Ramey, Forest Supervisor, National Forests in North Carolina
U.S. Forest Service, Anne Zimmerman, Forest Supervisor, Cherokee National Forest
U.S. Fish and Wildlife Service, Steve Alexander, Cookeville Field Office
U.S. Fish and Wildlife Service, V. Lee Andrews, Jr., Field Supervisor, Kentucky Field Office

U.S. Fish and Wildlife Service, Ray Aycock, Jackson Field Office, Field Supervisor
U.S. Fish and Wildlife Service, Lee Barclay, Field Supervisor, Cookeville Field Office
U.S. Fish and Wildlife Service, Brian Cole, State Supervisor, Asheville Field Office
U.S. Fish and Wildlife Service, Dwight Cooley, Manager, Wheeler National Wildlife Refuge
U.S. Fish and Wildlife Service, Larry Goldman, Daphne Field Office, Field Supervisor
U.S. Fish and Wildlife Service, Robin Goodloe, Supervisory Biologist, North Georgia Sub-Office
U.S. Fish and Wildlife Service, Sam D. Hamilton, Regional Director, Region 4, Southeast Region
U.S. Fish and Wildlife Service, Roberta Hylton, Field Supervisor, Southwest Virginia Field Office
U.S. Fish and Wildlife Service, Karen L. Mayne, Virginia Ecological Services Field Office
U.S. Fish and Wildlife Service, John Taylor, Manager, Tennessee National Wildlife Refuge
U.S. Fish and Wildlife Service, Sandy Tucker, Field Supervisor, Georgia Field Office
U.S. Geological Survey, Athena P. Clark, Montgomery, AL
U.S. Geological Survey, Mr. Leonard R. Frost, Jr., District Chief, Water Resources Division, Pearl, MS
U.S. Geological Survey, W. Scott Gain, Nashville, TN
U.S. Geological Survey, Robert M. Hirsch, National Center, Reston, VA
U.S. Geological Survey, Edward H. Martin, Atlanta, GA
U.S. Geological Survey, Gerald L. Ryan, Raleigh, NC

9.2 American Indian Nations

Alabama Indian Affairs Commission, Michael C. Gilbert, Executive Director, Montgomery
Poarch Creek Indians, Eddie L. Tullis, Chairman
Seminole Indian Tribe, Dr. Patricia Wickman, Tribal Historic Preservation Office
Georgia Council on American Indian Concerns
Band of Choctaw Indians, Christine Norris
Mississippi Band of Choctaw Indians, Kenneth Carleton
Eastern Shawnee Tribe of Oklahoma, Charles D. Enyart, Chief
North Carolina Historic Preservation Officer, Eastern Band of the Cherokee Indians, Leon Jones, Principal Chief
North Carolina Eastern Band of Cherokee Indians, Michael Bolt, Tribal Utilities
North Carolina Eastern Band of Cherokee Indians, Michelle Hamilton, Tribal Historic Preservation Officer
North Carolina Commission of Indian Affairs, Gregory Richardson, Executive Director
Absentee-Shawnee Tribe of Oklahoma, James “Lee” Edwards, Jr., Governor
Alabama Quassarte Tribal Town, Mekko Tarpie Yargee, Chief
Cherokee Nation of Oklahoma, Honorable Chadwick Smith, Chief
Chickasaw Nation, Bill Anoatubby, Governor
Choctaw Nation of Oklahoma, Olin Williams, Tribal Historic Preservation Office, Terry Cole, Cultural Resources Director
Kialegee Tribal Town, Honorable Lowell Wesley
Muscogee (Creek) Nation of Oklahoma, Honorable R. Perry Beaver, Principal Chief
Seminole Nation of Oklahoma, Ted Underwood
Shawnee Tribe, Ron Sparkman, Chairman
Thlopthlocco Tribal Town, Honorable Bryan McGrett
United Keetoowah Band, Honorable Dallas Proctor, Chief
Bureau of Indian Affairs, Kurt Chandler, Eastern Agency

Alabama-Coushatta Tribe, Walter Celestine, Program Director

9.3 State Agencies

Alabama

Alabama Department of Environmental Management, James E. McIndoe, Chief, Water Division
Alabama Historical Commission, Elizabeth Brown, Acting Executive Director
Alabama Office of Water Resources, Tom Littlepage
Department of Economic and Community Affairs, Onis “Trey” Glenn III, Office of Water Resources
Alabama Department of Conservation and Natural Resources, James D. Martin, Commissioner
Alabama Department of Conservation and Natural Resources, M. N. Pugh, Director, Wildlife and Fisheries Division
Alabama Department of Environmental Management, James W. Warr, Director
Geological Survey of Alabama, Danny Moore
Top of Alabama Regional Council of Governments, Jeff Perkins, Clearinghouse Coordinator

Georgia

Georgia Department of Natural Resources, Lonnice Barret, Commissioner
Georgia Department of Natural Resources, Ray Luce, State Historic Preservation Office
Georgia Department of Natural Resources, Denise P. Messick, Environmental Review Historian
Georgia Department of Natural Resources, David Waller, Director, Wildlife Resources Division
Georgia Environmental Protection Division, Harold Reheis, Director
Georgia Department of National Resources, Jeff Durniak, Regional Fisheries Supervisor, Wildlife Resources Division
Georgia State Clearinghouse, Barbara Jackson, Office of Planning and Budget

Kentucky

Kentucky Department for Environmental Protection, Alex Barber, Executive Staff Advisor
Kentucky Department for Environmental Protection, John Lyons, Division of Air Quality,
Kentucky Department of Fish and Wildlife Resources, C. Thomas Bennett, Commissioner
Federal Highway Administration, Paul Toussaint, Division Administrator
Kentucky Division of Water, Jeffrey W. Pratt
Kentucky Division of Water, Terry Anderson
Kentucky Division of Water, Leon Smothers
Kentucky Division of Water, Robert W. Ware
Kentucky Heritage Council, David L. Morgan, Executive Director
Kentucky State Clearinghouse, Ronald W. Cook, Department of Local Government

Mississippi

Mississippi Department of Environmental Quality, Charles Chisolm, Executive Director
Mississippi Department of Finance and Administration, Cathy Mallette, Clearinghouse Officer
Office of Pollution Control, Phil Bass, Director,
Mississippi Department of Transportation, Kenneth I. Warren, Executive Director
Natchez Trace Parkway, Gary Mason
Mississippi State Department of Health, Public Water Supply Program

Mississippi Department of Wildlife, Fisheries and Parks, Dr. Sam Polles, Executive Director
Mississippi Department of Environmental Quality, Barry Royals, Chief, Surface Water Division
Mississippi Department of Environmental Quality, Dwight K. Wylie, Chief, Air Division, Office of Pollution Control
Mississippi Department of Economic and Community Development, James C. Burns, Jr., Executive Director
Mississippi Department of Archives and History, Elbert R. Hilliard, Executive Director
Mississippi Museum of Natural Science, Department of Wildlife, Ken Gordon, Coordinator, Mississippi Natural Heritage Program, Fisheries and Parks

North Carolina

North Carolina Division of Archives and History, David Brook, State Historic Preservation Officer
North Carolina Division of Archives and History, David Morgan, Western Area
North Carolina Division of Water Quality, J. Todd Kennedy
North Carolina Division of Water Quality, Mary Kiesau
North Carolina Division of Water Quality, Collen Sullins
North Carolina Division of Water Resources, Steve Reed
Hiwassee State Scenic River, Jamie Nicholson, Manager
North Carolina Department of Environment and Natural Resources, Melba McGee, Environmental Review Coordinator
North Carolina State Clearinghouse, Chrys Baggett, Environmental Policy Act Coordinator
North Carolina Wildlife Resources Commission, Fred A. Harris, Chief, Division of Inland Fisheries
North Carolina Wildlife Resources Commission, Micky Clemmons
North Carolina Wildlife Resources Commission, Chris Goudreau
North Carolina Wildlife Resources Commission, Scott Loftis
North Carolina Wildlife Resources Commission, Frank McBride, Program Manager

Tennessee

Tennessee Department of Transportation, Glen Beckwith, Planning Division Director
Tennessee Division of Solid Waste, Mike Apple
Tennessee Division of Water Pollution Control, Paul Davis, Director
East Tennessee Development District, Robert Freeman, Executive Director
Tennessee Commission on Indian Affairs, Luvenia H. Butler, Director
Tennessee Department of Economic and Community Development, Wilton Burnette
Tennessee Department of Environment and Conservation, Paul Davis, Water Pollution Control
Tennessee Department of Environment and Conservation, Andrew Barrass, Division of Natural Heritage
Tennessee Department of Environment and Conservation, David Draughon, Division of Water Supply
Tennessee Department of Environment and Conservation, Nick Fielder, Archeological Reviews
Tennessee Department of Environment and Conservation, Joe Garrison, Historical Reviews
Tennessee Department of Environment and Conservation, Alan Leiserson, Director of Policy
Tennessee Department of Environment and Conservation, Barry Stephens, Division of Air Pollution
Tennessee Department of Environment and Conservation, Reggie Reeves, Division of Natural Heritage
Tennessee Division of Archeology, Jennifer Bartlett
Tennessee Historical Commission, Herbert L. Harper, Executive Director

Tennessee Wildlife Resources Agency, David McKinney
Tennessee Wildlife Resources Agency, Gary T. Myers
Tennessee Wildlife Resources Agency, Dan Sherry

Virginia

Virginia Department of Environmental Quality, Teresa Frazier
Virginia Department of Environmental Quality, Michael P. Murphy, Director, Division of Environmental Enhancement
Virginia Office of Environmental Impact Review, Ellie L. Irons, Program Manager
Virginia Department of Historic Resources, Cara Metz, Division of Resource Services and Review
Virginia Department of Transportation, Tracey E. Harmon, Aquatic Ecology Section
Virginia Department of Transportation, George B. Young, Assistant District Environmental Manager

Washington, D.C.

Appalachian Regional Commission, Thomas M. Hunter, Executive Director

9.4 Libraries

Alabama

Decatur Public Library, Decatur
Guntersville Public Library, Guntersville
Huntsville-Madison County Public Library, Huntsville
Muscle Shoals Public Library, Muscle Shoals

Georgia

LaFayette-Walker County Library, LaFayette
Catoosa County Library, Ringgold
Mountain Regional Library, Young Harris

Kentucky

Marshall County Public Library, Benton
Bowling Green Public Library, Bowling Green
Calloway County Public Library, Murray

Mississippi

Starkville-Oktibbeha County Public Library System, Starkville
Lee-Itawamba Library System, Tupelo

North Carolina

Marianna Black Library, Bryson City
Murphy Public Library, Murphy

Tennessee

Sullivan County Public Library, Blountville
Chattanooga-Hamilton County Bicentennial Library, Chattanooga
Clinton Public Library, Clinton
Putnam County Library, Cookeville
Johnson City Public Library, Johnson City
Lawson McGhee Library, Knoxville
Lenoir City Public Library, Lenoir City
Loudon County Public Library, Loudon
Memphis-Shelby County Public Library and Information Center, Memphis
Morristown-Hamblen County Public Library, Morristown
Main Nashville Public Library, Nashville
Betty Anne Jolly Norris Community Library, Norris
W. G. Rhea Public Library, Paris
Hardin County Library, Savannah
Coffee County Lannom Memorial Public Library, Tullahoma

9.5 Individuals and Organizations

Alabama

The Honorable Robert Aderholt, U.S. House of Representatives
Richard Alfiero
Eddie Allen
The Honorable Spencer Bachus, U.S. House of Representatives
Bill Beautjer
Larry Bennich, Morgan County Commission
Ron Boyd
James D. Brackin
Edwin D. Breland, Jr.
Chuck Brown
Doris Cooley Edmonds
The Honorable Robert E. “Bud” Cramer, U.S. House of Representatives
John Crowder
The Honorable Arthur Davis, U.S. House of Representatives
Buddy Denton
Michael Dudley, Tennessee Valley Indian Trail Association
Doris Cooley Edmonds
Carol English, Amcor
Terry and Jane Ewing
Keith B. Floyd
Horace H. Freeman
Kimberly Ann Garrard
William R. Gates
Stacy Lee George, Morgan County Commission
Gary W. Gray, City of Guntersville
Kerry Grissett
Hardie Haley
Paul Hargrove
Sam Harvey
Wendell Hathorn
H. A. Henderson
Richard Holst, North Alabama Council of Local Governments
William D. Hudson
William M. Hudson
Howard Hutcheson
James Loew, Florence Lauderdale Port Authority
Teresa M. Lucas, Blount County Water Authority
David Lyle
Angela Mack
Dennis Mack
D. L. Marshall
John McBride
Stanley Menafau, Limestone County Commissioner
Bruce Metts
Vicky Mitchell, Tennessee Valley Resource Conservation and Development
Nancy Muse
Larrandi Nichols
Ed Ortow
George M. Patrick, Jr.
Stuart Peck
Edwin L. Quigley
Alex Rawleigh
Harvey Reimer, U.S. Gypsum Company
James E. Rich
Jerry Rich, TAC Alloys
Juanita Riddle
Dr. Carl E. Rodenburg
The Honorable Mike Rogers, U.S. House of Representatives
Charles L. Rose
E. Carl Rudolph, Rudolph Marine & Salvage
Emilio Sahurie
Duane Sammons
Mike Scudamore, Alabama B.A.S.S. Federation
David Seibert, Commissioner, Limestone County
J. Wayne Sellers, City of Guntersville
The Honorable Jeff Sessions, United States Senate
The Honorable Richard Shelby, United States Senate
Claude H. Smith
G. David Smith
Ida Will Smith
Waylon Spurgeon
Robert Stansell, Pier Post River Journal
Roy K. Stepp Sr., Delphi
Mike Terry
Rick Terry, Port of Decatur
Robert N. Tidmore

Harold Webb
Richard J. Wells
Al Westlake
Clyde T. White
Victoria White
Andy Whitt
Duncan Wilkinson
Gary Wolfskill
Troy M. Wyers

Arizona

Curtis Davis
Harold Dehart

Florida

Mary P. Kitchen

Georgia

Denise Adams
Neal M. Allen
Bradley Arnold
Rainer Arnold
Russell Baggett
Ken Baker
Brenda Baldridge
Don Baldridge
Dick Bell
Hank Blackwood
Cecil G. Boland, President, Lake Nottely Improvement Association
Dorren Boroemeister
Patti Bransford
Steve Bratton
Donald C. Breslin
Carolyn and Mike Brock
Renai Brock
Charles Butler
C. Calder
F. C. Campbell
Mary Anne Camphell
Robert Canaan
Aif Candell
Alton and Penny Candler
Roy Cardell
Jim Carlin
Kelly Carlin
Tom Carlton
Beverly Caroell
Anne E. Caron
The Honorable Saxby Chambliss, United States Senate
John Chitwood
Julie A. Clancy
Carolyn Clarkson
Frazier Coffie
Terry Coil
Marvine Cole
Michael A. Cole
Patricia Cole
Syd and Toni Cole
Chris Collins
Fred L. Cone, Jr.
Doug Conlin
David R. Cook
Don Cope
Carry Corl
John Cory
Evelyn Crossley
Jean Crothers
Diane Daige
Mike Darnell
Robert Davies
Susan Davis
Emory Debord
The Honorable Nathan Deal, U.S. House of Representatives
Viki E. Dial
Raymond W. Doucette
Ronald and Lena Dycus
Myron Engebretson
Judy Enzman
Richard Ernstes
Randall W. Ertzbercer
Jack C. Etheridge
Phillip H Fauver
Arneta H. Ferguson
James D. Ferguson
Paul Filer
Lamar Franklin
Julia Franks
Shelia Garrison
Marie Geesa
Lynn Gill
Robert Gill
Henry L. Glove
Bobby Gordon
Eddie Graham
Richard Guenthen
Jan Hackett

Kevin Harris
Philip D. Hartley
Charles Hebert
William P. Hennells
Shirley Hennels
Roger Hutchison
Mary S. Johnson
Joseph L. Johnson, Jr.
Mr. and Mrs. Ray Johnston
Mike Jollen
Jerry Kehoe
Patricia Kehoe
Jack Kilgore
Judy King
Mike King
Robert A. Klein
Charlos Kraus
Charles Krick
Anthony Lagratta
Doug LemanJudy Leman
JoAnne Leone
The Honorable John Linder, U.S. House of Representatives
Pennye W. Loftin
Frank Maloney
Michelle Maloney
Gene Margelli
Tammy Massengall
Jim McAfe
Lori McDaniel
Robert H. McDonald
Ronnie McDonald
John McNeill
Louise E. McTaggart
Chris Merz
David A. Miller
The Honorable Zell Miller, United States Senate
Emma Moore
Joyce Morgan
Ronald Morgan
Bill Moshia
Bradley and Janie Nelson
Frank Neri
Linda Neri
Lois Newton
The Honorable Charlie Norwood, U.S. House of Representatives
Diana Novak
Tom Oprandi
Bill and Judy Osborne
Cindy Pack
Lamar Paris, Commissioner, Union County
Bill Parker
Ellen Pease
Allen Peters
Cindy Price
Van Price
Ed Prieto
Helen Prieto
Merril C. Prime
Noreen Prime
Wayne Probst
James R. Pulley
Jane Ralston
Joanna Robison
Ruth Rolander
Gail Romine
Leslie Rush
Scott Schwitters
Martha Scissom
Bob Seaton
MaryAnn Shannon
A. G. Sherman
Jonni Marie Shook
Bob Short, Staff, Miller
Peter Skop
Carolyn Smith
Harry E. Smith
Joyce A. Smith
Michael Smith
Robert A. Smith
Stephen Smith
Rebecca St. John
S. H. Starr
Stewart Haslan
Ken Stuart
Kenny Stuart
James Summey
Shirley N. Summey
Bob Toner
Doug Triestram
Linda Trundle
Carl Vanzura
Howard Walters
Edward Ward
Louis Ware
Parmelee Warel
Betty Watson
Dan Watson

Taylor Watson, Hiwassee Scenic River Stakeholders
Brad Wayne
George K. Weese
Mel Weingarten
D. C. Wenberg
Joanne Wenberg
Irene Werch
Arvil Westmoreland
Marie Westmoreland
Barry Wheeler
Linda Wheeler
Richard L. Wheeler
Birdie White
Anne Wiggin
C. L. Williams
Harry Williams
Sue R. Williams
Pam Witherow
Lawrence Wright
Marlene Wright

Indiana

Steven R. Cassidy

Kentucky

Victoria Alapo
Les Alonzo
Brad Arterburn
Harold Babb, Kentucky B.A.S.S. Federation
Jack C. Baird
Roy Baker
John Barham
Greg Batts
David Baxter
Mr. and Mrs. William Beasley
Vincent Beichnen
Kathy Bell
Larry Bennett
Don Billmaien
Lee W. Bird
Nancy Black
Herb Bowling
Robert M. Brewer
David M. Brown
Edna I. Brown
Joe and Mary Browning
Jerry Budzens
The Honorable Jim Bunning, United States Senate
Jim Burkholder
William Butler
Tina Carroll
Kathy Cassidy
Bill K. Castleberry
Douglas Coleman
Marty Coluburn
Louis C. Columbus
Pat Connaughton
Dick Cook
Naomi Craine
Dale Creech
Jan Crick
Kenneth Curtes
Midge Dacus
Jan Dalton
Bob Danner
Wes Davis
John DeFreitas
Dexter Douglas
Joseph Dresckiewicz
Margaret Dumbacher
Don and Alice Dycus
Carl Ecklund
Sally Ecklund
Richard Emigholz
Phillip Farnum
Gary Fletcher
Jan Flowers
Bobbie Foust
Adam T. Freeman
Paul E. Frey
Robert B. Gassett
Barry Gill
Richard Gorbett
Glenard E. Hale
Harley Hall, Tennessee Valley Towing
Robert B. Hall
Bob Harbison
Steven R. Hawkins
Prince A. Herzog
Judy Hicks
Freddie Hines, Atofina Chemicals
Clinton Horton
Bob and Linda Huebschman
Tony Hughes
John Humphries
Jeff A. Jones

Carole Kovich
Michael Kovich
Brenda Lady, Lake Realty
David Lawson
Sandra Lawson
Honorable J. D. Lee, Lyon County Judge Executive
Carol Lewis
The Honorable Ron Lewis, U.S. House of Representatives
Richard Logston
James and Lavada Mansfield
Joe and Marlene Mason
David Mast, Staff, Whitfield
Toni Matinagin
Kay McCollum
Lee McCollum
The Honorable Mitch McConnell, United States Senate
Dennis Metts
Bill Meyers
Raymond L. Meyers
James Millan
Ronnie E. Miller
Tony Miller
Raymond L. Moore
Wayne Morris
Gerald L. Mudroch
Jim Mullen
Michele Myer
Randy Newcomb
Frank J. Nichols
George Olinger
Christina Onnybecker
Ora Pittman
Tom Osthoff
Daniel B. Ouick
Wayne and Cheri Pederson
John T. Piercefield
Russ Randall
Walter Recbil
Sonny Reynolds
Bettye Riddle
Dale Ritter
The Honorable Harold Rogers, U.S. House of Representatives
Dorris J. Ross
Johnny Ross
Fred Sanders
Matt Sanders
Martin Seaton
Gary Sharp
W. R. Simpson
Melvin Smith
Steven R. Southern
Stacie Stacie Sutton
Richard Starkey
Troy Stovall
Barbara M. Suitor
Jim Suitor
Martin L. Swann
Walter Taylor
G. E. Tholness
Gary Thompson
Steven R. Thomson
Walter Thomson
Gary Enos Thornell
Chip Tuller
Larry Valentine
Joe Vancil
Michael Volpert
J. R. Waddell
B. J. Wadlington
Elizabeth Wadlington
Billy Walker
Janet Walker
The Honorable Edward Whitfield, U.S. House of Representatives
Georganna Whitfield
Glen Willett
Paula Willett
Bob and Marilyn Williams
Chuck Windhorst
Kathy Wood
Mark Wood
W. M. Worman
Garland Wyatt
Paul Yambert
William Zenter

Michigan

Dr. Ed Helbing

Missouri

M. Melinda Sanderson

Mississippi

Alvia J. Blakney
The Honorable Thad Cochran, United States Senate
Linda Gates
Bill and Judy Glenn
Charles Haley
Larry and Rhonda Howerton
The Honorable Trent Lott, United States Senate
Matthew Miller, The Nature Conservancy
The Honorable Chip Pickering, U.S. House of Representatives
Dale Price, Tishomingo County
David Robinson
Wayne Slocum
Johnny Timmons, Tupelo Water & Light
Dale Warrenir
Richard Warriner
The Honorable Roger Wicker, U.S. House of Representatives
Thomas E. Wilson
Amy Zuringue

North Carolina

David E. Alverson
B. Gray Appleton
John C. Ashe.
Pam Battles
Kandy Ballard
The Honorable Cass Ballenger, U.S. House of Representatives
Thomas A. Browning
The Honorable Richard Burr, U.S. House of Representatives
J. Linda Cable
John Carringer, Murphy Electric Power Board
Nicholas Carter
Kevin Colburn, American Whitewater
Mary Pat Dailey
Joanne H. Davis
Ulkesh Desai
The Honorable Elizabeth Dole, United States Senate
Bill Forysth
The Honorable John Edwards, United States Senate
Judy Edwards
Casteel Floyd
Tom Freisen
Merwin Geraghty
Doreen Gingrich
Jean Harris
Ruth B. Herbert
Bill Hughes
Linda Hurd
Dana Jones, Cherokee County Commission
Ernest Jones, Cherokee County Commission
William Kieffer
John Kindley
Marvin Ledford
Jeff Martin
Paula Martin
Mallory G. Martin
Fred Martin Jr
Jean Miller
Linda Miller
Terry McGavok
Bruce E. Medford
David and Ellen Monteith
Carmaleta L. Monteith
Gregg Newell
Eddie Norton
Bud Penland
Bob Penland II
Bill Romans
Jan Romans
Alex Starks
The Honorable Charles H. Taylor, U.S. House of Representatives
The Balins, Fontana Lake Estates
Robert F. Thornton
Barbara P. Vicknari, Cherokee County Commission
Lydia Wade
Nick Williams

South Carolina

Clark Woolum

Tennessee

Shirley and Allen Abbott
Robin Acuff
Betty Adkison
Oiusegun Areola
M. Jane Aiken

The Honorable Lamar Alexander, United States Senate
Rodney Alexander
Leila S. Al-Imad
Larry L. Allbritten
Anton and Anna Allen
Brad I. Anderson
Eugene Ashley
Floyd A. Ashley
Cheryl Askew
Andrew Atkins
Ramona L. Atkins
Thomas Atkins
Daxton J. Bacaoman
Christine Bailey
Elizabeth W. Bailey
Paul A. Bailey
Johnny T. Ball
Mr. and Mrs. Albert Ballowe
Herbert O. Beach
Caron Beard
Terry Becknell
Marian Bertotti
Lloyd Bible
Glen Bibbins
Gordon Bill and Mary Lae Jolly
Donna Bishop
The Honorable Marsha Blackburn, U.S. House of Representatives
Jeff Bloomer
Doug and Sheila Boggs
Jim Bond
Paula Bonner
Jim Boone
James Bornhoeft
George Bottcher
James R. Bowers
Joe Brang
David Briggs
Tim Broadbert
Ken Bronner
Jim Broson, Tennessee River Gorge Trust
Wilfred S. Brown, Trout Unlimited
Faye Burger
Jim Burke
Sharon Burke
Ray T. Burkhart
Pat Byrne
Michael Campbell
Ronald Scott Carpenter
M. Carratu
Jack Carrier
Aileen Carroll
Clara Carter
Doug Carter
Homer Carter
Carroll M. Cate
Ken Chase
Chris Cline
Robin Cobb
Patrick W. Coghlan
April Coll
Ruth Y. Combs
Phil Comer
Dave Cooper
The Honorable Jim Cooper, U.S. House of Representatives
Gary Cosby
Greg Cotter
Gordon Cox
J. Charles Cox
Michael P. Cox
David Cumbow
Tom and Jenny Davenport
The Honorable Lincoln Davis, U.S. House of Representatives
Jos. S. de Wit
Ralph Decicco
Don Denney
Brett Dillon
S. T. Dixon
Kelley Dodd
C. and J. Dodson
Shirley Dominick
Rick Driggans
The Honorable John J. Duncan, Jr., U.S. House of Representatives
Tom Durham IV
Michael Eargle Early
John Ehlendt
Robin Eiselstein
Dan and Sheryle Elkins
Virgil J. Englert
Chuck Estes
Kathy Evans
Dan Fairfax
Jim Fearon
Angela Felts
John T. Finney
Eddie and Fane Fisher

Steve Fitzgerald
Charles Flemming
Walter E. Flood
Frederick and Marjory Flynn
Jim Folck
Karl Forsbach
Andrea Foster
Henry Fribourgh
The Honorable Bill Frist, United States Senate
Craig Froehling
Steve Fry
Stephen Fullen
Michael T. Garland, Johnson City Power Squadron
Dick Geiger
Anne Gillenwater
R. Lynn Gilmore
The Honorable Bart Gordon, U.S. House of Representatives
Bob Graham
Sheryl Gramont
Ann Graves
Frank Gurley
Thomas Gutherie
Dennis Haldeman
David Hall
Joe Harrell
Brenda Hart
Carolyn and Eugene Henderson
Fred Hendrix
John Henna, Bristol Tennessee Electric System
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Chapter 10

Supporting Information

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Chapter 7—Potential Mitigation Measures

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10.2 Glossary

26a permit—written approval required under Section 26a of the TVA Act, which must be obtained from TVA prior to construction, operation, or maintenance of boat docks, piers, boathouses, rafts, buoys, floats, boat-launching ramps, fills, nonnavigable houseboats, or other such obstructions which may affect navigation, flood control, public lands, or reservations along or in the Tennessee River or its tributaries.

100-year floodplain—that area inundated by the 100-year flood.

100-year flood—the level of flooding with a 1-percent chance of being equaled or exceeded in any given year; does not indicate a time period of 100 years between floods of this magnitude.

access rights—property rights across TVA-owned shoreland held by some adjacent landowners. These rights provide ingress to and egress from the water and allow the landowner to request TVA permits for proposed docks and other water-use facilities.

adaptive management—regarding this EIS, includes environmental monitoring and the process by which TVA may adjust its reservoir system operations policy after implementation to further address effects of operations.

aeration—the mixing of air and water, usually by bubbling air through water or by contact of water to air.

algae—small (generally microscopic) plants that live either floating in the water or attached to submerged objects.

alluvium—material such as earth, sand, gravel, or other rock or mineral materials, transported by and laid down by flowing water.

anaerobic—oxygen-deficient conditions.

ancillary services—those services necessary to support the transmission of electric power from seller to purchaser, to maintain reliable operations of the transmission system; includes system control, reactive supply and voltage control, regulation, and spinning and supplemental operating reserve.

aquatic—typically living in water.

aquatic invasive plants—those species of plants that spread at a prolific rate and can crowd or out-compete other species with such speed and thoroughness that the ecosystems become negatively affected. This definition includes those plants that are exotic, or non-native, to the southeastern United States, as well as some native species that are capable of growing at levels sufficiently high to substantially alter the environment.

aquatic macrophytes—larger, generally rooted or floating aquatic plants.

aquifer—a geological formation that contains water, especially one that supplies the water for wells and springs.

archaeological resources—material remains of past human activity.

backlands—the land extending beyond 0.25 mile from the TVA system shoreline.

10.2 Glossary

backwater—locations along a river where the water level depends on the level at a downstream dam rather than strictly on the rate of flow in the stream channel.

balancing guide—the elevation defining the bottom of the normal operating zone that is used to help maintain relative balance among tributary storage projects for the Preferred Alternative.

bank stabilization—the physical strengthening of a streambank or shoreline to resist erosion. Typical stabilization techniques include placing of riprap, timbers, tires, or vegetation along the eroding area.

Base Case—serves to document TVA's existing reservoir operations policy. For purposes of this EIS, it is the No-Action Alternative. Under the Base Case, TVA would continue operating individual projects in accordance with existing guidelines as defined by guide curves, priorities, and project commitments and constraints.

benthic—refers to the bottom of a stream, river, or reservoir and the organisms that live there.

best management practices—construction or maintenance practices that have been shown to be the most effective and practical ways of preventing impacts environmental resources.

biodiversity—the number and types of species in the TVA region.

Board of Directors (Board)—TVA's three-member board. Members are appointed by the President of the United States and confirmed by the Senate. The President also determines which Board member will serve as Chairman. Each member serves a term that lasts 9 years.

buildout—a term used by TVA in this EIS when referring to the estimated maximum amount (percentage) of shoreline that could eventually be developed for residential uses.

carbon dioxide (CO_2)—a colorless, odorless nonpoisonous gas that results from fossil fuel combustion and is normally a part of the ambient air.

carbon monoxide (CO)—a colorless, odorless, poisonous gas produced by incomplete fossil fuel combustion.

census block group—the smallest geographic area, usually containing 600 to 3,000 people, for which the Bureau of the Census collects and publishes sample data.

cfs—cubic foot per second; typically used as a measure of flow in a stream. A cubic foot is equivalent to about 7.5 gallons.

channel capacity—the maximum rate of flow that may occur in a stream or river without causing it to flood its banks.

Clean Water Act (CWA)—an Act passed in 1972 to protect the Nation's water quality. The CWA is the primary law for regulating discharges of pollutants into the waters of the United States by enforcing water quality standards that are defined in Section 301 of the Act.

commercial (barge) waterway—a marked, 9-foot-draft navigation channel suitable for barge transportation, that exists on the Tennessee River and its tributaries.

consumptive use—the difference between water withdrawals from and returns back to the river system. It is the water that may be evaporated in industrial cooling, released from plants to the atmosphere, consumed by humans or livestock, or otherwise used and not returned to surface water or groundwater.

contiguous—adjacent, touching.

Council on Environmental Quality (CEQ)—the council responsible for developing environmental policy and advising federal agencies concerning implementing the National Environmental Policy Act (NEPA). Congress created the CEQ specifically to administer NEPA. Congress intended that each federal agency assume responsibility for meeting NEPA requirements, with guidance from the CEQ.

critical-period, 500-year storage—the maximum storage volume required to store the inflow from a storm with a recurrence interval of 500 years, or the probability of occurring in any give year of 0.002. The storage volume required for a specific reservoir also takes into account the reservoir's natural inflow/ discharge and inflows from upstream projects.

croplands—lands used for growing agricultural crops, such as soybeans and corn, and for pasture.

cubic yard—a measure of volume used in many construction activities; the amount of material that would fill a space 1 yard (3 feet) on each side (27 cubic feet); equals 0.00062 acre-foot.

cultural resources—any historic structure, historic site, or archaeological site that is protected by the National Historic Preservation Act (NHPA) or other preservation legislation.

cumulative impacts—impacts that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable actions, regardless of what agency or person undertakes such actions (40 CFR 1508.7).

derates/derating—a temporary or permanent reduction in a power plant's capacity to generate electricity caused by, among other things, age, loss of efficiency in, loss of availability of, or loss of reliability of the unit due to a number of impacts—including cooling water temperature.

designated uses—categories of beneficial uses of water in a stream that have been specifically identified by the Tennessee Department of Environment and Conservation (TDEC).

detention space—see "flood storage space."

dewatering areas—low-lying areas that are isolated from a mainstem river channel by a series of dikes allows those areas to be pumped out or "dewatered" during spring and summer. These lands can then be used for agricultural or wildlife management purposes; mosquito production is also controlled and timber resources are protected.

direct impacts—effects that are caused by the action and occur at the same time and place (40 CFR 1508.4).

discretionary operating zone—for tributary reservoirs, the storage space between the flood guide and minimum operations guide.

dissolved oxygen (DO)—the oxygen dissolved in water, necessary to sustain aquatic life; usually measured in milligrams per liter (mg/L) or parts per million (ppm).

draft—the depth below the water surface that a towboat and barge extends when fully loaded.

drawdown—the process of lowering reservoir levels. Drawdown usually is measured in feet or units of storage volume.

drawdown zone—fluctuation of pool levels, in combination with the steeper slopes of the tributary reservoirs, exposes what is referred to as a "bath tub ring" or barren drawdown zone around the shoreline.

dredging—the removal of material from an underwater location, primarily for deepening harbors and waterways.

easement—an interest in land owned by one party that allows another party to have specific, limited use of the land.

ecosystem—a community of organisms in a region and their surrounding physical resources and conditions.

edge—the junction of two different habitats, such as forest and grassland.

effluent—contaminated water, treated or untreated, discharged through a pipe from a wastewater source; generally applies to municipal and industrial wastewaters but can include wastewaters from other sources such as mining operations, yard drainage from industrial operations, and drainage from landfills.

EIS—Environmental Impact Statement**—**the most detailed type of environmental assessment document identified in NEPA.

embayment—a bay or arm of the reservoir.

emergent wetland—wetlands dominated by erect, rooted herbaceous plants such as cattails and bulrush.

emission shifting—the change in fuel emissions resulting from either a change in mode of transportation or a change in the number of trips of the existing mode.

endangered species—an animal or plant that is in danger of extinction throughout all or a significant part of its range.

Endangered Species Act—a federal law, first passed in 1973, leading to federal lists of endangered and threatened wildlife and plants, that requires federal agencies to ensure that actions they proposed to authorize, fund, or carry out are not likely to jeopardize the continued existence of listed species or adversely modify critical habitat.

Energy Vision 2020—a combined integrated resource plan and Programmatic EIS. In Energy Vision 2020 (TVA 1995), TVA identified and proposed to select short- and long-range strategies that would enable TVA to meet the additional needs of its customers for electricity from 1996 to 2020. TVA identified a portfolio of energy resource options from seven alternative strategies that best met TVA's evaluation criteria regarding costs, rates, environmental impacts, debt, and economic while meeting customer energy needs. Energy Vision 2020 identified short-term and long-term actions to provide flexible, competitive energy choices.

erosion—natural processes by which soil or rocks are moved from one location to another. Typical examples include streambank or shoreline erosion in which soil particles are washed away by the forces of water.

eutrophication—the nutrient enrichment and response in productivity of a water body (i.e., relatively high levels of aquatic plant life); this is a natural aging process that can be accelerated by nutrients added by humans.

Executive Order 11988—an order to federal agencies signed by the President requiring them to avoid taking or supporting siting actions in floodplains and to minimize the effects of such actions if they cannot be practically avoided.

Executive Order 11990—an order to federal agencies signed by the President requiring them to avoid new construction in wetlands and to minimize the effects of such actions if they cannot be practically avoided.

Executive Order 12898—an order to federal agencies signed by the President that requires some federal agencies to consider potential disparate effects of proposed actions on minority and low-income populations.

Executive Order 13112—an order to federal agencies signed by the President that requires federal actions to address invasive species ("alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health").

farmland conversion—shifting the use of land to non-farm uses, with irretrievable losses occurring when the land is developed.

fill period—the spring period of lessening runoff, when reservoirs are filled at a rate designed to maintain flood storage and reach targeted summer pool elevations

flats—includes mudflats as well as flats of other natural and artificial substrate types, such as various mixtures of sand, silt, cobble and gravel.

floodplain—the part of a stream valley that is covered with water during a flood event; typically associated with a flood that could occur at a given frequency.

floodway—the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that a specific recurrence interval flood (typically a 100-year flood) can be passed without substantial increases in flood heights. Minimum federal standards limit increases to 1.0 foot, provided that hazardous water velocities are not produced.

flood storage—the volume within an elevation range on a TVA reservoir that is reserved for the storage of floodwater.

flood crest—the highest (peak) water level in a stream or river during a flood.

flood guide—a curve defining the seasonal allocation of flood storage. It represents the elevation of the reservoir above which the space is reserved for temporary and intermittent storage of water to help reduce flows at downstream locations.

foraging habitat—an area where an animal or select group of animals search for and obtain food.

forb—a nonwoody plant other than a grass.

fossil fuels—any organic fuel, such as coal, oil, and natural gas.

geographic information system (GIS)—a collection of computer hardware and software that helps people efficiently capture, store, update, manipulate, analyze, and display information about the location of the Earth's natural, cultural, economic, and human resources, and the human-made environment. Location is normally shown on maps with associated textual and numeric information that describes the characteristics of those resources.

global warming –the theory that certain gases, such as carbon dioxide (CO_2), methane (CH_4), and chlorofluorocarbon (CFC) in the earth's atmosphere effectively restrict radiation cooling, thus elevating the earth's ambient temperatures.

grasslands—an area dominated by grasses; includes lawns, pastures, and hayfields.

greenhouse effect—the buildup of carbon dioxide and other trace gases that allows light from the sun's rays to heat the Earth but prevents a counterbalancing loss of heat.

greenhouse gases—emissions that are thought to be associated with global warming (also referred to as greenhouse emissions). The term "greenhouse gases" includes CO_2 (generally a product of combustion), methane (generally a product of natural gas and decomposition of organic material), nitrous oxide (a product of combustion), and chlorofluorocarbons (freons). Because emissions of CO_2 from combustion represent the largest quantity of greenhouse gas emissions, CO_2 often is used as a gauge of total greenhouse gas emissions. (See "global warming.")

gross regional product (GRP)—the sum dollar value of goods and services created in the region; because the GRP measures the sum of wages income and corporate profit, it is a broad measure of full economic effects.

groundwater—water that is located under the surface of the earth.

guide curves—see specific guide curve definitions (e.g., minimum operations guide and flood guide).

habitat—the combined physical and biological features of a particular location that provide conditions necessary for the survival of one or more species.

habitat suitability model—a model developed to describe the suitability of an area to a particular species or group of species. It normally includes measurements of many of the species' requirements, such as food or nest sites, and is useful in describing how the species will be affected by changes to an area.

headwater—the upstream portion of a watershed.

hydric soil—soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic (oxygen deficient) conditions in the upper part.

hydrology—the field of study of the distribution and movement of water.

hydroturbine—a wheel with attached blades mounted to a shaft. Water released from a reservoir pushes against these blades, causing the turbine to spin, which powers the generating unit.

impoundment—in this EIS, another term for reservoir.

indirect impacts—effects that are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (40 CFR 1508.4).

Interagency Team and Public Review Group (IAT/PRG)—individuals from the six Valley states, including 13 members of the public and representatives from 12 federal agencies, who were involved in review and development of the Reservoir Operations Study.

inter-basin transfer (IBT)—when water is moved from one watershed to another watershed. In 2000, the 13 IBTs from the Tennessee River watershed diverted 5.61 million gallons per day.

invasive species—an organism that successfully establishes itself, proliferates, and displaces native organisms in an ecosystem to the detriment of that ecosystem. Invasive species may include organisms referred to as non-native, exotic, alien, weeds, and pests, and may also include native species capable of rapid population expansion.

invertebrates—animals without backbones; used to refer to all animals except fish, amphibians, reptiles, birds, and mammals (the vertebrates).

karst—an irregular limestone region with sinks, underground streams, and caverns.

kilowatt hour (kWh)— the amount of energy equal to 1,000 watt-hours; common measure for use of electricity over time.

Lake Improvement Plan—the Tennessee River and Reservoir Operations and Planning Review (TVA 1990), commonly referred to as the Lake Improvement Plan. The Lake Improvement Plan proposed changes in TVA reservoir operations to maintain minimum flows below dams at critical times and locations, to increase dissolved oxygen (DO) below 15 dams by aerating releases, and to delay unrestricted summer drawdown until August 1 on 10 tributary reservoirs. These actions were proposed to recover over 170 miles of aquatic habitat lost from intermittent drying of the river bed below TVA tributary dams and improve levels of DO in over 300 miles of river where water quality was impaired in late summer and fall by releases through TVA dams.

landscape visibility—a combination of several factors that include the context of those viewing the landscape and the concern they have toward the scenic value of the lands under study. Other factors include duration of view, number of viewers, viewing distance, and discernable details that can be influenced by light/shadow, atmospheric conditions, and air quality.

load—the amount of electric power that is drawn from TVA's electric system at a given point in time.

lock—an enclosed dam chamber with gates at each end that allows water to be admitted and released; the change in water levels allows vessels to be raised and lowered so they can pass over unnavigable parts of a river. The locks in the dams on the Tennessee River make navigation possible for 652 miles—from Knoxville, Tennessee, to Paducah, Kentucky.

loess—a type of soil consisting of windblown silt.

macroinvertebrates—aquatic insects, snails, and mussels whose species and genus can be determined with the naked eye.

macrophytes—aquatic plants large enough to be seen by the naked eye.

mainstem or mainstream storage reservoirs—reservoirs located along the Tennessee River between Fort Loudoun Reservoir and the Ohio River. These reservoirs are managed with seasonal lowering (typically less than 5 to 10 feet) of water levels to provide storage for flood control and were designed to serve multiple purposes, especially commercial navigation and hydropower production.

managed area—specific, defined, land in public, institutional, or private ownership that has been established and is operated to protect significant features or resources.

mass wasting— the slumping, sliding, or toppling of sections of bank, caused by structural failure.

megawatt hour (MWh)— the amount of energy equal to 1 million watt-hours; common measure for use of electricity over time.

minimum flow—a release from one or more dams provided to meet downstream water needs (e.g., aquatic habitat, water supply, and waste assimilation), hydropower production, reservoir level targets, and other commitments; a minimum flow does not represent the lowest flow rate that TVA can pass from a dam or dams. Project minimum flows are the minimum flow required to be released from a specific dam over a specific time period. System minimum flows are minimum flows needed at some point in the system to meet certain specific needs for power, waste assimilation, navigation, and other beneficial uses.

Minimum Operations Guide (MOG)—a seasonal elevation guide for some tributary storage projects that denotes a level below which only minimum flows should be released. The system MOG is a seasonal storage guide based on the sum of the storage in 10 tributary storage projects.

minimum pool—the lowest planned water elevation set by TVA for a mainstem reservoir.

mitigation—an action that either would result in avoidance of an effect or lessen adverse effects on a resource.

modal diversion—shifting of cargoes from barge to the rail or truck mode.

modeling—for this study, use of computers to predict the effects of altered reservoir operations.

multi-purpose reservoirs—reservoirs which were constructed and are operated to accommodate multi-purposes.

National Environmental Policy Act (NEPA)—a 1970 federal law that requires federal agencies to determine the environmental impacts of proposed actions, to consider alternatives to those actions, and to include a consideration of the environmental impacts when deciding which actions to conduct. The federal agency must prepare an EIS for actions "significantly affecting the quality of the human environment" (42 USC 4332).

National Historic Preservation Act (NHPA)—a 1966 federal law that requires agencies to avoid or mitigate impacts on significant archaeological or historic resources.

National Wetlands Inventory (NWI)—a program of the U.S. Fish and Wildlife Service that maps and categorizes wetlands of the United States based on "Classification of Wetlands and Deepwater Habitats of the United States."

native species—a species, not introduced from another location, which historically occurred or currently occurs in a particular ecosystem or habitat.

navigable waterway—the Tennessee River and tributaries of the Tennessee River having a marked, 9-foot-draft navigation channel suitable for barge transportation.

Neotropical migrant birds—birds that nest in the United States or Canada and migrate to spend the winter in Mexico, Central America, the Caribbean, or South America.

nonpoint source pollution—pollution such as nutrient increases, fecal wastes, and siltation occurring from sources such as agriculture or general urban development of an area.

normal operating zone—the operating space between the flood guide and the balancing guide for the Preferred Alternative.

nutrient enrichment—the addition of excessive nutrients above those naturally found in a water system.

nutrient loading—the addition of nutrients such as phosphorus or nitrogen from various sources in a watershed.

objectives—reflect the public and TVA's range of preferences for emphasizing selected benefits from reservoir operations (such as improving recreation, reducing flood risk, and increasing tailwater aquatic habitat conditions).

operating guidelines—a set of guidelines that include guide curves, minimum flow requirements, water release requirements, and other requirements to meet system operating objectives.

option—one of many possible distinct types of water control operations or practices (such as maintaining specified winter or summer pool elevations and releasing minimum flows) that could be conducted at reservoir projects as part of one or more system-wide alternatives.

oxygen injection—a technique to improve dissolved oxygen levels in tailwaters, in which liquid oxygen is turned into gaseous form and then injected into the water before it enters a dam's turbine.

peaking capacity—a generating unit's or system's maximum output, generally applied to power resources whose output can be quickly changed to meet changing power requirements.

peaking power—supplying additional power quickly when daily power demands are highest.

permit for shoreline use—approval of proposed uses of TVA shoreline areas that can vary from the construction of water-use facilities or shoreline stabilization to the use of TVA lands for a variety of purposes, including vegetation management, recreational use, and agricultural use. These activities may be covered by a 26a permit or a TVA land use permit, depending on the type of activity.

personal income (PI)—wages and salary income, including transfer payments, dividend interest, and rent less personal social security payments.

physiographic regions—general divisions of land; each area has characteristic combinations of soil materials and topography**.**

point source pollution—pollution that typically comes from an identifiable source, such as industrial and municipal discharges.

policy alternative—a set of operational changes that would rebalance system operations to emphasize certain operating objectives, such as increased power production or opportunities for recreation. A policy alternative may emphasize several operating objectives at the same time.

pool recovery zone—the operating space below the balancing guide. Operations within this zone are usually made at minimum flow rates to try to fill the reservoirs back to within their normal operating zones.

Power Service Area—in this EIS, the area that receives its electricity from TVA sources. The Power Service Area includes 170 counties in much of Tennessee and parts of Alabama, Kentucky, Georgia, Mississippi, North Carolina, and Virginia.

Preferred Alternative—the policy alternative that TVA staff would prefer to implement in order to achieve the overall project purpose.

prime farmland soils—types of soils with physical and chemical properties that economically can sustain high crop yields.

programmatic review—a type of environmental review that is appropriate when a decision involves a policy or program, or a series of related actions by an agency over a broad geographic area, as compared to a specific project or action.

project minimum flow—see minimum flow.

protected species—in the context of this EIS, any plant or animal species that is on a state or federal list of endangered, threatened, or special concern or in need of management of some form.

pumping station—a structure housing pumps used to move water through a pipeline from one location to another over some higher elevation.

qualitative—analysis based on professional judgment and/or limited data.

quantitative—analysis based on hard data or numbers that can be substantiated from observations or modeled data.

ramping rate—how many hydropower turbines are simultaneously brought online or taken offline at a hydropower plant. The term ramping rate also indicates an increase or decrease in generation by an individual hydro turbine unit.

raptors—birds of prey such as hawks, eagles, and owls.

recreation period—see summer pool elevation.

recreation trip—engaging in one or more recreation activities at one or more recreation sites for an unspecified amount of time but generally more than 3-4 hours. Several recreation visits could be made during one recreation trip (i.e., a person could go camping, fishing, and boating, which would be counted as three visits to different recreation sites during one trip). (See “recreation visit” below.)

recreation visit—the visit to an area or site to engage in some form of recreation activity. Although no timeframe is associated with a visit, it generally is approximately equal to a visitor hour. A person could enter different recreation sites during a day or could make multiple visits to the same site in one day, which would be counted as more than one visit. (See “recreation trip” above.)

Regional Resource Stewardship Council—a 20-member council first convened in March 2000. The council is a formally authorized Federal Advisory Committee. The members of the Regional Council represent public and private stakeholders who benefit from TVA’s management of the river system. Members are nominated by the governors of the seven states in the TVA power service area, the distributors of TVA power, and TVA’s directly served customers. They serve 2-year terms. Representatives of other interested groups are chosen by TVA.

regulating zone(s)—regulating zones provide guidance for the temporary storage of floodwaters and for the effective recovery of flood control space at each project. Each regulating zone is associated with a discharge rate at which flood storage recovery efforts should be made.

regulating zone guide—this curve represents the reservoir elevation at which the flood storage recovery policy changes, usually resulting in higher discharge rates when the pool is above the guide.

reregulation weir—same as weir.

reserve margin—extra standby power generation capacity that is maintained to ensure power system reliability.

reservoir (pool) level—the elevation of the water in a reservoir at a given time.

Reservoir Operations Study (ROS)—a study and Programmatic EIS. The purpose of this ROS is to determine whether changes in TVA's reservoir operating policies would produce greater overall public value. TVA is using the EIS process to elicit and prioritize the values and concerns of stakeholders; identify issues, trends, events, and tradeoffs affecting reservoir operating policies; formulate, evaluate, and compare alternative reservoir operating policies; provide opportunities for public review and comment; and ensure that any decision to change its operating policies reflects a full range of stakeholder input.

reservoir-triggered seismicity (RTS)—the initiation of earthquakes by the impoundment or operation of a reservoir; reservoir-triggered earthquakes can be identified by a change in the pattern of earthquake activity in the immediate vicinity of a reservoir that usually begins during or shortly after (days to a few years) initial filling of the reservoir; rapid reservoir elevation changes can also trigger earthquakes.

residence time—the amount of time on average that water remains in a reservoir.

restricted drawdown—a lowering of reservoir pool levels that is limited by one or more restrictions on the rate of change.

riparian zone—an area of land with vegetation or physical characteristics that reflect permanent water influence; typically, a streamside zone or shoreline edge.

riprap—stones placed along the shoreline for bank stabilization and other purposes.

riverine—having characteristics similar to a river.

run-of-river reservoir—a project that relies on the flow of a stream or river to produce hydropower, with little or no capacity to store water; one of two major categories of projects, the other being storage. These projects pass water through a dam at nearly the same rate it enters the reservoir, so they are managed with minimal changes in seasonal reservoir levels.

runoff—rain that flows off from the land into streams. About 40 percent of rainfall in the drainage area of the Tennessee River system becomes runoff.

scenic attractiveness—a measure of scenic quality and its importance based on the perception of natural beauty that is expressed in the landscape.

scenic integrity—the measure of disturbance to a landscape and the degree to which the landscape deviates from the character and quality that are desired and valued for its scenic attractiveness. Scenic integrity is influenced by both the type and degree of shoreline development and pool-level elevations.

scope—range of operation; extent of activity or influence.

scoping—for this EIS, the process by which TVA gathered and analyzed comments from the public and government agencies on reservoir operating policies and then used that information to identify critical issues and subsequently develop alternative operating policies.

scrub/shrub—woody vegetation less than 20 feet tall, under the Cowardin et al. (1979) wetland classification system. Species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions.

sediment—material that is moved and deposited by wind and/or water.

shoreland—same as shoreline area.

shipper savings—costs that shippers avoid by moving cargo via barge versus rail or highway. Shipper savings are realized when navigation channels are deepened, or when available depth is sustained at consistent levels.

shoreline—the line where the water of a TVA reservoir meets the shore when the water level is at the normal summer pool elevation. This area is measured in miles in the SMI EIS.

Shoreline Aquatic Habitat Index (SAHI)—the index used to determine the quality of shoreline aquatic habitat, based on seven characteristics important to support good populations of sport and commercial fish.

shoreline area—the surface of land lying between the minimum winter pool elevation of a TVA reservoir and the maximum shoreline contour or TVA backlying property line (whichever is further). This area is measured in acres in the SMI EIS.

Shoreline Management Initiative (SMI)—An Assessment of Residential Shoreline Development Impacts in the Tennessee Valley (TVA 1998), known as the Shoreline Management Initiative, or SMI. In the SMI, TVA reviewed existing permitting practices and established a policy that better protects shoreline and aquatic resources, while accommodating reasonable access to the water by adjacent residents. The SMI document represents a review of alternative actions as well as an EIS. Seven alternatives for managing residential development were analyzed. This action affected 30 reservoir projects where TVA (under Section 26a of the TVA Act) has approval authority over proposed obstructions (such as docks, bank stabilization, and vegetation management). In 1998, 13 percent of the total shorelines miles on TVA's reservoirs was developed for residential uses, and lake front property owners had access rights along an additional 25 percent of the shoreline that was undeveloped. The SMI projected that up to 38 percent of TVA shoreline would eventually be developed for residential uses.

spillways—structures designed to allow relatively high flows of water over the top of a dam or through a separate structure. Spillways can be gated or uncontrolled.

storage reservoir—a reservoir that is capable of seasonally adjusting streamflow patterns to accomplish a variety of purposes.

stratification—the seasonal layering of water within a reservoir due to differences in temperature or chemical characteristics of the layers. (See "temperature stratification" below.)

substrate—the base or material to which a plant is attached and from which it receives nutrients.

summer operating zone—a zone that allows for fluctuations in reservoir levels for power production, flood control, and mosquito control.

surcharge zone—the area of the guide curve above the Top-of-Gates line. It represents the operating space above top of gates. It is available on reservoirs where TVA owns either flowage easements or fee simple land to an elevation several feet above the Top-of-Gates level.

surface water—water visible on the surface of the ground or in a stream, in contrast to groundwater.

suspended load—fine particles that move along in the mass of flowing water. Cloudy or muddy water typically includes suspended sediment.

system minimum flow—see minimum flow.

tailwater—the part of a river downstream from a dam; in this area, the flow and quality of the water are substantially affected by the dam discharge.

temperature stratification—the variation of water temperature with depth in a reservoir. The coldest water is typically the densest and is found on the bottom of the reservoir, whereas the warmest water is at the surface. In the Tennessee Valley, reservoirs usually begin stratifying in spring and become very stratified in May and June. Stratification disappears by winter.

Tennessee River system—the Tennessee River and its tributaries, the drainage area of which covers about 41,000 square miles, including 125 counties within much of Tennessee and parts of Alabama, Kentucky, Georgia, Mississippi, North Carolina, and Virginia.

Tennessee Valley 201-county region—the combined TVA Power Service Area and the Tennessee River watershed, comprising 201 counties within a 58-million acre area.

terrestrial—typically found on land.

thermal plant—a power plant that produces electricity from heat energy released by combustion of a fossil fuel (coal, oil, or gas) or consumption of a fissionable material (nuclear).

threatened species—an animal or plant that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

tiering—refers to the coverage of general matters in broader EISs with subsequent narrower EISs or Environmental Assessments incorporating by reference the general discussions from the programmatic EIS and concentrating solely on the issues specific to the subsequent project-specific action.

Top of Gates—this is the elevation at which spilling must occur to accommodate any additional inflow to the reservoir. The "Top of Gates" line indicates the elevation of the reservoir at the dam when the spillway gates are fully seated on the spillway crest.

tributary—a river or stream flowing into a larger stream; in this EIS, refers to the streams and rivers that eventually flow into the Tennessee River.

tributary storage reservoirs—storage reservoirs located on tributaries to the Tennessee River.

turbid—the clouded appearance of water because of the fine sediment it contains.

turbidity—all the organic and inorganic living and nonliving materials suspended in a water column. Higher levels of turbidity affect light penetration and typically decrease productivity of water bodies.

turbine pulsing—the operation of a hydroturbine for a short duration (from 15 to 60 minutes), often at regular intervals from 2 to 24 hours apart for the purpose of maintaining a minimum flow at some downstream location.

turbine venting—a technique to improve dissolved oxygen levels in tailwaters, in which air is drawn into hydroturbines and mixed with water as power is generated.

unrestricted drawdown—lowering of reservoir levels with no restrictions on the rate of change.

upland—the higher parts of a region, not closely associated with streams or lakes.

vascular plants—plants with specialized tissues that conduct water and synthesized foods.

vector—an insect (such as a mosquito) or other organism that can transmit a disease.

waste assimilation—the process by which a river accepts and dilutes wastewater.

wastewater—spent or used water from agricultural, residential, or industrial sources that contains dissolved or suspended matter.

wastewater discharge—water released into a stream or reservoir after being processed through a wastewater (sewage) treatment plant.

water column—the vertical section of water in a reservoir from its surface to its bottom.

water-compelled rates—a concept inferring that costs (rates) of shipping goods by rail are lower when water transportation is available to the shipper due to competitive factors and the need for the railroads to maximize utility.

water control system—the interconnected system of dams and reservoirs, tailwaters, navigation locks, and hydropower generation facilities on the Tennessee River and its tributaries.

water intake—a pipe or more complex structure designed and used to withdraw water from a stream or reservoir.

water quality—the physical, chemical, and biological characteristics of water compared to recognized standards of quality necessary to maintain certain uses.

water supply—water removed from a stream or reservoir for municipal or industrial use.

Weekly Scheduling Model (WSM)—the TVA reservoir system simulation model used to estimate reservoir elevations, discharges, and hydropower generations over a period of time.

weirs—structures (could be considered as low dams) placed in a river to temporarily back up or divert water. Generally, these structures are less than 10 feet high.

wetlands—areas inundated by surface or groundwater often enough to support a prevalence of vegetation or aquatic life that requires saturated or seasonably saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, mud flats, and natural ponds.

winter drawdown elevation—the planned winter elevation for a reservoir.

winter operating zone—a zone that denotes normal reservoir level fluctuations in the December-through-March period on mainstem projects.

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Appendix A

Base Case Water Control System Description Tables

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Table A-01 General Project Characteristics

Project	Year Completed	Length of Reservoir (miles)[2]	Miles of Shoreline	Navigation Facilities	Turbine Units (rated capacity in MW)[6]	Turbine Discharge Capacity[6] (total cfs for all units)	
						Most Efficient Load (MEL)	Maximum Sustainable Load (MSL)
Mainstem Projects							
Kentucky	1944	184.3	2,064.3	2 Locks, canal[3]	5 (223)	–[8]	70,000
Pickwick	1938	52.7	490.6	2 Locks, canal[4]	6 (240)	–[8]	89,000
Wilson	1924[1]	15.5	166.2	2 Locks	21 (675)	–[8]	115,000
Wheeler	1936	74.1	1,027.2	2 Locks	11 (412)	–[8]	120,000
Guntersville	1939	75.7	889.1	2 Locks	4 (135)	–[8]	50,000
Nickajack	1967	46.3	178.7	Lock	4 (104)	–[8]	45,000
Chickamauga	1940	58.9	783.7	Lock	4 (160)	–[8]	45,000
Watts Bar	1942	95.5*	721.7	Lock	5 (192)	–[8]	47,000
Fort Loudoun	1943	60.8*	378.2	Lock	4 (155)	–[8]	32,000
Total Mainstem		**663.8**	**6,699.7**	**14 Locks**	**64 (2,296)**		
Tributary Projects							
Norris	1936	129.0	809.2		2 (131)	6,900	9,100
Melton Hill	1963	44.0	193.4	Lock	2 (72)	17,000	22,000
Douglas	1943	43.1	512.5		4 (156)	19,000	24,600[9]
South Holston	1950	23.7	181.9		1 (39)	2,700	3,300[10]
Boone	1952	32.7*	126.6		3 (92)	10,900	13,200
Fort Patrick Henry	1953	10.4	31.0		2 (59)	6,100	9,000
Cherokee	1941	54.0	394.5		4 (160)	15,700	17,800
Watauga	1948	16.3	104.9		2 (58)	2,700	3,300
Wilbur	1912[1]	1.8	4.8		4 (11)	2,500	2,900
Fontana	1944	29.0	237.8		3 (294)	9,000	11,300
Tellico	1979	33.2	357.0	Canal[5]	0[7]	–	–
Chatuge	1942	13.0	128.0		1 (11)	1,500	1,650
Nottely	1942	20.2	102.1		1 (15)	1,420	1,900
Hiwassee	1940	22.2	164.8		2 (176)	8,100	9,800
Apalachia	1943	9.8	31.5		2 (100)	2,700	2,900
Blue Ridge	1930[1]	11.0	68.1		1 (22)	1,600	1,800
Ocoee #1	1911[1]	7.5	47.0		5 (19)	3,200	3,800

Table A-01 General Project Characteristics (continued)

Project	Year Completed	Length of Reservoir (miles)[2]	Miles of Shoreline	Navigation Facilities	Turbine Units (rated capacity in MW)[6]	Turbine Discharge Capacity[6] (total cfs for all units)	
						Most Efficient Load (MEL)	Maximum Sustainable Load (MSL)
Tributary Projects (continued)							
Ocoee #2	1913[1]	–	–		2 (23)	900	1,050
Ocoee #3	1942	7.0	24.0		1 (29)	1,100	1,500
Tims Ford	1970	34.2	308.7		1 (45)	3,700	4,000
Normandy	1976	17.0	75.1		0[7]	–	–
Great Falls	1916[1]	22.0	120.0		2 (34)	2,700	3,700
Upper Bear Creek	1978	14.0	105.0		0[7]	–	–
Bear	1969	12.0	52.0		0[7]	–	–
Little Bear Creek	1975	6.0	45.0		0[7]	–	–
Cedar Creek	1979	9.0	83.0		0[7]	–	–
Total Tributary		**622.1**	**4,307.9**	**1 Lock**	**45 (1,546)**		
Total Projects		**1,285.9**	**11,007.6**	**15 Locks**	**109 (3,842)**		

Notes:

cfs = Cubic feet per second; MW = Megawatts.

1 Projects acquired from others.
2 Normal summer pool. *Fort Loudoun–49.9 miles on the Tennessee River, 6.5 miles on the French Broad River, and 4.4 miles on the Holston River; Watts Bar–72.4 miles on the Tennessee River and 23.1 miles on the Clinch River; Norris–73 miles on the Clinch River and 56 miles on the Powell River; Boone–17.4 miles on the South Fork Holston River and 15.3 miles on the Watauga River.
3 Includes new main lock chamber (110 feet wide and 1,200 feet long) and the Barkley Canal.
4 Tennessee–Tombigbee Waterway; Bay Springs Reservoir is connected to Pickwick Reservoir by a navigation canal.
5 River diversion through a canal increases energy generation at Fort Loudoun.
6 Actual capacity and turbine flows at any time depend on several factors, including operating head, turbine capability, generator cooling, water temperature, and power factor. Capacities and turbine flows include modernization of turbine units (HMODs) already performed, as well as those in the design, construction, or authorization phase. Turbine discharge assumes availability of all units at maximum discharge.
7 Project design does not include power generation capacity.
8 Mainstem projects can be operated well below MSL values but are predominately operated at MSL values because of higher capacities that can be achieved with acceptable loss of efficiency.
9 Primarily operated at this flow rate during flood control operations or emergency power demands.
10 Limited to a flow rate of 3,000 cfs during non-flooding situations to minimize downstream streambank erosion.

Source: TVA file data.

Table A-02 Reservoir Operating Characteristics

Project	Reserved Flood Storage January 1 to Top of Gates[2] (1,000 acre-feet)	Top of Gates Elevations (feet above mean sea level)	Flood Guide Elevations (feet above mean sea level)			Minimum Targeted Summer Level (feet above mean sea level)	Operating Range of Elevations for Run-of-River Projects[4] (feet above mean sea level)
			Jan 1	Mar 15	Jun 1	Aug 1	
Mainstem Projects							
Kentucky	4,008	375	354	354	359	–	
Pickwick	493[3]	418	408	408	414	–	
Wilson	0	507.88	–	–	–	–	504.5–507.8
Wheeler	349	556.28	550	550	556	–	
Guntersville	162	595.44	593	593	595	–	
Nickajack	0	635	–	–	–	–	632–634
Chickamauga	345	685.44	675	675	682.5	–	
Watts Bar	379	745	735	735	741	–	
Fort Loudoun[1]	111	815	807	807	813	–	
Total Mainstem	**5,847**						
Tributary Projects							
Norris	1,473	1,034	985	1,000	1,020	1,010	
Melton Hill	0	796	–	–	–	–	790–796
Douglas	1,251	1,002	940	958.8	994	990	
South Holston	290	1,742	1,702	1,713	1,729	1,721	
Boone	92	1,385	1,358	1,375	1,382	1,382	
Fort Patrick Henry	0	1,263	–	–	–	–	1,258–1,263
Cherokee	1,012	1,075	1,030	1,042	1,071	1,060	
Watauga	223	1,975	1,940	1,952	1,959	1,949	
Wilbur	0	1,650	–	–	–	–	1,635–1,650
Fontana	580	1,710	1,644	1,644	1,703	1,693	
Tellico[1]	120	815	807	807	813	--	
Chatuge	93	1,928	1,912	1,916	1,926	1,923	
Nottely	100	1,780	1,745	1,755	1,777	1,770	

Table A-02 Reservoir Operating Characteristics (continued)

Project	Reserved Flood Storage January 1 to Top of Gates[2] (1,000 acre-feet)	Top of Gates Elevations (feet above mean sea level)	Flood Guide Elevations (feet above mean sea level)			Minimum Targeted Summer Level (feet above mean sea level)	Operating Range of Elevations for Run-of-River Projects[4] (feet above mean sea level)
			Jan 1	Mar 15	Jun 1	Aug 1	
Tributary Projects (continued)							
Hiwassee	270	1,526.5	1,465	1,482	1,521	1,515	
Apalachia	0	1,280	–	–	–	–	1,272–1,280
Blue Ridge	69	1,691	1,668	1,678	1,687	1,682	
Ocoee #1	0	830.76	820	820	829		
Ocoee #2	0	1115.2	–	–	–	–	Not applicable[6]
Ocoee #3	0	1,435	–	–	–	–	1,428 –1,435
Tims Ford	220	895	873	879	888	–[5]	
Normandy	48	880	864	866.7	875		
Great Falls	0	805.3	–	–	–	–	785–800
Upper Bear Creek	0	797	–	–	–	–	790–797
Bear Creek	37	602	565	572.8	576	–	
Little Bear Creek	25	623	603	615	620	–	
Cedar Creek	76	584	560	574.2	580	–	
Total Tributary	**5,979**						
Total Projects	**11,826**						

Notes:

1 Projects are operated in tandem because of diversion canal to increase power generation at Fort Loudoun.
2 The observed flood storage varies, depending on rainfall and runoff.
3 Includes additional storage volume from Bay Springs Reservoir.
4 The observed range varies, depending on demands on the river system.
5 Tims Ford has no August 1 target level; it does have a minimum elevation requirement of 883 feet above sea level from May 15 through October 15.
6 Does not have a permanent pool.

Source: TVA file data.

Table A-03 Minimum Flows, Techniques, Requirements, and Commitments

Project	Techniques	Minimum Flows (cfs)	Frequency and Duration of Flows	Operating Objective
Mainstem Projects				
Kentucky	Appropriate daily scheduling	18,000	Bi-weekly average: June–August	Water supply, water quality
		15,000	Bi-weekly average: May and September	
		12,000	Daily average: October–April	
		5,000	Year-round instantaneous flows if Paducah, Kentucky, stage on Ohio River is greater than 16 feet (occurs about half the time)	Navigation
		15,000	Continuous when Paducah stage is between 14 and 16 feet (occurs about half the time)	Navigation
		20,000	Continuous when Paducah stage is less than 14 feet (occurs about 2% of time)	Navigation
Pickwick[1]	Appropriate daily scheduling	15,000	Bi-weekly average: June–August	Water supply, water quality
		9,000	Bi-weekly average: May and September	
		8,000	Daily average: October–April	
		16,000	Instantaneous when Kentucky headwater is at 354-foot elevation	Navigation
		8,000	Instantaneous when Kentucky headwater is at 355-foot elevation	Navigation
Wilson	Appropriate daily scheduling	8,000	Instantaneous when Pickwick headwater is at or below 409.5-foot elevation	Navigation
Wheeler and Guntersville	Appropriate daily scheduling (45% Wheeler plus 55% Guntersville flows)	10,000	Daily average: July–September	Operation of downstream nuclear plant
		11,000	Daily average: December–March	
		7,000	Otherwise	
Chickamauga	Appropriate daily scheduling	13,000	Bi-weekly average: June–August	Water supply, water quality
		7,000	Bi-weekly average: May and September	
		3,000	Daily average: October–April	

Table A-03 Minimum Flows, Techniques, Requirements, and Commitments (continued)

Project	Techniques	Minimum Flows (cfs)	Frequency and Duration of Flows	Operating Objective
Mainstem Projects (continued)				
Watts Bar	No more than 15 hours of zero flow for holding pond drainage	1,200	Daily average	Operation of downstream nuclear plant
Douglas and Cherokee flows for Knoxville	Appropriate daily scheduling of Cherokee and Douglas along with local inflow	2,000	Daily average	Water supply, water quality
Norris	Turbine pulsing and reregulation weir	200	Daily average: pulse every 12 hours for 30 minutes	Water supply, water quality
For Bull Run fossil plant	Appropriate daily scheduling	800	Daily average: February–March	Thermal compliance–operation of downstream fossil plant
		1,000	Daily average: April–May	
		1,200	Daily average: June	
		1,500	Daily average: July–September	
		2,000	Daily average: October	
		600	Daily average: November–January	
Melton Hill	Appropriate daily scheduling	400	Daily average	Water supply, water quality
Douglas	Turbine pulsing	585	Daily average: every 4 hours for 30 minutes	Water supply, water quality
Douglas for Knoxville	Appropriate daily scheduling of Cherokee and Douglas along with local inflow	2,000	Daily average	
South Holston	Turbine pulsing and reregulation weir	90	Daily average: pulse every 12 hours for 30 minutes	Water supply, water quality
Boone	Turbine pulsing	400	Daily average	Water supply, water quality

Table A-03 Minimum Flows, Techniques, Requirements, and Commitments (continued)

Project	Techniques	Minimum Flows (cfs)	Frequency and Duration of Flows	Operating Objective
Tributary Projects				
Fort Patrick Henry[2]	Turbine pulsing	800	Average 3-hour discharge–year round	Water supply, water quality
		1,250	Instantaneous: January	Operation of downstream fossil plant
		1,300	Instantaneous: February–March	
		1,500	Instantaneous: April–May	
		1,833	Instantaneous: June–September	
		1,450	Instantaneous: October–November	
		1,350	Instantaneous: December	
Cherokee	Turbine pulsing	325	Daily average: every 6 hours for 30 minutes	Water supply, water quality
Cherokee for Knoxville	Appropriate daily scheduling of Cherokee and Douglas along with local inflow	2,000	Daily average	
Watauga measured from Wilbur[3]	Turbine pulsing	107	Daily average: small unit every 4 hours for 1 hour or large unit every 4 hours for 15 minutes	Water supply, water quality
Fontana measured from Chilhowee[4]	Appropriate daily scheduling	1,000	Daily average: May–October Fontana and Santeetlah plus local inflow	Water supply, water quality
Chatuge	Turbine pulsing and reregulation weir	60	Daily average: every 12 hours for 30 minutes	Water supply, water quality
Nottely	Small hydro unit when large unit is not generating	55	Continuous	Water supply, water quality
Apalachia[5]	Turbine pulsing	200	Daily average: every 4 hours for 30 minutes	Water supply, water quality
	Appropriate daily scheduling of discharges from Apalachia and Ocoee #1	600	Daily average	
Blue Ridge[2]	Small hydro unit when large unit is not generating	115	Continuous	Water supply, water quality

Table A-03   Minimum Flows, Techniques, Requirements, and Commitments (continued)

Project	Techniques	Minimum Flows (cfs)	Frequency and Duration of Flows	Operating Objective
Tributary Projects (continued)				
Ocoee #1	Turbine pulsing	140	Daily average: every 4 hours for 1 hour	Water supply, water quality
	Appropriate daily scheduling of discharges from Apalachia and Ocoee #1	600	Daily average	
Tims Ford	Small hydro unit when large unit is not generating	80	Continuous	Water supply, water quality
For Fayetteville	Appropriate daily scheduling	120	Continuous	
Normandy for Shelbyville	Appropriate daily scheduling	40 155	Continuous	Water supply, water quality
Upper Bear Creek		5	Continuous	Water quality, water supply
Bear Creek for Red Bay		21	Continuous	Water quality, water supply
Little Bear Creek		5	Continuous	Water quality, water supply
Cedar Creek		10	Continuous	

Notes:

cfs = Cubic feet per second.

1 Minimum tailwater below Pickwick is maintained at or above a 355-foot elevation for navigation. Continuous minimum discharge from Pickwick is used to maintain this minimum elevation whenever Kentucky headwater is at or below a 355-foot elevation. These discharges vary as the Kentucky headwater varies between elevations of 354 and 355 feet.

2 Fort Patrick Henry is required to supply a minimum flow for the John Sevier Steam Plant that equals the plant cooling water intake plus a minimum bypass flow for the current time of year. The minimum bypass flow is defined as follows in the National Pollutant Discharge Elimination System permit for John Sevier:

> To the maximum extent practicable (considering only the short and long term availability of water for release from upstream impoundments and alternative sources of generation to meet the public demand for power), not less than 350 cfs nor one-third of the plant cooling water flow, whichever is greater, shall be passed over the dam during the period from June 1 to September 30 at any time the plant is in operation. During the winter months, or during the period of October 1 to May 31, the minimum bypass flow shall be 100 cfs. These are the minimum volumes of cold-water to be provided which will ensure the protection of spawning, development and survival of fish eggs, larvae, and fry and to provide living space for fish consistent with classified uses downstream from the diversion dam.

3 Watauga minimum flow is met at downstream Wilbur.

4 Fontana minimum flow is met at downstream Chilhowee Dam.

5 Apalachia plus Ocoee #1 must meet a combined minimum flow of 600 cfs as the combined daily average.

Source: TVA file data.

Table A-04   Ramping Constraints by Project

Project	Number of Turbine Units	Ramping Rate
Watauga	2	Ramp units up and down a maximum of one unit per hour for downstream safety
Cherokee	4	Ramp units up and down a maximum of two units per hour to minimize downstream bank erosion
Douglas	4	Ramp units up and down a maximum of two units per hour to minimize downstream bank erosion
Apalachia	2	Ramp units up a maximum of one unit per hour for downstream safety
South Holston	1	Maximum turbine flow of 3,000 cubic feet per second (cfs) (below Maximum Sustainable Level [MSL] flows) for hydropower needs required to minimize downstream bank erosion; MSL flows allowed for flood control
Pickwick	6	Turbines limited to a ramp rate of 60 megawatts (MW) per hour when ramping up and a maximum of 40 MW per hour when ramping down for downstream navigation and bank stabilization
Kentucky	5	When Paducah stage is greater than 16 feet–maximum hourly discharge variation of one unit per hour When Paducah stage is less than 16 feet but greater than 14 feet–maximum hourly discharge variation of one unit per hour If Kentucky is not spilling–maximum daily discharge variation of 35,000 cfs per day
Chickamauga	4	From November through April, ramp units up and down a maximum of one unit per hour for Sequoyah Nuclear Plant thermal compliance

Source: TVA file data.

Table A-05 Fishery Types, Dissolved Oxygen Targets, and Type of Aeration Facilities at Reservoir Tailwaters

Project	Fishery Type	DO Target (mg/L)	Type of Aeration Facilities
Mainstem Projects			
Watts Bar		4	Oxygen injection
Fort Loudoun		4	Oxygen injection
Tributary Projects			
Norris	Cold-water	6	Turbine venting
Douglas	Warm-water	4	Turbine venting, surface water pumps, oxygen injection
South Holston	Cold-water	6	Turbine venting, aerating weir
Boone	Cold-water	4	Turbine venting
Fort Patrick Henry[1]	Cold-water	4	Upstream improvements
Cherokee	Warm-water	4	Turbine venting, surface water pumps, oxygen injection
Watauga	Cold-water	6	Turbine venting
Fontana	Cold-water	6	Turbine venting
Chatuge[2]	Warm-water	4	Aerating weir
Nottely	Warm-water	4	Turbine air injection
Hiwassee	Cold-water	6	Turbine venting, oxygen injection
Apalachia[3]	Cold-water	6	Turbine venting
Blue Ridge	Cold-water	6	Oxygen injection
Tims Ford	Cold-water	6	Turbine air injection, oxygen injection

Notes:

mg/L = Milligrams per liter.

1 The first 4 miles below Fort Patrick Henry are classified as a cold-water fishery; below this point, the tailwater is classified as a warm-water fishery.
2 Chatuge is classified by state standards as a warm-water fishery but has a trout fishery in its tailwater.
3 Below the powerhouse.

Source: TVA file data.

Table A-06 Year 2030 Additional Net Water Supply Demand by Project

Project	Additional Net Water Demand (cfs)
Mainstem Projects	
Kentucky	49.91
Pickwick	42.39
Tennessee–Tombigbee Waterway flows	968.80
Wilson	23.99
Wheeler	132.45
Guntersville	17.15
Nickajack	21.70
Chickamauga	31.12
Watts Bar	14.44
Fort Loudoun	16.92
Tellico	1.44
Tributary Projects	
Norris	5.44
Melton Hill	21.99
Douglas	43.22
South Holston	3.79
Boone	-8.62
Fort Patrick Henry	167.60
Cherokee	-133.87
Watauga	23.84
Wilbur	–
Fontana	1.42
Chatuge	3.32
Nottely	0.66
Hiwassee	0.30
Apalachia	0.69
Blue Ridge	16.91
Ocoee #1	-9.02
Ocoee #2	–
Ocoee #3	–
Tims Ford	24.01
Normandy	0.00
Great Falls	–
Upper Bear Creek	0.00
Bear Creek	–
Little Bear Creek	–
Cedar Creek	0.00

Note:

cfs = Cubic feet per second.

Source: TVA file data.

Table A-07 Drawdown Limits for Tributary Reservoirs

Project[1]	Description	Drawdown Limits[2]
Apalachia	Concrete	3 feet per day not to exceed 12 feet per week
Blue Ridge	Hydraulic fill	2 feet per day not to exceed 7 feet per week for 28 feet; then 3 feet per week
Chatuge	Impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet; then 3 feet per week
Cherokee	Concrete and impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet; then 3 feet per week
Douglas	Concrete and impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet; then 3 feet per week
Fontana	Concrete	2 feet per day not to exceed 7 feet per week for 28 feet; then 3 feet per day not to exceed 12 feet per week
Great Falls	Concrete	2 feet per day not to exceed 12 feet per week
Hiwassee	Concrete	2 feet per day not to exceed 7 feet per week
Norris	Concrete and earth fill	2 feet per day not to exceed 7 feet per week for 28 feet; then 3 feet per week
Nottely	Impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet; then 3 feet per week
South Holston	Impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet; then 3 feet per week
Watauga	Impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet; then 3 feet per week

Notes:

[1] For those reservoirs not shown, the drawdown rate would follow the rate shown for Blue Ridge.
[2] Restrictions are based on dam safety and erosion considerations.

Source: TVA file data.

Table A-08 Fill and Drawdown Dates

Mainstem Project	Operating Mode	Reservoir Fill Target Date	Target Date for Start of Reservoir Drawdown
Kentucky	Storage	May 1	July 5; sloped to December 1
Pickwick	Storage	April 5	July 1; 1-foot fluctuation for mosquito control from mid May to mid-September
Wilson	Run-of-river	Mid-April	December 1
Wheeler	Storage	Mid-April	August 1; 1-foot fluctuation for mosquito control from mid-May to mid-September
Guntersville	Limited drawdown	Mid-April	July 1; with 1-foot drawdown to November 1; 1-foot fluctuation for mosquito control from mid-May to mid-September
Nickajack	Run-of-river	–	–
Chickamauga	Storage	Mid-April	July 1; with 1.5-foot drawdown to mid-August, remainder of winter drawdown begins on October 1; 1-foot fluctuation for mosquito control from mid-May to mid-September
Watts Bar	Storage	Mid-April	August 1; 1-foot drawdown to September 1, then begin remainder of winter drawdown
Fort Loudoun[1]	Storage	Mid-April	November 1
Tributary Project	**Operating Mode**	**Reservoir Fill Target Date**	**Date for Start of Unrestricted Reservoir Drawdown**
Norris	Storage	June 1	August 1
Melton Hill	Run-of-river	–	–
Douglas	Storage	June 1	August 1
South Holston	Storage	June 1	August 1
Boone	Storage	Mid-May	Labor Day (follows guide curve)
Fort Patrick Henry	Run-of-river	–	–
Cherokee	Storage	June 1	August 1
Watauga	Storage	June 1	August 1
Wilbur	Run-of-river	–	–
Fontana	Storage	June 1	August 1
Tellico[1]	Storage	Mid-April	November 1

Table A-08 Fill and Drawdown Dates (continued)

Tributary Project	Operating Mode	Reservoir Fill Target Date	Date for Start of Unrestricted Reservoir Drawdown
Chatuge	Storage	June 1	August 1
Nottely	Storage	June 1	August 1
Hiwassee	Storage	June 1	August 1
Apalachia	Run-of-river	–	–
Blue Ridge	Storage	June 1	August 1
Ocoee #1	Storage	May 1	November 1
Ocoee #2	Run-of-river	–	–
Ocoee #3	Run-of-river	–	–
Tims Ford[2]	Storage	Mid-May	October 15
Normandy	Storage	May 1	November 1; usually falls throughout summer to meet downstream minimum flows
Great Falls	Storage	August 1	October 1
Upper Bear Creek	Run-of-river	–	–
Bear Creek	Storage	Mid-April	November 15
Little Bear Creek	Storage	Mid-April	November 1
Cedar Creek	Storage	Mid-April	November 1

Notes:

[1] Tellico, connected by canal to Fort Loudoun, has a pool elevation the same as Fort Loudoun. Because Fort Loudoun is targeted to reach its summer pool level by April 15 and its drawdown does not begin until November 1, Tellico has a flat summer pool.

[2] Tims Ford, by design and original project allocation, has always been operated with a minimum summer pool level of 883 feet, which applies until October 15.

Source: TVA file data.

Table A-09 Hydro Modernization Projects To Be Completed by 2014

Power Plant	Status in October 2001[1,2]	Runner Performance Planned	Increased Flow[3]
Phase 2 and Phase 3 Projects			
Douglas (Units 1–4)	Phase 3	High efficiency and capacity	Yes
Guntersville (Units 1–4)	Phase 3	Increased efficiency and capacity	No
Raccoon Mountain (Units 1–4)	Phase 3	High capacity	Yes
Fort Loudoun (Units 3–4)	Phase 3	Increased efficiency and capacity	Mix
Boone (Units 1–3)	Phase 2	High efficiency, low flow	Insignificant
Chatuge (Unit 1)	Phase 2	High capacity	Yes
Apalachia (Units 1–2)	Phase 2	Increased efficiency and capacity	Insignificant
Watts Bar (Units 1–5)	Phase 2	Increased efficiency and capacity	Yes
Phase 1 and Not Started Projects			
Cherokee (Units 1–4)	Phase 1	High efficiency, low flow	Yes
Wheeler (Units 1–8)	Phase 1	High efficiency, low flow	Not expected
Wilson (Units 19–21)	Phase 1	Increased efficiency and capacity	Expected
Fort Loudoun (Units 1–2)	Not started	Increased efficiency and capacity	Mix
Wilson (Units 1–4)	Not started	High efficiency	Yes
Wilson (Units 5–8)	Not started	High efficiency	Yes
Ocoee #3 (Unit 1)	Not started	Increased efficiency and capacity	Yes
Nickajack (Units 3–4)	Not started	Increased efficiency and capacity	Yes
South Holston (Unit 1)	Not started	Increased efficiency and capacity	No
Melton Hill (Units 1–2)	Not started	Increased efficiency and capacity	No
Watauga (Units 1–2)	Not started	Increased efficiency and capacity	Yes
Blue Ridge (Unit 1)	Not started	Increased efficiency and capacity	Yes
Wilbur (Units 1–4)	Not started	Increased efficiency and capacity	Insignificant

Notes:

HMOD = Hydro Modernization.
Phase 1 = No plans developed to date; Phase 2 = Design; Phase 3 = Construction.

1 HMOD projects that have been completed or are scheduled to start soon include:

Tims Ford (Unit 1)	Wheeler (Units 9–11)
Chickamauga (Units 1–4)	Kentucky (Units 1–5)
Wilson (Units 9–18)	Nottely (Unit 1)
Norris (Units 1–2)	Fontana (Units 1–3)
Fort Patrick Henry (Units 1–2)	Hiwassee (Units 2)
Guntersville (Units 1 and 4)	Douglas (Units 2, 3, and 4)
Douglas (Unit 1)	Guntersville (Unit 3)
Raccoon Mountain (Unit 3)	Fort Loudoun (Unit 4)
Guntersville (Unit 2)	Hiwassee (Unit 1)

2 HMOD projects that were in Phase 2 (design) and Phase 3 (construction) in October 2001 are included in the Base Case. Projects that were in Phase 1 or not started in October 2001 are addressed in the cumulative effects analysis.

3 HMOD flows for completed projects and those in Phase 2 (design) and Phase 3 (construction) are included in Table A-01.

Source: TVA file data 2001.

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Appendix B

Reservoir Operations Study

Preliminary Alternatives

TVA

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RESERVOIR OPERATIONS POLICY ALTERNATIVES EVALUATED IN DETAIL

Alternative Name	Former Number Code
Reservoir Recreation A	2A
Reservoir Recreation B	3C
Summer Hydropower	4D
Equalized Summer/Winter Flood Risk	5A
Commercial Navigation	6A
Tailwater Recreation	7C
Tailwater Habitat	8A

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Preliminary Alternative 1A

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify summer reservoir elevations and/or drawdown dates	• Maintain reservoir elevations at or above current August 1 levels through Labor Day for South Holston, Watauga, Cherokee, Douglas, Fontana, Chatuge, Nottely, Hiwassee, Blue Ridge, and Norris. • For Great Falls—Revise the operating guide curve to fill the reservoir by June 1 and maintain summer elevations through Labor Day. • No changes to the following reservoirs for the reasons described: ▸ Wilbur—run-of-river project. ▸ Boone—maintains summer elevation through Labor Day. ▸ Fort Patrick Henry—run-of-river project. ▸ Apalachia—run-of-river project. ▸ Ocoee #1—maintains summer elevation through November 1. ▸ Melton Hill—run-of-river project. ▸ Tims Ford—maintains summer elevation through mid-October. ▸ Upper Bear Creek—maintains the same fluctuation range year round. ▸ Bear Creek—maintains summer elevation to mid-November. ▸ Little Bear Creek—maintains summer elevation through November 1. ▸ Cedar Creek—maintains summer elevation through November 1. • Normandy—guide curve stays at summer elevation through mid-October, however; this elevation is subject to meeting downstream minimum flows and usually falls throughout the summer.	• Extend the current summer elevation through August 1 for Watts Bar, Chickamauga, Guntersville, Wheeler, Pickwick, and Kentucky/Barkley. • Then slope the guide curve from August 1 through Labor Day by 1 foot for each reservoir. • After Labor Day, slope the new curve to meet the current curve. • No changes to the following reservoirs for the reasons described: ▸ Fort Loudoun—maintains summer elevation through November 1. ▸ Nickajack—run-of-river project. ▸ Wilson—maintains summer elevation through December 1.

Preliminary Alternative 1A (continued)

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify winter reservoir elevations and/or fill dates	• No change	• No change
Modify drawdown restrictions	• No change	• No change
Modify rate of flood storage recovery	• Slower flood recovery; extend the current 7- to 10-day flood recovery policy to 14 to 20 days when warranted (except for Hiwassee). • Raise Cherokee and Nottely minimum operations guide based on revised observed inflows.	• No change
Modify water releases	• No change in water releases associated with producing power and increasing flood storage capacity. • Same as Base Case minimum flow commitments. • No change in recreation releases below Watauga, Apalachia, Tims Ford, Ocoee #2, and Ocoee #3.	• No change in water releases associated with producing power and increasing flood storage capacity. • Same as Base Case minimum flow commitments, except for increasing weekly average release from Chickamauga to 25,000 cfs between August 1 and Labor Day.

cfs = Cubic feet per second.

Preliminary Alternative 2A

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify summer reservoir elevations and/or drawdown dates	• Maintain reservoir elevations at or above current August 1 levels until Labor Day for South Holston, Watauga, Cherokee, Douglas, Fontana, Chatuge, Nottely, Hiwassee, Blue Ridge, and Norris. • For Great Falls—Revise the operating guide curve to fill the reservoir by June 1 and maintain summer elevations through Labor Day. • No changes to the following reservoirs for the reasons described: ▸ Wilbur—run-of-river project. ▸ Boone—maintains summer elevation through Labor Day. ▸ Fort Patrick Henry—run-of-river project. ▸ Apalachia—run-of-river project. ▸ Ocoee #1—maintains summer elevation through November 1. ▸ Melton Hill—run-of-river project. ▸ Tims Ford—maintains summer elevation through mid-October. ▸ Upper Bear Creek—maintains the same fluctuation range year round. ▸ Bear Creek—maintains summer elevation to mid-November. ▸ Little Bear Creek—maintains summer elevation through November 1. ▸ Cedar Creek—maintains summer elevation through November 1. ▸ Normandy—guide curve stays at summer elevation through mid-October; however, this elevation is subject to meeting downstream minimum flows and usually falls throughout the summer.	• Extend the current summer elevation through August 1 for Watts Bar, Chickamauga, Guntersville, Wheeler, Pickwick, and Kentucky/Barkley. • Then slope the guide curve from August 1 through Labor Day by 1 foot for each reservoir. • After Labor Day, slope the new curve to meet the current curve. • No changes to the following reservoirs for the reasons described: ▸ Fort Loudoun—maintains summer elevation through November 1. ▸ Nickajack—run-of-river project. ▸ Wilson—maintains summer elevation through December 1.

Preliminary Alternative 2A (continued)

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify winter reservoir elevations and/or fill dates	• Raise the winter flood guides equal to the current March 15 flood guide elevations for South Holston, Watauga, Cherokee (this would be equivalent to the new flood guide elevations established in Preliminary Alternative 1), Douglas, Chatuge, Nottely (this would be equivalent to the new flood guide elevations established in Preliminary Alternative 1), Hiwassee, Blue Ridge, Norris, and Tims Ford. • No change to spring fill dates.	• Raise the minimum winter elevation by 2 feet to create a 13-foot navigation channel (11 feet with 2 feet overdraft) on Fort Loudoun, Watts Bar, Chickamauga, Wheeler, and Pickwick. • Modify the winter operating range of these reservoirs to allow only 1 foot of fluctuation versus the current 2 feet of fluctuation allowed. • No change to spring fill dates.
Modify drawdown restrictions	• No change	• No change
Modify rate of flood storage recovery	• Slower flood recovery; extend the current 7- to 10-day flood recovery policy to 14 to 20 days when warranted (except for Hiwassee). • Raise Cherokee and Nottely minimum operating guide based on revised observed inflows.	• No change
Modify water releases	• Release only Base Case minimum flows during June and July, unless additional releases are necessary to manage reservoir levels that have exceeded flood guides or to support special operations during a power system alert. • Same as Base Case minimum flow commitments. • No change in recreation releases below Watauga, Apalachia, Tims Ford, Ocoee #2, and Ocoee #3.	• Release only Base Case minimum flows during June and July, unless additional releases are necessary to manage reservoir levels that have exceeded flood guides or to support special operations during a power system alert. • Same as Base Case minimum flow commitments except for increasing weekly average release from Chickamauga to 25,000 cfs between August 1 and Labor Day. • No change in release below Watts Bar for Sauger spawn.

cfs = Cubic feet per second.

Preliminary Alternatives 3A, 3B, and 3C

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify summer reservoir elevations and/or drawdown dates	• Fill reservoirs to full summer pool levels by June 1. After that, release only Base Case minimum flows, unless additional releases are necessary to manage reservoir levels that have exceeded flood guides or to support special operations during a power system alert, to arrive at or above current August 1 levels on: ▸ November 1, if possible, for Alternative 3A; ▸ October 1, if possible, for Alternative 3B; and, ▸ Labor Day, if possible, for Alternative 3C. • If August 1 levels on November 1 (3A), October 1 (3B), and Labor Day (3C) are not possible, state the elevation for these dates that has 90 percent reliability with releasing Base Case minimum flows only.	• Hold full summer pool levels until: ▸ November 1 for Alternative 3A; ▸ October 1 for Alternative 3B; and, ▸ Labor Day for Alternative 3C. • Current drawdown dates that are later than those specified for each alternative would not be moved to the earlier date.
Modify winter reservoir elevations and/or fill dates	• Increase winter levels based on being able to store in each reservoir an inflow volume equal to the 7-day, 500-year storm.	• Raise the minimum winter elevation by 2 feet to create a 13-foot navigation channel (11 feet with 2 feet overdraft) on Fort Loudoun, Watts Bar, Chickamauga, Wheeler, and Pickwick. • Modify the winter operating range of these reservoirs to allow only 1 foot of fluctuation versus the current 2 feet of fluctuation allowed.
Modify drawdown restrictions	• No change. If delaying unrestricted drawdown to November 1 (3A), October 1 (3B), or Labor Day (3C) prohibits meeting dam safety limits on the maximum allowable drawdown rate, the date would be adjusted accordingly.	• No change
Modify rate of flood storage recovery	• No change	• No change

Preliminary Alternatives 3A, 3B, and 3C (continued)

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify water releases	• Release only Base Case minimum flows between June 1 and November 1 for Alternative 3A, October 1 for Alternative 3B, or Labor Day for Alternative 3C, unless additional releases are necessary to manage reservoir levels that have exceeded flood guides or to support special operations during a power system alert. • Same as Base Case minimum flow commitments. • No change in recreation releases below Watauga, Apalachia, Tims Ford, Ocoee #2, and Ocoee #3.	• Release only Base Case minimum flows between June 1 and November 1 for Alternative 3A, October 1 for Alternative 3B, or Labor Day for Alternative 3C, unless additional releases are necessary to manage reservoir levels that have exceeded flood guides or to support special operations during a power system alert. • Same as Base Case minimum flow commitments.

cfs = Cubic feet per second.

Preliminary Alternatives 4A, 4B, 4C, 4D, 4E, and 4F

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify summer reservoir elevations and/or drawdown dates	• Fill reservoirs to current full summer pool levels by June 1. • After that, unrestricted drawdown begins immediately to maximize power production and flood storage capacity.	• Fill reservoirs to current full summer pool levels by June 1. • Begin drawdown on June 1 to maximize power production.
Modify winter reservoir elevations and/or fill dates	• Increase winter levels based on being able to store in each reservoir an inflow volume equal to the 7-day, 500-year storm.	• No change
Modify drawdown restrictions	• Unrestricted drawdown begins on June 1.	• Unrestricted drawdown begins on June 1.
Modify rate of flood storage recovery	• No change	• No change
Modify water releases	• Maximize summer water releases to increase power production. • No tailwater recreation releases except for Ocoee #2. • Same as Base Case minimum flow commitments.	• Maximize summer water releases to increase power production. • Alternatives 4A through 4F—same as Base Case minimum flow commitments except for increasing weekly average release from Chickamauga between June 1 and September 15 as follows: ▸ Alternative 4A – 20,000 cfs ▸ Alternative 4B – 25,000 cfs ▸ Alternative 4C – 30,000 cfs ▸ Alternative 4D – 35,000 cfs ▸ Alternative 4E– 40,000 cfs ▸ Alternative 4F – 45,000 cfs (turbine capacity at Chickamauga)

cfs = Cubic feet per second.

Preliminary Alternative 5A

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify summer reservoir elevations and/or drawdown dates	• Establish year-round flood guides at a level that is based on each reservoir being able to store, at a minimum, its inflow volume for the critical-period, 500-year storm.	• Set elevations on the upper mainstem reservoirs (Fort Loudoun, Watts Bar, and Chickamauga) to hold a volume equal to the critical-period, 500-year storm inflow with a 30-foot flood stage release at Chattanooga. Reshape lower mainstem reservoir guide curves, except Kentucky, based on those for upper mainstem reservoirs. Hold Kentucky summer elevation only to Labor Day.
Modify winter reservoir elevations and/or fill dates	• Establish year-round flood guides at a level that is based on each reservoir being able to store, at a minimum, its inflow volume for the critical-period, 500-year storm.	• Set elevations on the upper mainstem reservoirs (Fort Loudoun, Watts Bar, and Chickamauga) to hold a volume equal to the critical-period, 500-year storm inflow with a 30-foot flood stage release at Chattanooga. Reshape lower mainstem reservoir guide curves, except Kentucky, based on those for upper mainstem reservoirs. In March, however, take only as low as their current minimum elevation.
Modify drawdown restrictions	• No change	• No change
Modify rate of flood storage recovery	• No change	• No change
Modify water releases	• Perform water releases to “equalize” seasonal flood risk. • Release only Base Case minimum flows during June and July, unless additional releases are necessary to manage reservoir levels that have exceeded flood guides or to support special operations during a power system alert. • Same as Base Case minimum flow commitments. • No change in recreation releases below Watauga, Apalachia, Tims Ford, Ocoee #2, and Ocoee #3.	• Perform water releases to “equalize” seasonal flood risk. • Release only Base Case minimum flows during June and July unless additional releases are necessary to manage reservoir levels that have exceeded flood guides or to support special operations during a power system alert. • Same as Base Case minimum flow commitments except for increasing weekly average release from Chickamauga to 25,000 cfs between August 1 and Labor Day.

cfs = Cubic feet per second.

Preliminary Alternatives 6A and 6B

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify summer reservoir elevations and/or drawdown dates	• No change	• Alternative 6A—same as Base Case. • Alternative 6B—same as Base Case.
Modify winter reservoir elevations and/or fill dates	• No change	• Alternative 6A—raise winter elevations by 2 feet to create 13-foot navigation channel, where possible (11 feet with 2-foot overdraft). • Alternative 6A— Modify the winter operating range of these reservoirs to allow 1 foot of typical operating range versus the current 2 foot operating range. • Alternative 6B—lower winter elevations to 9 feet (no overdraft) except on Wheeler and Guntersville.
Modify drawdown restrictions	• No change	• No change
Modify rate of flood storage recovery	• No change	• No change
Modify water releases	• Same as Base Case minimum flow commitments. • No change in recreation releases below Watauga, Apalachia, Tims Ford, Ocoee #2, and Ocoee #3.	• Alternative 6A—same as Base Case flow commitments except for: ▸ Release continuous minimum instantaneous flows of 25,000 cfs from Kentucky. ▸ Release maximum flow of 28,000 cfs below Barkley. ▸ Release continuous minimum instantaneous flows of 18,000 cfs from Pickwick during the winter when Kentucky elevation is less than or equal to 357 (weeks 1-15 and 34-52). ▸ Release continuous minimum instantaneous flows of 18,000 cfs from Wilson during the winter when Pickwick elevation is less than or equal to 411 (weeks 1-12 and 39-52). • Alternative 6B—same as Base Case flow commitments.

Preliminary Alternatives 7A, 7B, and 7C

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify summer reservoir elevations and/or drawdown dates	• Fill reservoirs to full summer pool levels by June 1. After that, release only Base Case minimum flows AND tailwater recreation flows, unless additional releases are necessary to manage reservoir levels that have exceeded flood guides or to support special operations during a power system alert, to arrive at or above current August 1 levels on: ▸ November 1, if possible, for Alternative 7A; ▸ October 1, if possible, for Alternative 7B; and, ▸ Labor Day, if possible, for Alternative 7C. • If August 1 levels on November 1 (7A), October 1 (7B), and Labor Day (7C) are not possible, state the elevation for these dates that has 90 percent reliability with releasing Base Case minimum flows only AND tailwater recreation flows.	• Hold full summer pool levels until: ▸ November 1 for Alternative 7A; ▸ October 1 for Alternative 7B; and, ▸ Labor Day for Alternative 7C. • Current drawdown dates that are later than those specified for each alternative would not be moved to the earlier date.
Modify winter reservoir elevations and/or fill dates	• Increase winter levels based on being able to store in each reservoir an inflow volume equal to its 7-day, 500-year storm.	• Raise the minimum winter elevation by 2 feet to create a 13-foot navigation channel (11 feet with 2 feet overdraft) on Fort Loudoun, Watts Bar, Chickamauga, Wheeler, and Pickwick. • Modify the winter operating range of these reservoirs to allow only 1 foot of fluctuation versus the current 2 feet of fluctuation allowed.
Modify drawdown restrictions	• No change. If delaying unrestricted drawdown to November 1 prohibits meeting dam safety limits on the maximum allowable drawdown rate, date will be adjusted accordingly.	No change
Modify rate of flood storage recovery	• No change	• No change

Preliminary Alternatives 7A, 7B, and 7C (continued)

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify water releases	• Release only Base Case minimum flows and tailwater recreation flows between June 1 and November 1 for Alternative 7A, October 1 for Alternative 7B, or Labor Day for Alternative 7C, unless additional releases are necessary to manage reservoir levels that have exceeded flood guides or to support special operations during a power system alert. • Same as Base Case minimum flow commitments.	• Release only Base Case minimum flow commitments and tailwater recreation flows between June 1 and November 1 for Alternative 7A, October 1 for Alternative 7B, or Labor Day for Alternative 7C, unless additional releases are necessary to manage reservoir levels that have exceeded flood guides or to support special operations during a power system alert. • Same as Base Case minimum flow commitments.
Modify tailwater recreation releases	• Norris—provide flows year round on Saturday and Sunday ▸ No release prior to 10:00 a.m. ▸ Two-unit use for 8 hours. • Watauga—provide flows from April 1 to November 1, 7 days per week ▸ Two-unit use for 4 hours. ▸ One-unit use for 2 hours. • Apalachia—provide flows from April 1 to November 1, 7 days per week ▸ Minimum flow of 200 cfs until 9:00 a.m. ▸ One-unit use from 9:00 to 10:00 a.m. ▸ Two-unit use for 8 hours. • Ocoee #1—provide flows from Memorial Day to September 30, 7 days per week ▸ Minimum flow until 10:00 a.m. ▸ Two-unit use for 6 hours (1,000 cfs). • Ocoee #2—no change. • Ocoee #3—no change. • Melton Hill—zero flow one weekend per month, from April 1 to November 1. • Great Falls—no change.	• No change

Preliminary Alternatives 7A, 7B, and 7C (continued)

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
	• Tims Ford—no change. • Blue Ridge—no change. • Upper Bear—no change. • South Holston—provide continuous minimum flows of 180 cfs below the weir from March 15 to October 15, 7 days per week.	

cfs = Cubic feet per second.

Preliminary Alternatives 8A, 8B, and 8C

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify summer reservoir elevations and/or drawdown dates	• No minimum operating guide, target minimum elevations, or annual drawdown schedule. Flood guides would be set the same as for Alternative 2A. • Reservoir elevations would be determined by retaining a percentage of inflows listed below, unless additional releases are necessary to manage reservoir levels that have exceeded flood guides, to meet Base Case minimum flow commitments, or to support special operations during a power system alert: ▸ Alternative 8A—retain 75 percent of inflows. ▸ Alternative 8B—retain 50 percent of inflows. ▸ Alternative 8C—retain 25 percent of inflows.	• No minimum operating guide, target minimum elevations, or annual drawdown schedule. The same guide curves as described for Alternative 2A would be used. • Reservoir elevations would be determined by retaining a percentage of inflows listed below, unless additional releases are necessary to manage reservoir levels that have exceeded flood guides, to meet Base Case minimum flow commitments, or to support special operations during a power system alert: ▸ Alternative 8A—retain 75 percent of inflows. ▸ Alternative 8B—retain 50 percent of inflows. ▸ Alternative 8C—retain 25 percent of inflows.
Modify winter reservoir elevations and/or fill dates	• No minimum operating guide, target minimum elevations, or annual fill schedule. Flood guides would be set the same as for Alternative 2A. • Pass the releases listed below, unless additional releases are necessary to stay below the flood guide, meet Base Case minimum flow commitments, or to support special operations during a power system alert. ▸ Alternative 8A—pass 25 percent of inflows. ▸ Alternative 8B—pass 50 percent of inflows. ▸ Alternative 8C—pass 75 percent of inflows.	• No minimum operating guide, target minimum elevations, or annual fill schedule. The same guide curves as described for Alternative 2A would be used. • Pass the releases listed below, unless additional releases are necessary to stay below the flood guide, to meet Base Case minimum flow commitments, or to support special operations during a power system alert. ▸ Alternative 8A—pass 25 percent of inflows. ▸ Alternative 8B—pass 50 percent of inflows. ▸ Alternative 8C—pass 75 percent of inflows.
Modify drawdown restrictions	• No change	• No change
Modify rate of flood storage recovery	• No change	• No change

Preliminary Alternatives 8A, 8B, and 8C (continued)

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify water releases	• High inflows—release water from reservoirs as necessary to keep elevations below the flood guide. • Low inflows—release water from reservoirs as necessary to meet Base Case minimum flow commitments. • When elevations are below the flood guide and minimum flows are being met, pass inflows as specified above. • No peaking will be performed unless low flow dips below the minimum amount required to operate one unit. Then peaking will be performed only to the extent necessary to peak one unit at the most efficient load.	• High inflows—release water from reservoirs as necessary to keep elevations below the flood guide. • Low inflows—release water from reservoirs as necessary to meet Base Case minimum flow commitments. • When elevations are below the flood guide and minimum flows are being met, pass inflows as specified above. • No peaking will be performed unless low flow dips below the minimum amount required to operate one unit. Then peaking will be performed only to the extent necessary to peak one unit at the most efficient load.

cfs = Cubic feet per second.

Preliminary Alternatives 9A, 9B, 9C

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify summer reservoir elevations and/or drawdown dates	• Fill reservoirs to full summer pool levels by June 1. After that, discretionary water is still available after the following flows have been met and water remains in the reservoirs: ▸ Base Case minimum flows. ▸ 25,000 cfs from Chickamauga (from August through Labor Day). ▸ Alternative 9A—pass 25 percent of inflow (like Alternative 8A, but peaking flows would be allowed) with 20 hours of peaking guaranteed per week from June 1 to September 15 and from December through February. ▸ Alternative 9B—pass 25 percent of inflow (like Alternative 8A, but peaking flows would be allowed) with 40 hours of peaking guaranteed per week from June 1 to September 15 and from December through February. ▸ Alternative 9C—pass 50 percent of inflow (like Alternative 8B, but peaking flows would be allowed) with 40 hours of peaking guaranteed per week from June 1 to September 15 and from December through February.	• Extend the current summer elevation through August 1 for Watts Bar, Chickamauga, Guntersville, Wheeler, Pickwick, and Kentucky/Barkley. • Then slope the guide curve from August 1 through Labor Day by 1 foot for each reservoir. • After Labor Day, slope the new curve to meet the current curve. • No changes to the following reservoirs for the reasons described: ▸ Fort Loudoun—maintains summer elevation through November 1. ▸ Nickajack—run-of-river project. ▸ Wilson—maintains summer elevation through December 1.
Modify winter reservoir elevations and/or fill dates	• Raise the winter flood guides equal to the current March 15 flood guide elevations for South Holston, Watauga, Cherokee (this would be equivalent to the new flood guide elevations established in Preliminary Alternative 1), Douglas, Chatuge, Nottely (this would be equivalent to the new flood guide elevations established in Preliminary Alternative 1), Hiwassee, Blue Ridge, Norris, and Tims Ford. • No change to spring fill dates.	• Raise the minimum winter elevation to permit a 13-foot navigation channel (11 feet with 2 feet overdraft) on Fort Loudoun, Watts Bar, Chickamauga, Wheeler, and Pickwick. • Modify the winter operating range of these reservoirs to allow only 1 foot of fluctuation versus the current 2 feet of fluctuation allowed. • No change to spring fill dates.

Preliminary Alternatives 9A, 9B, 9C (continued)

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify drawdown restrictions	• No change	• No change
Modify rate of flood storage recovery	• No change	• No change
Modify water releases	• Same as Base Case minimum flow commitments. • No change in recreation releases below Watauga, Apalachia, Tims Ford, Ocoee #2, and Ocoee #3.	• Same as Base Case minimum flow commitments.

cfs = Cubic feet per second.

Preliminary Alternative 10A

Alternative Characteristics	Tributary Reservoirs
Modify summer reservoir elevations and/or drawdown dates	• Tributary reservoirs are divided into three groups. • Each group is operated differently to focus on different reservoir system objectives. • Each reservoir group cycles through the three different types of reservoir operations over a 3-year period. **Operation 1** • Fill reservoirs to full summer pool levels by June 1 and hold until Labor Day. • Between June 1 and Labor Day, release only the amount of water necessary to: ▸ Meet Base Case minimum flow commitment for each reservoir; and, ▸ Supply 10 percent of the water needed to meet system minimum flow commitments at Chickamauga, Pickwick, and Kentucky and to prevent additional thermal power plant derates. **Operation 2** • Fill reservoirs to full summer pool levels by June 1. • Between June 1 and Labor Day, release only the amount of water necessary to: ▸ Meet Base Case minimum flow commitment for each reservoir; ▸ Meet tailwater recreation flows; and, ▸ Supply 30 percent of the water needed to meet system minimum flow commitments at Chickamauga, Pickwick, and Kentucky and to prevent additional thermal power plant derates. **Operation 3** • Fill reservoirs to full summer pool levels by June 1. • Between June 1 and Labor Day, release only the amount of water necessary to: ▸ Meet Base Case minimum flow commitment for each reservoir; and, ▸ Supply 60 percent of the water needed to meet system minimum flow commitments at Chickamauga, Pickwick, and Kentucky and to prevent additional thermal power plant derates.

Preliminary Alternative 10A (continued)

Alternative Characteristics	Tributary Reservoirs
	Notes: • Remove Boone Reservoir from the cyclic operation due to substantial impacts on reservoir levels. • Increase weekly release from Chickamauga to 25,000 cfs between August 1 and Labor Day. • Operate mainstem reservoirs the same as described for Alternative 2A. • Provide tailwater recreation flows as described for Alternative 7. • For mainstem reservoirs, summer guide curves would be the same as described for Alternative 2A.

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Reservoir groups	Group A: Norris, South Holston, Nottely, Tims Ford Group B: Douglas, Watauga, Chatuge, Fontana Group C: Cherokee, Hiwassee, Blue Ridge	Not applicable
Modify winter reservoir elevations and/or fill dates	• Raise the winter flood guides equal to the current March 15 flood guide elevations for South Holston, Watauga, Cherokee (this would be equivalent to the new flood guide elevations established in Preliminary Alternative 1), Douglas, Chatuge, Nottely (this would be equivalent to the new flood guide elevations established in Preliminary Alternative 1), Hiwassee, Blue Ridge, Norris, and Tims Ford. • No change to spring fill dates.	• Raise the minimum winter elevation to permit a 13-foot navigation channel (11 feet with 2 feet overdraft) on Fort Loudoun, Watts Bar, Chickamauga, Wheeler, and Pickwick. • Modify the winter operating range of these reservoirs to allow only 1 foot of fluctuation versus the current 2 feet of fluctuation allowed. • No change to spring fill dates.

Preliminary Alternative 10A (continued)

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify drawdown restrictions	• No change	• No change
Modify rate of flood storage recovery	• Slower flood recovery; extend the current 7- to 10-day flood recovery policy to 14 to 20 days when warranted (except for Hiwassee). • Raise Cherokee and Nottely minimum operating guide based on revised observed inflows.	• No change
Modify water releases	• Provide tailwater recreation flows as described for Alternative 7C. • Release only Base Case minimum flows and tailwater recreation flows between June 1 and Labor Day.	• Release only Base Case minimum flows during June and July, unless additional releases are necessary to manage reservoir levels that have exceeded flood guides or to support special operations during a power system alert. • Same as Base Case minimum flow commitments except for increasing weekly release from Chickamauga to 25,000 cfs between August 1 and Labor Day.

cfs = Cubic feet per second.

Preferred Alternative

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify summer reservoir elevations and/or drawdown dates	• Subject to each project meeting its minimum flow requirements and a proportionate share of the system minimum flow requirements, maintain elevations as close as possible to the flood guides during summer (June 1 through Labor Day) for Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Nottely, Hiwassee, Norris, South Holston, and Watauga. • No changes to the following reservoirs for the reasons described: ▸ Apalachia—run-of-river project. ▸ Bear Creek—maintains summer elevations to mid-November. ▸ Boone—maintains summer elevations through Labor Day. ▸ Cedar Creek—maintains summer elevations through October 31. ▸ Fort Patrick Henry—run-of-river project. ▸ Great Falls—maintains summer elevations through September 30. ▸ Little Bear Creek—maintains summer elevations through October 31. ▸ Melton Hill—run-of-river project. ▸ Normandy—subject to meeting downstream minimum flows summer elevations are maintained through mid-October. ▸ Ocoee #1—maintains summer elevations through October 31. ▸ Tims Ford—maintains summer elevations through mid-October. ▸ Upper Bear Creek—maintains the same fluctuation range year round. ▸ Wilbur—run-of-river project.	• Maintain Base Case summer operating zone through Labor Day for Chickamauga, Guntersville, Pickwick, and Wheeler. • Eliminate 1-foot drawdown from August 1 to November 1 for Watts Bar. • No changes to the following reservoirs for the reasons described: ▸ Fort Loudoun—maintains summer operating zone through October 31. ▸ Nickajack—run-of-river project. ▸ Wilson—maintains summer operating zone through November 30. ▸ Kentucky—potential resource and flood risk impacts.

Preferred Alternative (continued)

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify winter reservoir elevations and/or fill dates	• Raise winter flood guide to elevations based on flood risk analysis for Boone, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Norris, Nottely, South Holston, and Watauga. • Great Falls—Fill reservoir to summer pool by Memorial Day.	• Raise minimum winter pool elevation by 0.5 foot at Wheeler. • Follow the Base Case fill schedule during the first week in April for Fort Loudoun, Watts Bar, and Chickamauga. Then delay the fill to reach summer operating zone by mid-May.
Modify drawdown restrictions	• Restrict drawdown June 1 through Labor Day, and proportion withdrawals to meet system minimum flows to keep tributary reservoir pool elevations as close as possible to the flood guides.	• Maintain Base Case summer operating zone at Chickamauga, Guntersville, Wheeler, and Pickwick through Labor Day.
Modify water releases	• Same as Base Case minimum flow commitments except for additional scheduled tailwater recreation releases as shown below. • Apalachia—provide 25 cfs continuous minimum flow in bypass reach from June 1 through November 30.	• Establish weekly average Chickamauga Reservoir releases from the first week in June through Labor Day as described below. ▸ If above system minimum operations guide curve, increase weekly average minimum flow from Chickamauga each week during June and July (beginning with 14,000 cfs the first week in June, increasing 1,000 cfs each week for the next 3 weeks, then increasing 2,000 cfs each week for the next 4 weeks, and ending with 25,000 cfs the last week in July). ▸ If below system minimum operations guide curve, release 13,000 cfs weekly average minimum flow from Chickamauga during June and July. • Release 29,000 cfs weekly average minimum flow from Chickamauga from August 1 through Labor Day if above system minimum operations guide curve or 25,000 cfs if below system minimum operations guide curve. • Provide continuous minimum flows up to 25,000 cfs at Kentucky, as needed, to maintain minimum tailwater elevation of 301 feet.

Preferred Alternative (continued)

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify tailwater recreation releases	• No change in tailwater recreation releases below Great Falls, Ocoee #2, Ocoee #3, Tims Ford, and Upper Bear Creek Reservoirs. • Provide tailwater recreation flows for the projects as described below: ▸ Apalachia May 1 through October 31 (Saturdays and Sundays only) Minimum flow only prior to 10 a.m. Memorial Day through Labor Day (7 days per week) One-unit use from 10 a.m. to 11 a.m. Two-unit use from 11 a.m. to 7 p.m. (8 hours) Labor Day through October 31 (Saturdays only) One-unit use from 10 a.m. to 11 a.m. Two-unit use from 11 a.m. to 3 p.m. (4 hours) ▸ Norris May 1 through October 31 (Saturdays and Sundays only) Minimum flow only prior to 10 a.m. Memorial Day through Labor Day (Saturdays and Sundays only) One-unit use from 10 a.m. to 2 p.m. (4 hours) Two-unit use from 2 p.m. to 6 p.m. (4 hours) Labor Day through October 31 (Saturday only) One-unit use from 10 a.m. to 1 p.m. (3 hours) Two-unit use from 1 p.m. to 4 p.m. (3 hours)	• No change

Preferred Alternative (continued)

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify tailwater recreation releases (continued)	▸ Ocoee #1 June 1 through August 31 (Tuesdays and Wednesdays only) Minimum flow only until 11 a.m. Minimum two-unit use from 11 a.m. to 5 p.m. (6 hours) ▸ South Holston April 1 through October 31 Increase minimum flow below the weir to 150 cfs ▸ Watauga operation for recreation flows below Wilbur Memorial Day through Labor Day Mondays – Fridays—one-unit use from 1 p.m. to 6 p.m. (5 hours) Saturdays—one-unit use from 12 p.m. to 1 p.m. Two-unit use from 1 p.m. to 5 p.m. (4 hours) One-unit use from 5 p.m. to 6 p.m. Labor Day through October 31 Saturdays only—one-unit use from 1 p.m. to 6 p.m. (5 hours)	

cfs = Cubic feet per second.

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Appendix C

Model Descriptions and Results

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Analytic Models

C.1 Introduction

Computer simulations using recognized computer models were used in the Reservoir Operations Study (ROS) to analyze potential impacts on environmental resources that could result from implementation of any of the reservoir operations policy alternatives. Computer models were used to provide information for analysis in six principal areas:

- Reservoir levels, water availability, and hydropower production;
- Energy production costs;
- Water quality;
- Flood risk modeling;
- Land values; and,
- Economic modeling.

The models used to develop the information listed above are described in the succeeding sections. Graphs summarizing the results of the Weekly Scheduling Model (WSM) are included after the model descriptions.

C.2 Reservoir Levels, Water Availability, and Hydropower Production Modeling

Interactions of unregulated streamflow, regulated discharges, and reservoir pool elevations must be determined to analyze the effects of policy alternatives. To evaluate these interactions, TVA used computer simulations to model the existing reservoir system operations under the existing operations policy and establish a Base Case against which all proposed alternatives were compared. This approach allowed TVA to consider 99 years of hydrologic record under the existing reservoir system and operations policy. The modeling, modeling approach, calibration, and input and output of this effort are described in the following sections.

Weekly Scheduling Model Description

TVA used the WSM as its basic simulation tool. This proprietary software was developed by TVA for modeling major water control projects in the Tennessee and Cumberland River basins.

This deterministic model simulates operation of the Tennessee and Cumberland River projects on a weekly time interval for a specified period of historical record. For the ROS, the period of record was the 99-year period beginning in 1903 and continuing through 2001. The model operates 1 week at a time, solving the mass balance equations for all reservoirs and satisfying operating constraints/guidelines in a prioritized order (i.e., higher priority guidelines are satisfied first and then secondary guidelines are satisfied next to the extent possible, without violating higher priority operating objectives). The model uses a linear programming approach to develop a solution for each time interval.

TVA has used the model for many years, for many different applications—including contractual power agreements with the Southeastern Power Administration and U.S. Army Corps of Engineers for generation and marketing of Cumberland River hydropower generation, contractual power agreements for purchase of Tapoco power from four facilities on the Little Tennessee River, reservoir studies for the TVA 1990 Lake Improvement Plan, monthly forecasting of power generation for the TVA and Cumberland River systems, and studies for special operations for the TVA reservoir system and unit outage planning.

Model input requirements include:

(1) Average historical weekly unregulated inflows to each reservoir in the model. These were derived from TVA operational data after completion of the projects and from gaged streamflow data prior to completion of the projects.

(2) Plant operating characteristics for all hydropower generating facilities, relating power capacity and energy per unit volume of water as a function of operating head.

(3) Physical characteristics of reservoirs, including maximum and minimum levels, and storage versus elevation curves.

(4) Initial conditions, including pool elevations at the beginning of the simulation.

(5) Operations policy expressed as a prioritized linear programming constraint set, including minimum and maximum flows, minimum and maximum operating levels, and guide curves—all of which can be expressed on a seasonal (or weekly) basis and as conditional constraints based on flow or level conditions at the beginning of each week.

Of the above model inputs, only (4) and (5) were changed when simulating various alternatives to compare to the Base Case.

Available model outputs for each reservoir include:

(1) End of week reservoir elevations (feet above mean sea level);
(2) Weekly average total discharge (in cubic feet per second [cfs]);
(3) Weekly generation (in megawatts per hour [MWH]);
(4) Weekly average turbine discharge capacity (cfs); and,
(5) Maximum generation capacity (MW).

Two examples of post-processed model output are shown in Figures C-01 and C-02.

The WSM was re-calibrated prior to the start of the ROS to ensure that the existing operations policy and project operating characteristics were simulated by the model as accurately as possible. The 10-year period from 1991 to 2000 was used as the calibration period, and yearly results as well as 10-year statistics were used.

In addition to providing detailed information about reservoir levels and water availability, the WSM provided the basis for more detailed information required for the Water Quality modeling and power system evaluations. Post-processing of the WSM results are described below for these two resource areas.

Water Quality modeling required using data for hourly discharges at each of the TVA projects. Because the WSM produces only average weekly discharges, a reasonable disaggregation of the weekly averages into chronological (by hour) release patterns was required. TVA used existing proprietary software to estimate hourly schedules based on the following:

(1) Assumed hydropower peaking hours for each season of the year;

(2) Regression analysis of historical data for each project to determine the ratio of flows on weekdays vs. weekends;

(3) Use of water for hydro peaking at one unit use to cover peak hours, then two-unit use, etc. until available water is scheduled;

(4) If more water is available than will pass through the hydro units, then spill at a steady rate for the week was assumed;

(5) Minimum flows (instantaneous or pulsing) are met first; and,

(6) Ramping rates for the project are satisfied.

Each policy alternative was also evaluated for its impacts on TVA power supply costs. This evaluation required that weekly hydroelectric generation statistics be provided to the overall power resource evaluation modeling effort, as described in Section 5.23 in Volume I of this FEIS.

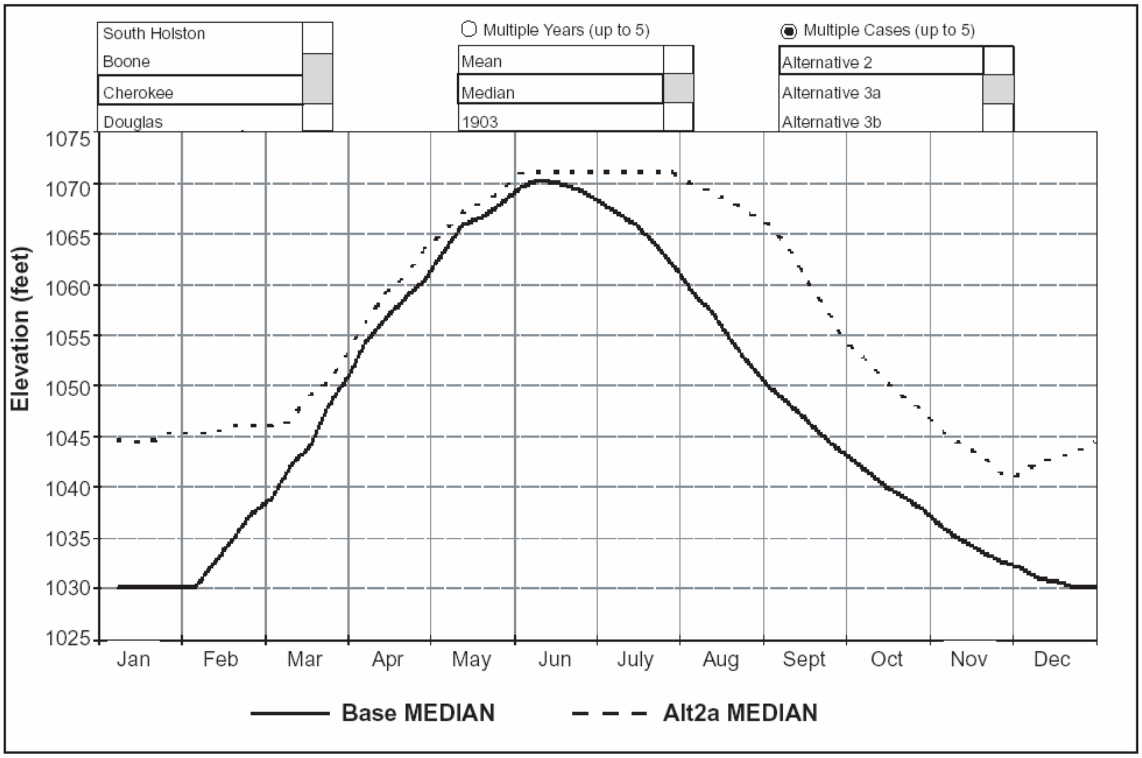


Figure C-01 Median Project Elevations for Two Alternatives

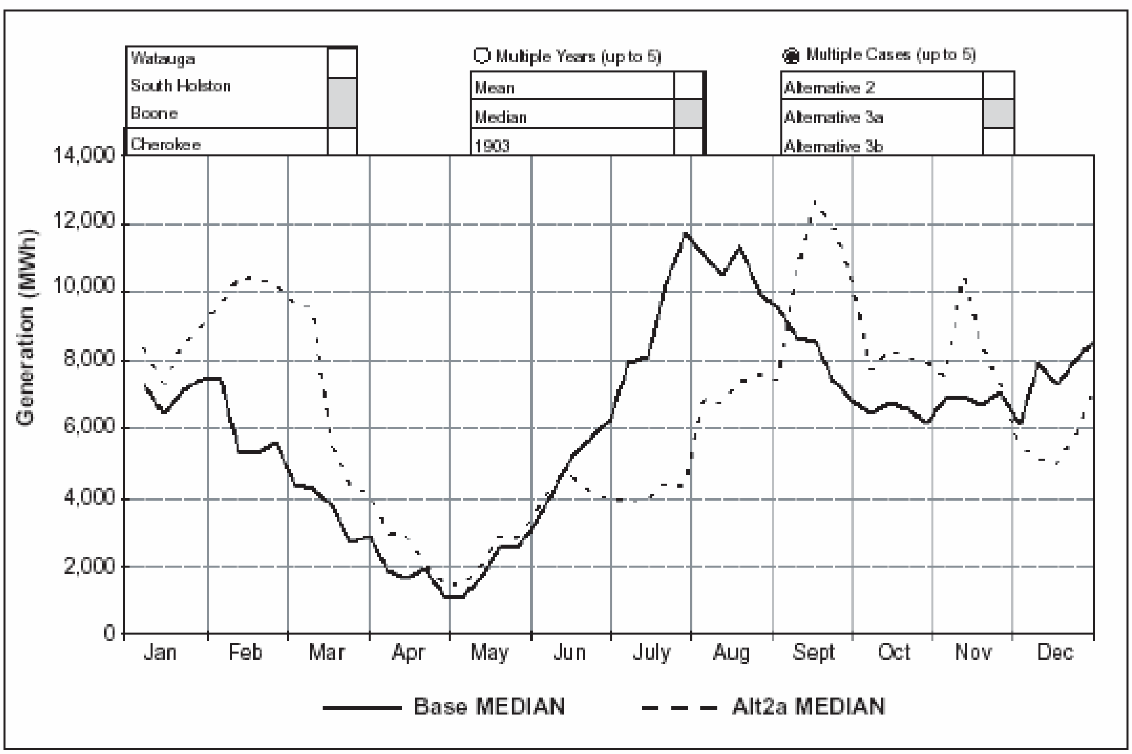


Figure C-02 Average Project Generation for Two Alternatives

The power evaluation model required the following statistics for each alternative:

(1) For a median year, the weekly system hydropower (energy, MWH) available to TVA, and the minimum and maximum power levels (MW) throughout the week at which the generation can be dispatched; and,

(2) The 10^{th} and 90^{th} percentile of ranked generation for each week over the period of record of the simulation, and the 10^{th} and 90^{th} percentile of minimum and maximum power levels.

The WSM provides weekly generation for each project for each week of the historical record, from which the system hydropower generation energy statistics can be computed. Hydropower capacity values were computed based on the assumption that the available generation at each plant will be dispatched during the highest cost hours, at the highest available capacity, subject to reserving energy (water) for meeting minimum flow requirements throughout the week.

Weekly Scheduling Model Results

The WSM was a central tool in the impact assessment for the policy alternatives. This model was used to convert reservoir operations policy changes into predicted future changes in reservoir levels and discharges from the ROS projects in the TVA water control system, given the annual variability in rainfall and runoff within the TVA system.

The WSM provided outputs for each alternative, for different reservoirs and for different time periods. Depending on the comparison desired, a single week, groups of weeks, or an entire year (or years) was selected. The various outputs that can be generated from the WSM include:

- Elevation and flow plots—weekly average reservoir elevation (msl) or flow releases (cfs) for a given period of time;
- Generation and turbine capacity plots—average weekly generation (MW) and weekly average turbine capacity (cfs) for a given period of time; and,
- Probability elevation and flow plots—the predicted frequency at which different average weekly reservoir elevations, flows, or generation would occur over the next 99-year record of a reservoir over any defined set of weeks (e.g., Labor Day, the month of June, or August through October). These are expressed as percentiles—the percentage of time that different levels and flows would occur.

The WSM is important to the EIS because reservoir elevations and reservoir releases and tailwater flows are the drivers for most impacts. This tool quantitatively compares the effects of alternatives on the water control system.

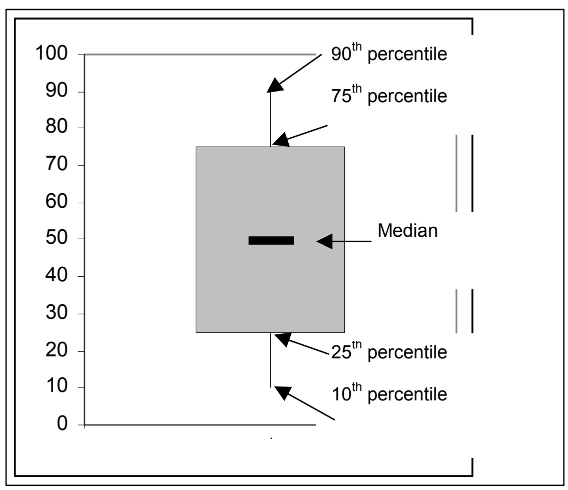
Overview of Weekly Scheduling Model Results

The results of the WSM predictions are presented in Section C.8. Graphical comparisons in the form of box plots showing the differences in reservoir elevations and flows that would occur under the various alternatives are provided for each of the reservoirs for selected periods, as shown below. The tributary storage reservoirs were plotted for elevation, and all reservoirs in the WSM within the scope of the ROS were plotted for flow. Additionally, elevation probability plots along with flood guide curves for the tributary reservoirs and operating guides for the mainstem reservoirs are presented for the Base Case and the Preferred Alternative.

Elevation	Flow
January 1 (week 52)	Spring fill (weeks 12 – 22)
March 15 (week 12)	Summer pool (weeks 22 – 35)
Labor Day (week 35)	Fall drawdown (weeks 36 – 48)
Memorial Day (week 21)	
Last week of October (week 43)	

Box Plots

Box plots are used to demonstrate the variability in the results among the alternatives, and the variability that results from interaction between the reservoir operations policy and the wide range of rainfall and runoff conditions that occur from year to year in the Tennessee River basin.

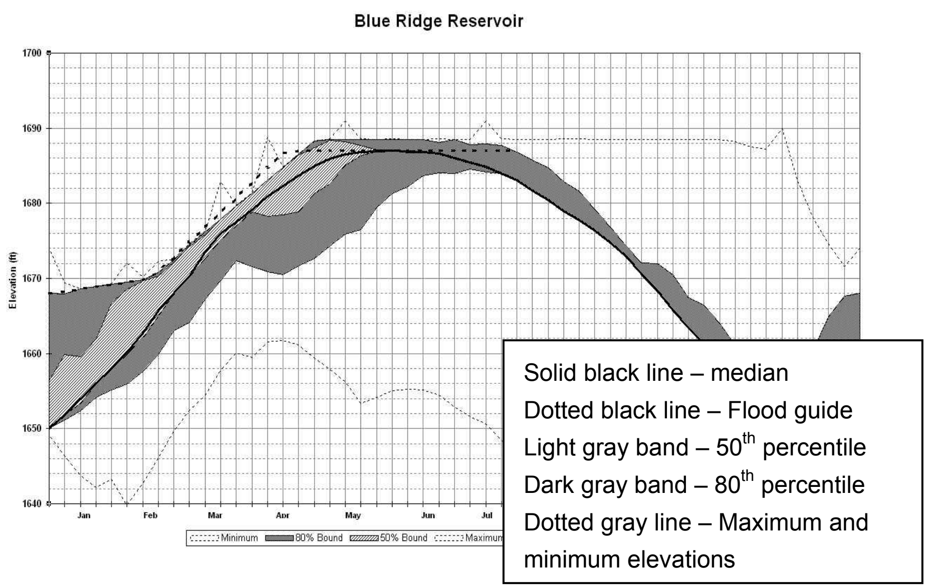


Box plots present, in a single graphic depiction, the full range and distribution of the flows and reservoir levels that would occur over the predicted 99-year record. The statistics presented in box plots and their interpretations are described in the inset box and the table on the next page.

Percentiles Used in Box Plots	
90th percentile	Reservoir elevations/flow release would be lower/less than this elevation 90% of the time (higher 10% of the time)
75th percentile	Reservoir elevations/flow release would be lower/less than this elevation 75% of the time (higher 25% of the time)
Median	Reservoir elevations/flow release would be higher than this elevation 50% of the time and lower than this elevation 50% of the time
25th to 50th percentile range (grey box)	Reservoir elevations/flow release would fall within this range (grey box) 50% of the time
25th percentile	Reservoir elevations/flow release would be lower/less than this elevation 25% of the time (higher 75% of the time)
10th percentile	Reservoir elevations/flow release would be lower/less than this elevation 10% of the time (higher 90% of the time)

Probability Plots

Probability plots were developed using the WSM and 99 years of available hydrologic data. Each alternative analyzed was loaded into the WSM and run with the 99 years of hydrologic data. This resulted in 99 plots of modeled weekly elevations for each reservoir. The elevation probability plots represent the results of these 99 years of



weekly elevations. The median line indicates the weekly median elevation for the 99 years (i.e., for any given week, 50% of the 99 modeled elevation points for that week were at or above the point in the median line and 50% of the 99 modeled elevation points for that week were at or below the median point). The 50% bound for any given week indicates the range where 50% of the 99 modeled elevation points for that week fell. Similarly, the 80% bound indicates where 80% of the points fell. The maximum and minimum lines (the highest modeled elevation for each week and the lowest modeled elevation for each week, respectively) are also included, along with the flood guide elevation (see glossary in Chapter 10 for definition).

C.3 Energy Cost Modeling

The models used in the power generation analyses for this EIS include the WSM, the PROSYM model, and the RELY model.

The PROSYM model is a commercially available and well established electric power production costing simulation computer software package. This proprietary model is licensed by The Henwood Energy Services, Inc. of Sacramento, California. It is designed for performing planning and operational studies; because of its chronological nature, the model accommodates detailed hour-by-hour investigation of TVA's power operations. PROSYM simulates TVA's power system operation on a chronological hourly basis in 1-week increments and is used to define power system operating costs to meet power loads. Input into the model includes fuel costs, variable operation and maintenance costs, and startup costs specific to TVA's plants. PROSYM determines how to meet hourly loads in the most economical manner possible, given a specified set of generating resources as well as the future capacity needed to maintain power system reliability as determined by the RELY model described below. Output from PROSYM is production cost by power resource.

The RELY model is a generation reliability model used to determine the capacity needed to maintain the reliability of the power system. It calculates the TVA system loss of load probability (LOLP) hourly for the summer and winter peak load seasons through 2022. The results were based on the capacity of the generating resources and purchases, expected equivalent forced outage rates, planned outages, the hourly load forecast, contract load available for interruptions, and uncertainty on the load forecast. The impact of the hourly dispatch each week of the various hydropower alternatives was analyzed to determine the different electric generation capacity needs and to compare them to the capacity needs of the Base Case. On the basis of assumptions about the construction costs of peaking and base types of power plants, TVA then converted the resulting differences to capacity cost differences among the scenarios.

TVA currently uses PROSYM and RELY in its operations and planning activities.

C.4 Water Quality Modeling

TVA has developed numerical water quality models for various reservoirs in the Tennessee River, Cumberland River, and other river systems to investigate water quality issues typically involving water temperature and dissolved oxygen (DO). The water quality models presently in use in the Tennessee River system include TVARMS, BETTER, CEQUAL-W2, and SysTemp. Each of these models is described below.

TVA uses TVARMS (the Tennessee Valley Authority River Modeling System) to simulate tailwaters and regulated stream reaches. TVARMS consists of two individual models: a flow model (ADYN) and a water quality model (RQUAL) (Hauser et al. 1995). These models can be used independently or in sequence. ADYN is a one-dimensional, longitudinal, unsteady flow model that is valid for streams and the tailwater portions of reservoirs. ADYN solves the one-dimensional equations for conservation of mass and momentum using a four-point implicit finite difference scheme, or McCormack explicit scheme. RQUAL is a one-dimensional water quality model used in conjunction with ADYN. RQUAL solves the mass transport equation with the same numerical scheme as the flow model. RQUAL is useful for studying temperature and nitrogenous and carbonaceous biochemical oxygen demand. TVA rigorously calibrated and verified this model, and has applied it on numerous rivers and reservoirs (Beard and Hauser 1986, Hauser 1985, Brown and Shiao 1985, Hauser and Ruane 1985, Hill and Hauser 1985, Hauser 1983, Hauser et al. 1983, Hauser and Beard 1983). TVA distributed this software and trained others in its use. Several consulting firms use the model.

For the ROS, TVA used TVARMS to simulate tailwaters, including:

Norris	Beard et al. 1986, Hauser et al. 1983
Cherokee	Hauser et al. 1983
Douglas	Hauser et al. 1989
South Holston	Hauser et al. 1985, Hadjerioua and Lindquist 2002
Chatuge	Julian 2003
Nottely	Shiao 2002
Watauga	Julian 2002
Fort Patrick Henry	Hadjerioua 2003 (not yet published)
Apalachia	Proctor 2003 (not yet published)
Normandy	Bevelheimer 2003 (not yet published)

An additional model was used in the Water Quality analysis. The Box Exchange, Transport and Temperature of a Reservoir (BETTER) model simulates temperature, DO, nutrients, pH, and algal biomass in the longitudinal and vertical dimensions. The strengths of BETTER are:

- Relatively easy simulation of seasonal water quality patterns;
- Representations of numerous physical and biochemical processes; and,
- No major execution problems such as numerical instabilities.

BETTER solves conservation of mass but does not include the momentum equation (Bender et al. 1990). Model results have been accepted by the Tennessee Department of Environment and Conservation (TDEC). For the ROS, TVA used the pre-existing calibrated BETTER models for eight reservoirs:

Normandy	Beard and Brown 1984
Boone	Bender et al. 1990
Cherokee	Hauser et al. 1983 and 1987
Douglas	Brown et al. 1987
Fort Loudoun	Brown et al. 1985a
Guntersville	Bender et al. 1990
Kentucky	Shiao 2000
Nickajack	Shiao 2000
Nottely	Shiao 1995
Pickwick	Brown et al. 1985b
Tellico	Hauser et al. 1982
Watts Bar	Shiao (not published)
Wheeler	Shiao (not published)

CE-QUAL-W2 was developed by the U.S. Army Corps of Engineers (Cole and Buchak 1995). It is a two-dimensional, laterally averaged, hydrodynamic and water quality model that is widely distributed, accepted, and used. The model is best suited for long, narrow waterbodies with longitudinal and vertical water quality gradients. A branching algorithm allows application to geometrically complex waterbodies. The model is useful for predicting water surface elevations, velocities, and temperatures, as well as 21 other water quality constituents. TVA had previously calibrated CE-QUAL-W2 models for Melton Hill and Douglas Reservoirs (Hadjerioua and Lindquist 2000a, 2000b). As part of the ROS, CE-QUAL-W2 models were calibrated for 16 additional reservoirs, as described in the following reports:

Apalachia	Proctor 2003
Bear Creek	FTN 2003
Blue Ridge	Proctor 2002
Cedar Creek	FTN 2003
Chatuge	Shiao 2003
Fontana	Hadjerioua and Lindquist 2003a
Fort Patrick Henry	Hadjerioua and Lindquist 2003b
Great Falls	FTN 2003
Hiwassee	Proctor 2003
Little Bear Creek	FTN 2003
Norris	Hadjerioua and Lindquist 2000c
South Holston	Hadjerioua and Lindquist 2003
Tims Ford	Julian 2002
Upper Bear Creek	Ruane 2003
Watauga	Higgins 2003
Wilson	Proctor (not published)

TVA developed a system-wide water temperature model (SysTemp) to simulate how the TVA system of connected reservoirs thermally responds to meteorology and changes in reservoir operations (Miller et al. 1992). SysTemp extends from Melton Hill and Watts Bar Reservoirs through seven additional reservoirs to Kentucky Dam. Each reservoir in the system includes a BETTER model within each reservoir. SysTemp uses release temperatures and flow from Norris and Watts Bar Hydro Plants as upstream boundary conditions. Headwater elevation at Kentucky Dam forms the downstream boundary condition. As input, SysTemp uses releases from each hydro plant and meteorological conditions. TVA routinely uses SysTemp to provide 90-day water temperature forecasts, which are automatically updated daily.

For the ROS, TVA upgraded the SysTemp model to link the TVARMS, CE-QUAL-W2, and BETTER models to simulate a larger portion of TVA's water control system. The upgraded version has been designated SysTempO and uses water quality model output from upstream waterbodies as input for the next tailwater or reservoir downstream. The individual elements in SysTempO were pre-calibrated for at least 1 year of data before being linked. After linking models together in SysTemp, 8 years of modeled temperature and DO were compared to measured data, and the model was adjusted. The model was then used to simulate the Base Case and policy alternatives to examine the effect of alternative reservoir operations policies on water quality.

All of the reservoirs and tailwaters listed above were linked together except Upper Bear Creek, Bear Creek, and Little Bear Creek Reservoirs. These were not included because changes in operations were not proposed for these reservoirs. Models were not calibrated for Ocoee #1, #2 and #3 Reservoirs. Hiwassee Reservoir results were used as an analog to estimate impacts on the Ocoees. The Tapoco projects between Fontana and Tellico Reservoirs were also not modeled. Empirical relationships were developed by Montgomery (2003) to estimate the changes in water quality between Fontana and Tellico Reservoirs.

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C.5 Floodflow Modeling

Modeling for the flood control analysis was conducted using RiverWare, a general purpose river basin modeling software system developed by the University of Colorado under primary sponsorship by TVA and the U. S. Bureau of Reclamation. Optimization and simulation functions of this model have been used for several years by TVA to schedule the operation of the reservoir system. For the flood risk analysis in the ROS, the rule-based simulation capabilities of RiverWare were used to model the entire water control system for the 99-year period of record, using a 6-hour timestep.

The model allows sophisticated operating rules to be written for all projects that mimic TVA's operations of these projects during flood control operations and during flood recovery operations. The model results show the headwater elevation for each project and the maximum outflow rates at each project for each storm (minor and major) that has occurred at any location in the Tennessee Valley during the past 99 years, as well as for a number of synthesized design floods. Model calibration for both the physical modeling attributes and the representation of the operations policy for the Base Case was conducted based on recent floods back to 1973.

Additional information on RiverWare can be retrieved from the University of Colorado's web site at: http://cadswes.colorado.edu.

Use of Modeling Results in Developing the Preferred Alternative

Except for the Base Case, none of the alternatives in the Draft Environmental Impact Statement were completely acceptable from a flood risk standpoint. Detailed analyses indicated that all alternatives investigated were characterized by an unacceptable increase in the risk of flooding at one or more critical locations in the Tennessee Valley. However, the analysis also indicated that each of the alternatives satisfied flood risk evaluation criteria at least for certain seasons at certain locations. This suggested the possibility of combining specific elements of the alternatives investigated in a new, "blended" alternative. It was therefore necessary to conduct additional floodflow modeling to determine whether a Preferred Alternative could be developed that would allow meaningful changes in reservoir pool levels without violating the flood risk criteria.

The RiverWare model was used in developing a series of eight blended alternatives based on successive attempts to limit increases in flood risk to an acceptable level at all locations. Reservoir Recreation Alternative A was used as a baseline for developing Blend 1. Winter flood guides were raised for 11 tributary storage projects, summer flood guides were lowered for five tributary storage projects, winter flood guides were raised for five mainstem projects, and summer flood guides were extended for six mainstem projects. Modeling results showed unacceptable increases in flood risk throughout the system, but particularly in the Hiwassee River watershed and the Tennessee River.

To address these issues, additional modifications were made to the flood guide curves and regulating zones for individual projects where problems were identified, resulting in Blend 2. Modeling of Blend 2 identified additional flood issues, leading to more incremental changes in flood guide curves and regulating zones at individual projects and the development of Blend 3. This process continued until flood risk issues at the critical locations considered were eliminated based on modeling of Blend 8.

Flood risk issues identified for a particular simulation could be associated either with the period of record (flood events observed over a continuous 99-year period), design storms (hypothetical flood events based on scaled replicas of large historical events), or both.

C.6 Hedonic Valuation Model – Estimated Changes in Property Values

The hedonic valuation model was used to estimate changes in property values as they relate to reservoir levels, a key parameter that varied among the policy alternatives. This model is derived mostly from Lancaster's (1966) consumer theory and Rosen's (1974) model. Numerous studies have used this technique to examine the relationship between attribute preference and the price of properties (Gillard 1981, Li & Brown 1980, Sirpal 1994, Walden 1990). More specifically, applications have included the influence on property sales price of residential and neighborhood attributes, such as land use (Crecine et al. 1967), residential quality and accessibility (Kain and Quigley 1970, Richardson et al. 1974, Randolph 1988, Can 1990, Dubin 1992), externalities in the local surrounding environment (Ridker and Henning 1968; Anderson and Crocker 1971; Wilkinson 1973; Smith and Deyak 1975; Nelson 1978; Berry and Bednarz 1979; Mark 1980; Clark et al. 1997; Simons et al. 1997, 1998, 1999), and water-related amenities (Milon et al.1984, Brown and Pollakowski 1977).

The hedonic valuation model is well suited for linear regression analysis. In the hedonic valuation model, the implicit price of each characteristic of the property embedded in the market price of the property is identified.

The following identifies the basic equation used in this analysis.

(1) $Y_i = a + BX_i + CZ_i + E_i$, where

Y is a vector of assessed property values,

X is a matrix of property attributes exclusive of water fluctuations,

Z is a vector of values of average annual distance to pool, and

E is a vector of normally distributed residual values.

For the purpose of the ROS, it was postulated that the value of residential property located adjacent to the TVA reservoirs reflects the recreational and aesthetic (RA) benefits received from the reservoir by residents (i.e., residential property on or near reservoirs will have a higher value if the winter reservoir level drawdown exposes less area between the summer high pool and winter low pool elevations).

Average annual distance to pool (ADTP) was the variable that linked elevations to property values in the hedonic valuation model and is defined as

(2) ADTP = (Horizontal distance to summer pool) + (Reservoir maximum elevation – average elevation)/(parcel slope fraction).

ADTP variables were derived from distance to pool and slope data for sample parcels from several reservoirs, using a Geographic Information System and historical pool elevation levels. Thus, with simulated weekly elevations for alternative operating scenarios in the context of highly regulated, annual fluctuations in pool levels, potential policy changes can be mapped directly into property values through the ADTP variable. If an operations alternative requires summer reservoir levels to remain at the normal maximum elevation for an additional 30 days per year, for example, the ADTP will be less than it is in the existing condition.

The coefficient for ADTP, then, yields a dollar value per foot of change in average annual distance to pool, and the effect of changes in reservoir operations on property values can be estimated.

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C.7 Economic Modeling

This project uses TVA's 10-area economic simulation and forecasting model purchased from *Regional Economic Models, Inc.* (REMI) to estimate the total effects, which are reported as economic impacts of alternatives. The REMI model is an integral part of a system of models and processes that TVA uses for economic forecasting and analyses. REMI constructs models that reveal the economic and demographic effects that policy initiatives or external events may impose on a local economy. A REMI model has been built especially for the TVA region that is based on 31 years of historical data. REMI's model-building system uses hundreds of programs developed over the past two decades to build customized models using data from the Bureau of Economic Analysis, the Bureau of Labor Statistics, the Department of Energy, the Census Bureau and other public sources.

REMI Policy Insight, the newest version of REMI's software, utilizes years of economic experience. A major feature of REMI is that it is a dynamic model, which forecasts how changes in the economy and adjustments to those changes will occur on a year-by-year basis. The model is sensitive to a very wide range of policy and project alternatives, and to interactions between the regional and national economies.

The REMI model is a structural model, meaning that the REMI TVA ROS Model includes cause-and-effect relationships. Estimated changes to the five direct drivers are model inputs. The model builds on two key underlying assumptions that guide economic theory: households maximize utility and producers maximize profits. In the model, businesses produce goods to sell to other firms, consumers, investors, governments and purchasers outside the region. The output is produced using labor, capital, fuel and intermediate inputs. The demand for labor, capital and fuel per unit of output depends on their relative costs; an increase in the price of any of these inputs leads to substitution away from that input to other inputs. The supply of labor in the model depends on the number of people in the population and the proportion of those people who participate in the labor force. Economic migration affects the population size. People will move into an area if the real after-tax wage rates, the likelihood of being employed, and the access to consumer goods increases in a region.

Supply and demand for labor in the model determines the wage rates. These wage rates, along with other prices and productivity, determine the cost of doing business for every industry in the model. An increase in the cost of doing business causes an increase in production costs and the price of the goods or service, which would decrease the share of the domestic and foreign markets supplied by local firms. This market share, combined with the demand described above, determines the amount of local output. The model has many other feedbacks. For example, changes in wages and employment affect income and consumption, while economic expansion changes investment and population growth affects government spending.

Figure C-03 is a pictorial representation of the model. The Output block shows a factory that sells to all the sectors of final demand as well as to other industries. The Labor & Capital Demand block shows how labor and capital requirements depend both on output and their relative costs. Population & Labor Supply are shown as contributing to demand and to wage determination in the product and labor market. The feedback from this market shows that economic migrants respond to labor market conditions. Demand and supply interact in the Wage, Costs, & Prices block. Once costs and prices are established, they determine market shares, which along with components of demand determine output.

Linkages indicated by the dashed arrows account for the effects of agglomeration in both the labor and product markets. These effects are crucial to accurately capture the key to why certain areas with a concentration of similar businesses can prosper despite high wages and real estate costs. By having a choice of suppliers and workers, each firm can obtain specialized labor and inputs that best fulfill their needs. This increases productivity and efficiency. Nashville's agglomeration of musical artists, producers, recording studios, show case venues, songwriters, agents, and entertainment lawyers is the perfect example of an agglomeration economy.

The dashed arrow from the Output block to the Cost block shows that more suppliers will increase the efficiency of inputs, which will then reduce production costs and competitiveness. The dashed arrow from the Labor block shows that more labor will increase the productivity of labor, thus reducing labor costs and thereby making the area more competitive. The arrow from Output to the Population block shows that the greater output provides more variety of choices and enhances consumer satisfaction, and thus inward migration. The arrow from the Output to the Shares block shows that the areas with concentration can offer more to purchasers, thus having an effect on market share in addition to the price advantages through the Cost & Price block.

The REMI model has strong dynamic properties, which means that it forecasts what will happen and when it will happen. The model brings together all of the above elements to determine the value of each of the variables in the model for each year in the baseline forecast. Inter-industry relationships contained in typical input-output models are captured in the REMI Output block; but REMI goes well beyond typical input-output models by including the relationships among all of the other blocks shown in Figure C-03.

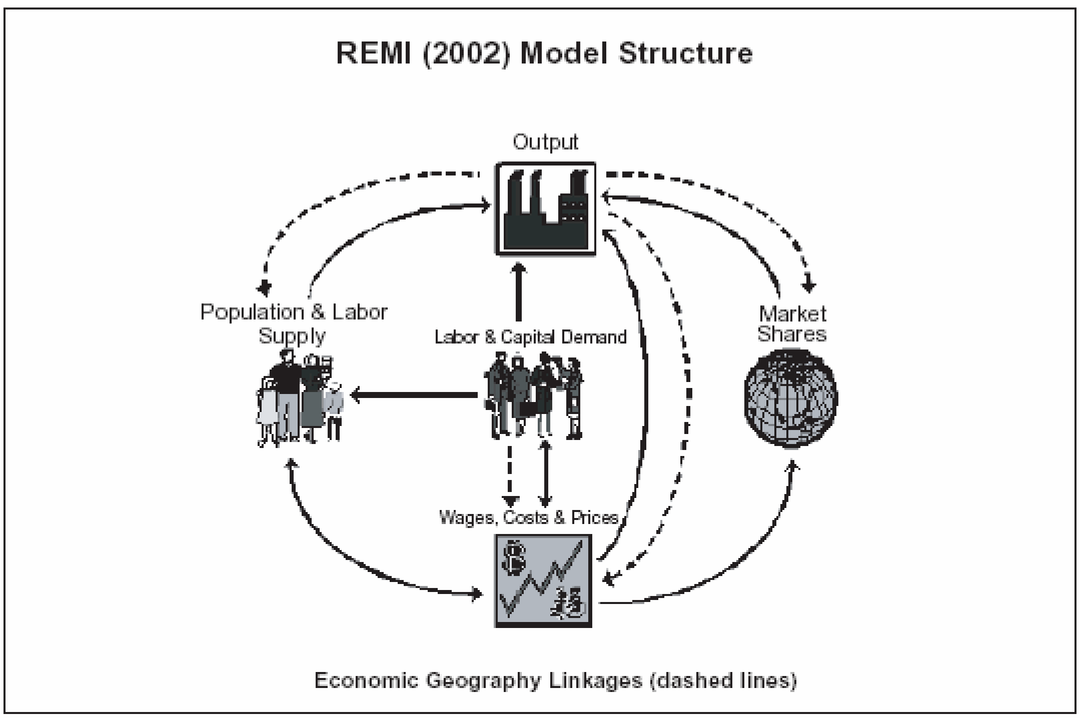


Figure C-03 Pictorial Representation of the REMI Model

The REMI TVA ROS model is designed to examine the effects of policy changes or direct economic changes to the TVA regional economy arising from the five economic drivers. The baseline forecast uses the baseline assumptions about the national and regional economic variables. Alternative forecasts have been generated using selected input variable values for the five drivers that reflect changes caused by alternative reservoir operations. Figure C-04 shows how this process would work for a reservoir operations change called Alternative X.

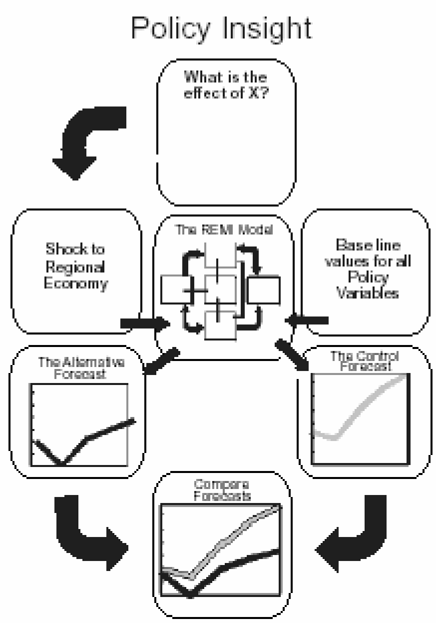


Figure C-04 REMI Model Process for Measuring Changes in Reservoir Operating Policies

The REMI model comes with default baseline economic forecasts for the United States and the TVA region, referred to as “Control Forecasts.” Specified alternatives that will have some effects on the regional economy have been studied to understand and estimate their direct effects. The direct changes to industries affected by reservoir operations are introduced into the model, which is then run to produce a new forecast incorporating the impacts of the specified alternatives. Results are shown in terms of how the new forecast differs from the Control Forecast. For example, reservoir operation changes that sustain tributary reservoir water levels longer into fall would affect local recreation activity and associated spending. The REMI model tracks these changes as consumer spending in relation to specific recreation activities. This study reports incremental changes between the baseline and alternative as the results.

C.8 Weekly Scheduling Model Results Outputs

The following pages include the tabular and box plot results for selected reservoirs. The conversion chart below relates the letter and number code to the alternative names used in the text of the main document.

RESERVOIR OPERATIONS POLICY ALTERNATIVES EVALUATED IN DETAIL

Alternative Name	Former Number Code
Reservoir Recreation A	2A
Reservoir Recreation B	3C
Summer Hydropower	4D
Equalized Summer/Winter Flood Risk	5A
Commercial Navigation	6A
Tailwater Recreation	7C
Tailwater Habitat	8A

Reservoir Elevation (feet above MSL) on January 1st

Tims Ford Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	870.0	875.0	871.0	871.0	865.0	870.0	871.0	875.0	870.0
25	870.0	875.0	871.0	871.0	865.0	870.0	871.0	875.0	870.0
50	870.5	875.0	871.0	871.0	865.0	870.0	871.0	875.0	870.0
75	873.0	878.1	873.0	873.0	865.0	873.0	873.0	878.7	873.0
90	873.2	879.0	873.5	873.0	865.0	873.2	873.5	879.0	873.2

Blue Ridge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1650.0	1660.0	1660.0	1624.5	1666.0	1648.2	1660.0	1677.9	1664.8
25	1650.0	1660.0	1660.0	1649.8	1666.0	1650.0	1660.0	1678.0	1664.8
50	1650.0	1669.2	1660.0	1660.0	1667.0	1650.0	1660.0	1678.0	1667.2
75	1656.5	1677.5	1668.0	1663.5	1672.4	1656.5	1668.0	1680.0	1670.1
90	1668.0	1680.0	1668.0	1668.0	1677.0	1668.0	1668.0	1680.0	1672.0

Hiwassee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1460.0	1472.0	1482.9	1465.9	1479.9	1460.0	1482.9	1482.0	1479.0
25	1464.9	1475.3	1482.9	1474.8	1479.9	1461.8	1482.9	1482.0	1479.0
50	1466.5	1480.8	1488.2	1483.1	1482.0	1465.9	1488.2	1483.0	1483.5
75	1476.1	1486.9	1491.9	1490.0	1486.7	1476.1	1491.9	1489.2	1490.0
90	1476.2	1490.0	1493.1	1493.0	1488.0	1476.2	1493.1	1490.1	1491.8

Nottely Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1743.0	1753.0	1760.0	1742.0	1763.3	1743.0	1760.0	1760.0	1758.0
25	1745.0	1754.3	1760.0	1750.5	1764.0	1743.5	1760.0	1760.0	1758.0
50	1745.8	1757.0	1762.4	1760.0	1764.5	1745.6	1762.4	1760.6	1760.7
75	1752.1	1763.0	1766.3	1764.9	1766.6	1752.1	1766.2	1764.4	1762.0
90	1752.1	1765.0	1767.1	1766.9	1768.0	1752.1	1767.1	1765.1	1762.0

Chatuge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1911.0	1913.5	1916.0	1907.9	1915.9	1911.0	1916.0	1916.0	1916.0
25	1912.0	1913.7	1916.0	1913.3	1915.9	1911.2	1916.0	1916.0	1916.0
50	1912.5	1915.2	1917.5	1916.0	1916.4	1912.3	1917.5	1916.4	1917.5
75	1916.1	1917.8	1918.6	1918.0	1919.3	1916.1	1918.6	1918.6	1918.0
90	1916.1	1919.0	1919.1	1919.0	1920.0	1916.1	1919.1	1919.1	1918.0

Reservoir Elevation (feet above MSL) on January 1st (cont.)

Norris Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	981.5	992.0	1006.0	962.8	998.7	981.5	1004.1	1000.0	994.0
25	982.2	992.2	1006.0	987.1	1001.0	981.5	1006.0	1000.0	994.0
50	985.0	998.2	1009.0	1005.3	1002.4	985.0	1008.2	1000.0	997.0
75	990.1	1000.0	1010.0	1009.3	1004.2	989.5	1010.0	1000.0	1000.0
90	995.0	1003.3	1014.4	1010.6	1006.5	995.0	1014.2	1004.7	1003.0

Fontana Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1597.7	1597.7	1597.7	1597.3	1597.7	1597.7	1597.7	1596.6	1626.1
25	1625.0	1625.0	1658.0	1627.3	1658.5	1625.0	1658.0	1644.0	1647.8
50	1639.3	1625.5	1659.7	1658.0	1659.1	1636.9	1659.5	1644.0	1650.9
75	1644.0	1642.0	1663.0	1663.0	1660.0	1644.0	1663.0	1644.0	1653.0
90	1648.1	1647.3	1669.0	1663.7	1660.9	1648.0	1669.0	1651.7	1653.0

Douglas Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	940.0	950.0	960.0	945.7	956.0	940.0	960.0	958.0	950.0
25	940.0	950.0	960.0	956.9	956.0	940.0	960.0	958.0	950.0
50	940.0	955.2	963.0	960.0	957.4	940.0	963.0	958.0	953.0
75	940.2	958.0	963.0	963.0	959.0	940.2	963.0	958.0	954.0
90	943.6	958.0	963.0	963.0	959.0	943.5	963.0	958.0	954.0

Cherokee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1028.0	1040.0	1049.0	1028.8	1048.0	1028.0	1049.0	1046.0	1041.0
25	1028.2	1040.3	1049.0	1040.4	1048.0	1028.0	1049.0	1046.0	1041.0
50	1030.0	1044.5	1051.4	1049.0	1049.0	1030.0	1051.4	1046.0	1043.4
75	1030.0	1046.0	1053.0	1052.8	1050.0	1030.0	1053.0	1046.0	1045.0
90	1030.0	1046.0	1053.0	1053.0	1050.0	1030.0	1053.0	1046.0	1045.0

South Holston Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1695.0	1706.2	1711.7	1679.1	1704.5	1693.9	1713.6	1710.9	1702.4
25	1695.6	1707.0	1721.0	1695.0	1714.9	1695.0	1721.0	1713.0	1704.8
50	1701.1	1710.0	1722.1	1713.5	1720.0	1700.3	1722.2	1713.0	1706.4
75	1702.0	1713.0	1723.0	1722.1	1721.0	1702.0	1723.0	1713.0	1708.0
90	1702.8	1713.0	1723.0	1723.0	1721.0	1702.7	1723.0	1713.0	1708.0

Reservoir Elevation (feet above MSL) on January 1st (cont.)

Watauga Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1935.0	1943.3	1947.2	1924.7	1942.0	1933.8	1940.3	1946.8	1947.1
25	1935.4	1945.4	1954.0	1940.6	1951.3	1935.0	1947.4	1952.0	1949.2
50	1939.8	1949.1	1955.1	1949.1	1955.0	1939.1	1954.0	1952.0	1950.4
75	1940.0	1952.0	1957.0	1954.9	1957.0	1940.0	1956.9	1952.0	1952.0
90	1940.1	1952.0	1957.0	1957.0	1957.0	1940.0	1957.0	1952.0	1952.0

Reservoir Elevation (feet above MSL) on March 15

Tims Ford

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	878.2	878.2	878.1	878.1	865.8	878.2	878.1	878.2	878.2
25	878.3	878.3	878.3	878.3	865.8	878.3	878.3	878.3	878.3
50	878.7	878.9	878.7	878.7	866.2	878.6	878.7	878.9	878.7
75	879.1	879.2	879.1	879.1	866.2	879.1	879.1	879.2	879.1
90	879.4	880.2	879.4	879.4	868.0	879.3	879.4	880.2	879.4

Blue Ridge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1668.5	1673.9	1672.5	1665.0	1660.7	1665.1	1672.4	1678.8	1674.0
25	1673.8	1676.1	1674.8	1674.2	1664.7	1673.5	1674.8	1678.9	1674.7
50	1674.8	1679.5	1675.2	1675.0	1667.0	1674.8	1675.2	1679.9	1676.6
75	1676.2	1680.7	1676.5	1676.4	1667.0	1676.2	1676.5	1680.9	1678.9
90	1677.0	1681.0	1677.0	1677.0	1669.1	1677.0	1677.0	1681.0	1679.3

Hiwassee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1482.0	1482.0	1481.8	1481.8	1460.4	1481.0	1481.8	1482.8	1482.6
25	1482.0	1483.3	1482.0	1482.0	1467.3	1482.0	1482.0	1484.2	1484.4
50	1482.7	1488.6	1485.0	1484.5	1468.4	1482.7	1485.0	1489.5	1488.5
75	1488.4	1492.5	1491.7	1490.7	1474.8	1488.4	1491.7	1492.7	1491.7
90	1492.4	1493.3	1493.3	1493.2	1477.0	1492.4	1493.3	1493.6	1497.2

Nottely Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1754.7	1759.2	1760.0	1759.4	1760.6	1754.4	1760.0	1760.7	1760.6
25	1755.3	1760.8	1761.3	1761.1	1762.3	1755.3	1761.3	1761.5	1761.5
50	1755.7	1763.0	1762.9	1762.8	1762.6	1755.7	1762.9	1763.7	1762.3
75	1758.2	1764.8	1764.1	1763.9	1764.8	1758.0	1764.1	1764.8	1762.3
90	1760.0	1765.1	1764.4	1764.4	1765.3	1760.0	1764.4	1765.1	1762.5

Chatuge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1916.0	1916.1	1916.4	1916.1	1914.4	1915.8	1916.4	1916.4	1917.3
25	1916.2	1916.5	1917.4	1917.0	1915.3	1916.2	1917.4	1916.8	1917.7
50	1916.3	1917.8	1918.3	1918.2	1915.4	1916.3	1918.3	1918.1	1918.2
75	1917.4	1918.8	1918.9	1918.8	1916.1	1917.2	1918.9	1918.9	1918.2
90	1918.1	1919.0	1919.1	1919.0	1916.6	1918.1	1919.1	1919.2	1918.6

Reservoir Elevation (feet above MSL) on March 15 (cont.)

Norris Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	995.7	999.2	1001.4	999.0	992.6	993.8	1001.4	1000.6	997.2
25	998.5	1000.0	1001.7	1001.5	992.9	998.4	1001.7	1000.7	998.4
50	999.6	1001.5	1004.4	1004.2	995.6	999.5	1004.4	1001.7	1001.0
75	1000.8	1004.8	1006.5	1006.0	996.5	1000.6	1006.5	1006.6	1004.5
90	1005.6	1009.5	1008.7	1008.4	999.0	1005.5	1008.7	1009.5	1007.1

Fontana Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1643.5	1643.5	1651.2	1648.3	1649.0	1643.5	1651.2	1645.5	1651.1
25	1643.8	1644.0	1653.9	1653.9	1650.5	1643.5	1653.9	1645.5	1652.5
50	1645.5	1645.5	1655.1	1655.1	1650.5	1645.4	1655.1	1645.5	1654.2
75	1645.5	1645.5	1656.2	1656.2	1651.7	1645.5	1656.2	1645.6	1654.2
90	1651.2	1652.0	1667.5	1667.5	1658.8	1651.2	1667.5	1652.1	1660.3

Douglas Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	958.0	958.6	957.9	957.9	943.8	958.0	957.9	959.1	956.0
25	958.1	958.9	958.2	958.2	943.8	958.1	958.2	959.1	956.9
50	958.5	959.1	958.5	958.5	943.8	958.5	958.5	959.1	958.6
75	958.5	959.1	958.5	958.5	944.5	958.5	958.5	959.1	958.6
90	958.5	959.8	958.5	958.5	949.0	958.5	958.5	959.8	958.6

Cherokee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1041.6	1045.8	1049.0	1049.0	1049.0	1041.2	1049.0	1047.5	1043.6
25	1042.5	1046.4	1050.7	1050.6	1049.9	1042.5	1050.7	1047.7	1044.2
50	1043.3	1047.7	1053.0	1053.0	1050.0	1043.3	1053.0	1047.7	1045.6
75	1043.8	1047.7	1053.0	1053.0	1050.0	1043.8	1053.0	1047.7	1045.6
90	1043.8	1047.7	1053.4	1053.0	1050.3	1043.8	1053.4	1047.7	1045.6

South Holston Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1707.1	1711.9	1721.0	1702.4	1717.4	1705.6	1721.0	1713.5	1711.1
25	1710.8	1713.0	1721.7	1721.0	1717.9	1710.4	1721.7	1713.8	1712.5
50	1713.2	1713.8	1722.4	1722.4	1718.2	1713.2	1722.4	1713.8	1713.2
75	1713.5	1713.8	1722.4	1722.4	1718.2	1713.5	1722.4	1713.8	1713.2
90	1713.5	1716.7	1725.0	1724.4	1722.3	1713.5	1724.7	1716.7	1714.3

Reservoir Elevation (feet above MSL) on March 15 (cont.)

Watauga Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1944.0	1949.5	1954.0	1943.5	1956.4	1940.8	1954.0	1950.3	1949.5
25	1947.7	1950.8	1955.0	1954.0	1957.1	1946.5	1954.9	1950.9	1951.0
50	1950.2	1952.2	1957.0	1957.0	1958.1	1950.0	1957.0	1952.2	1952.2
75	1951.4	1952.2	1957.0	1957.0	1958.1	1951.4	1957.0	1952.2	1952.2
90	1951.5	1953.0	1957.8	1957.5	1959.2	1951.5	1957.7	1953.0	1952.7

Reservoir Elevation (feet above MSL) on Memorial Day

Tims Ford Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	885.6	885.6	885.6	885.6	875.1	885.6	885.6	885.6	885.6
25	887.0	887.0	887.0	887.0	877.9	887.0	887.0	887.0	887.0
50	887.9	887.9	887.9	887.9	879.3	887.9	887.9	887.9	887.9
75	887.9	887.9	887.9	887.9	880.3	887.9	887.9	887.9	887.9
90	887.9	887.9	887.9	887.9	880.5	887.9	887.9	887.9	887.9

Blue Ridge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1680.0	1683.0	1683.7	1678.6	1673.6	1676.8	1685.6	1685.4	1683.2
25	1686.9	1686.9	1686.9	1686.8	1676.2	1683.0	1686.9	1687.0	1686.3
50	1686.9	1686.9	1686.9	1686.9	1678.6	1686.9	1686.9	1687.0	1686.8
75	1687.4	1687.5	1687.4	1687.4	1678.7	1687.4	1687.5	1687.6	1687.0
90	1688.5	1688.5	1688.5	1688.5	1679.9	1688.5	1688.5	1688.5	1688.0

Hiwassee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1511.5	1514.0	1514.5	1509.5	1493.6	1509.0	1503.1	1509.6	1511.8
25	1516.7	1518.0	1518.3	1517.0	1501.4	1514.6	1511.5	1515.2	1516.5
50	1520.3	1520.3	1520.3	1520.3	1507.7	1520.2	1516.0	1520.8	1520.7
75	1520.5	1520.5	1520.5	1520.5	1508.0	1520.5	1520.5	1520.9	1520.7
90	1521.0	1521.0	1521.1	1521.1	1508.9	1521.0	1521.0	1521.4	1521.3

Nottely Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1767.6	1768.5	1768.9	1769.5	1768.1	1766.1	1764.3	1769.3	1770.2
25	1771.7	1772.6	1773.2	1773.7	1770.3	1769.8	1768.4	1772.2	1773.3
50	1776.6	1776.6	1776.6	1776.6	1771.6	1776.3	1774.0	1776.3	1776.6
75	1776.8	1776.8	1776.8	1776.8	1772.1	1776.8	1776.8	1777.0	1776.8
90	1777.0	1777.0	1777.0	1777.0	1772.6	1777.0	1777.0	1777.3	1776.8

Chatuge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1922.2	1922.6	1922.8	1922.1	1920.2	1921.1	1920.5	1922.9	1922.4
25	1924.1	1924.4	1924.9	1924.7	1921.5	1923.2	1922.3	1924.5	1924.2
50	1925.9	1925.9	1925.9	1925.9	1922.7	1925.8	1924.8	1925.9	1925.7
75	1925.9	1925.9	1925.9	1925.9	1922.7	1925.9	1925.9	1926.0	1925.8
90	1926.0	1926.0	1926.0	1926.0	1923.0	1926.0	1926.0	1926.1	1925.8

Reservoir Elevation (feet above MSL) on Memorial Day (cont.)

Norris Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1009.0	1010.6	1011.8	1007.2	1002.0	1006.1	1010.0	1011.0	1009.2
25	1012.8	1014.4	1014.7	1012.9	1004.6	1012.2	1013.0	1015.1	1013.6
50	1017.1	1017.7	1017.8	1017.5	1007.3	1017.0	1016.6	1019.5	1019.2
75	1019.2	1019.2	1019.8	1019.8	1011.1	1019.2	1019.7	1020.0	1019.9
90	1019.9	1019.9	1020.0	1020.0	1013.8	1019.9	1020.0	1020.1	1020.2

Fontana Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1693.1	1695.1	1696.3	1694.7	1670.2	1687.4	1694.3	1690.5	1695.7
25	1700.6	1701.7	1702.1	1702.3	1675.1	1697.0	1701.6	1697.4	1702.5
50	1702.6	1702.6	1702.6	1702.6	1678.3	1702.6	1702.6	1702.9	1702.9
75	1702.6	1702.6	1702.6	1702.6	1678.3	1702.6	1702.6	1702.9	1702.9
90	1702.9	1702.9	1702.9	1702.9	1678.7	1702.9	1702.9	1702.9	1703.0

Douglas Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	989.1	990.4	991.2	987.0	970.3	984.7	991.1	986.4	985.7
25	993.2	993.6	993.7	992.8	976.3	991.0	993.7	992.3	991.2
50	993.8	993.8	993.8	993.8	981.6	993.8	993.8	994.0	993.7
75	993.8	993.8	993.8	993.8	982.9	993.8	993.8	994.0	993.7
90	994.0	994.0	994.0	994.0	983.0	994.0	994.0	994.0	993.8

Cherokee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1056.8	1058.5	1059.3	1060.9	1057.2	1053.6	1059.0	1060.1	1058.7
25	1061.1	1064.5	1065.7	1065.6	1058.6	1059.9	1065.2	1063.9	1063.1
50	1068.4	1070.1	1070.5	1070.4	1059.8	1068.4	1070.7	1068.8	1067.4
75	1070.9	1070.9	1070.9	1070.9	1060.3	1070.9	1070.9	1071.0	1070.3
90	1071.0	1071.0	1071.0	1071.0	1060.5	1071.0	1071.0	1071.0	1070.5

SouthHolston Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1721.6	1722.4	1724.2	1719.7	1722.5	1720.5	1723.7	1720.7	1719.5
25	1726.4	1726.5	1726.8	1725.1	1723.5	1725.5	1727.1	1724.0	1724.3
50	1727.4	1728.3	1728.6	1728.5	1724.4	1727.3	1728.7	1727.2	1727.2
75	1728.9	1728.9	1728.9	1728.9	1724.8	1728.9	1728.9	1729.0	1728.8
90	1729.0	1729.0	1729.0	1729.0	1725.0	1729.0	1729.0	1729.0	1729.0

Reservoir Elevation (feet above MSL) on Memorial Day (cont.)

Watauga Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1949.4	1953.1	1956.1	1945.6	1959.2	1948.9	1952.3	1953.1	1950.9
25	1957.0	1957.4	1957.5	1955.5	1960.4	1956.2	1954.9	1955.4	1954.2
50	1957.9	1958.5	1958.7	1958.6	1961.5	1957.8	1957.2	1957.6	1957.0
75	1958.9	1958.9	1958.9	1958.9	1962.0	1958.9	1958.6	1959.0	1958.8
90	1959.0	1959.0	1959.0	1959.0	1962.2	1959.0	1958.9	1959.0	1959.0

Reservoir Elevation (feet above MSL) on Labor Day

Tims Ford Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	885.2	885.2	887.6	873.3	878.2	885.2	887.6	885.2	885.2
25	885.2	885.2	887.9	873.3	880.8	885.2	887.9	885.2	885.2
50	885.2	885.2	888.0	873.3	883.7	885.2	888.0	885.2	885.2
75	885.2	885.2	888.0	873.3	885.4	885.2	888.0	885.2	885.2
90	885.2	885.2	888.0	873.3	885.4	885.2	888.0	885.2	885.2

Blue Ridge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1676.4	1675.7	1682.3	1651.4	1664.3	1676.0	1681.8	1682.9	1676.7
25	1676.4	1679.8	1685.4	1659.1	1669.6	1676.4	1685.6	1686.1	1679.5
50	1676.4	1682.3	1686.8	1665.6	1672.9	1676.4	1686.9	1687.0	1680.5
75	1676.4	1685.0	1687.0	1676.0	1676.3	1676.4	1687.0	1687.0	1681.1
90	1679.2	1686.9	1687.0	1683.1	1676.9	1679.2	1687.0	1687.0	1682.1

Hiwassee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1503.4	1503.9	1511.3	1470.9	1468.9	1501.5	1500.0	1506.9	1503.1
25	1503.6	1509.9	1515.6	1480.1	1487.1	1503.4	1510.9	1515.5	1508.9
50	1505.2	1513.6	1519.3	1490.0	1496.2	1505.0	1518.2	1519.1	1510.6
75	1509.0	1518.0	1521.0	1505.3	1505.9	1509.0	1520.9	1521.0	1511.6
90	1516.5	1520.6	1521.0	1515.8	1508.0	1516.5	1521.0	1521.0	1513.1

Nottely Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1763.1	1767.2	1771.5	1748.4	1761.4	1762.7	1765.0	1769.0	1766.9
25	1763.3	1770.6	1773.9	1753.6	1763.8	1763.1	1771.3	1773.9	1769.5
50	1764.5	1772.8	1776.1	1759.3	1765.0	1764.3	1775.4	1775.9	1770.4
75	1767.5	1775.3	1777.0	1768.0	1766.2	1767.5	1777.0	1777.0	1771.1
90	1773.4	1776.8	1777.0	1774.0	1766.5	1773.4	1777.0	1777.0	1771.9

Chatuge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1920.0	1921.7	1923.6	1913.5	1915.2	1919.5	1920.8	1922.5	1920.5
25	1920.0	1923.2	1924.7	1915.8	1917.4	1920.0	1923.5	1924.6	1921.8
50	1920.6	1924.2	1925.6	1918.2	1918.5	1920.4	1925.3	1925.5	1922.3
75	1922.1	1925.2	1926.0	1922.1	1919.6	1922.1	1926.0	1926.0	1922.8
90	1924.7	1925.9	1926.0	1924.7	1919.9	1924.7	1926.0	1926.0	1923.3

Reservoir Elevation (feet above MSL) on Labor Day (cont.)

Norris Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1004.2	1009.3	1012.2	986.5	998.2	1002.3	1008.4	1013.3	1004.9
25	1004.5	1012.8	1015.2	994.5	1003.4	1004.4	1011.9	1015.4	1008.4
50	1006.4	1015.0	1018.3	999.8	1010.1	1006.0	1016.8	1018.7	1011.4
75	1010.2	1017.9	1019.6	1009.6	1017.0	1009.8	1019.3	1019.7	1014.3
90	1016.0	1019.4	1020.0	1014.5	1020.5	1016.0	1020.0	1020.0	1018.0

Fontana Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1659.0	1667.6	1667.6	1646.3	1654.4	1659.0	1667.7	1667.6	1659.0
25	1681.0	1684.3	1693.9	1651.6	1658.0	1680.2	1693.2	1695.5	1683.5
50	1682.2	1692.9	1702.1	1664.7	1664.2	1682.0	1702.3	1702.5	1693.2
75	1685.4	1698.8	1703.0	1681.6	1671.0	1685.2	1703.0	1703.0	1696.9
90	1694.2	1701.8	1703.0	1692.9	1673.5	1694.2	1703.0	1703.0	1699.4

Douglas Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	978.2	977.6	987.4	942.2	949.1	978.2	988.1	988.7	976.3
25	978.2	983.6	992.1	953.2	958.5	978.2	992.2	992.9	982.0
50	979.3	987.2	993.8	962.8	964.5	979.1	993.9	994.0	984.9
75	982.0	991.2	994.0	977.7	970.5	982.0	994.0	994.0	987.3
90	990.8	993.7	994.0	987.3	972.6	990.7	994.0	994.0	990.9

Cherokee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1048.7	1058.5	1065.7	1031.7	1053.4	1048.7	1066.2	1067.0	1054.9
25	1048.9	1063.1	1069.2	1040.1	1058.7	1048.9	1069.5	1070.1	1058.4
50	1050.0	1065.8	1070.9	1047.0	1062.1	1049.7	1070.9	1071.0	1061.2
75	1053.1	1068.9	1071.0	1058.7	1065.5	1052.9	1071.0	1071.0	1064.1
90	1062.1	1070.8	1071.0	1065.1	1066.5	1061.0	1071.0	1071.0	1068.0

South Holston Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1713.0	1716.5	1716.7	1703.1	1711.5	1711.5	1718.7	1716.3	1710.7
25	1713.0	1721.9	1721.6	1708.7	1718.8	1713.0	1724.2	1721.5	1719.8
50	1714.7	1725.2	1726.9	1713.2	1723.0	1714.7	1727.6	1726.9	1721.8
75	1718.0	1727.5	1728.8	1720.9	1725.4	1717.9	1729.0	1728.9	1725.0
90	1725.9	1728.8	1729.0	1725.1	1726.5	1725.7	1729.0	1729.0	1728.1

Reservoir Elevation (feet above MSL) on Labor Day (cont.)

Watauga Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1941.4	1950.1	1950.3	1940.0	1948.5	1941.4	1944.2	1950.1	1948.6
25	1941.8	1954.0	1953.7	1944.5	1954.2	1941.6	1947.8	1953.9	1950.7
50	1944.2	1956.3	1957.4	1947.7	1955.5	1943.9	1952.6	1957.4	1951.8
75	1946.7	1957.9	1958.9	1953.1	1956.1	1946.7	1956.2	1959.0	1955.0
90	1954.3	1958.9	1959.0	1956.3	1957.1	1954.1	1958.1	1959.0	1958.1

Reservoir Elevation (feet above MSL) at end of October

Tims Ford Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	881.3	881.3	880.8	870.4	869.7	881.3	880.8	881.3	881.3
25	881.3	881.3	880.8	870.9	869.7	881.3	880.8	881.3	881.3
50	881.3	881.3	880.8	871.0	869.7	881.3	880.8	881.3	881.3
75	881.3	881.3	880.8	871.0	869.7	881.3	880.8	881.3	881.3
90	881.8	881.3	880.8	871.0	869.7	881.8	880.8	881.3	881.8

Blue Ridge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1659.5	1667.3	1671.8	1620.0	1665.6	1659.4	1671.6	1679.5	1669.4
25	1659.5	1669.1	1673.7	1643.6	1670.7	1659.5	1673.8	1685.4	1669.9
50	1659.5	1671.8	1674.3	1659.4	1672.9	1659.5	1674.3	1687.0	1671.1
75	1659.5	1675.1	1675.7	1667.7	1673.0	1659.5	1675.7	1687.0	1672.6
90	1664.0	1679.9	1679.2	1675.5	1674.6	1664.0	1679.2	1687.0	1675.3

Hiwassee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1483.0	1484.4	1498.1	1450.0	1474.0	1482.4	1490.7	1504.0	1488.2
25	1484.1	1486.2	1501.0	1459.6	1492.4	1483.7	1498.3	1504.0	1489.4
50	1486.5	1490.5	1502.9	1480.8	1499.2	1486.4	1502.3	1504.0	1491.5
75	1493.8	1498.7	1504.8	1492.5	1499.2	1492.7	1504.3	1504.5	1493.2
90	1504.0	1504.0	1508.6	1505.2	1499.2	1504.0	1507.9	1506.1	1499.3

Nottely Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1751.7	1757.2	1766.2	1735.0	1760.8	1751.6	1761.9	1770.4	1761.7
25	1752.4	1758.4	1767.9	1739.9	1761.7	1752.2	1766.2	1776.3	1762.2
50	1753.8	1760.3	1768.8	1755.4	1762.0	1753.8	1768.6	1777.0	1763.3
75	1758.6	1763.9	1769.8	1762.4	1762.1	1757.8	1769.6	1777.2	1764.3
90	1764.9	1769.6	1771.3	1769.9	1764.0	1764.9	1771.2	1777.7	1766.3

Chatuge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1915.4	1916.5	1920.1	1905.0	1915.4	1914.9	1918.2	1923.2	1917.9
25	1915.5	1916.9	1920.8	1911.9	1916.9	1915.4	1920.1	1925.6	1918.1
50	1916.4	1917.9	1921.3	1915.8	1917.5	1916.4	1921.2	1926.0	1918.7
75	1918.5	1920.3	1921.8	1918.9	1917.5	1918.3	1921.7	1926.1	1919.2
90	1921.9	1923.1	1922.8	1922.1	1918.0	1921.9	1922.7	1926.4	1920.4

Reservoir Elevation (feet above MSL) at end of October (cont.)

Norris Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	988.4	996.2	1007.9	965.2	994.3	988.3	1003.3	1009.2	998.4
25	989.3	997.7	1010.9	983.1	1000.4	988.8	1007.5	1009.3	999.4
50	991.4	1000.2	1012.9	991.9	1007.5	991.2	1011.7	1009.3	1001.5
75	999.0	1005.2	1013.7	1003.5	1014.6	999.1	1013.4	1009.3	1003.8
90	1004.2	1009.3	1015.5	1011.6	1015.2	1004.0	1015.0	1009.6	1008.7

Fontana Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1603.0	1612.0	1612.0	1603.0	1603.0	1603.0	1612.0	1612.0	1603.0
25	1650.4	1651.9	1677.0	1608.8	1656.8	1649.3	1676.6	1684.8	1661.9
50	1653.3	1658.0	1681.7	1652.5	1666.4	1652.7	1681.6	1684.8	1664.3
75	1660.3	1669.5	1682.3	1669.6	1666.4	1660.1	1682.4	1684.8	1667.7
90	1673.4	1676.7	1686.8	1679.6	1667.4	1673.3	1686.9	1684.8	1672.5

Douglas Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	956.0	958.3	975.2	940.0	953.9	953.5	975.2	991.2	959.6
25	956.2	960.0	977.3	942.1	963.7	956.0	977.5	991.6	961.3
50	957.8	964.5	978.0	955.6	964.6	957.8	978.0	991.6	963.0
75	964.3	971.4	979.3	967.1	964.7	964.3	979.4	991.6	965.9
90	972.7	978.0	983.6	979.0	965.6	972.4	983.7	991.6	973.5

Cherokee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1035.6	1044.7	1057.9	1020.9	1058.0	1035.5	1058.1	1058.4	1046.4
25	1036.3	1045.4	1060.0	1031.0	1063.8	1036.0	1060.2	1058.4	1047.4
50	1037.9	1047.6	1060.7	1042.7	1066.1	1037.9	1060.7	1058.4	1049.0
75	1042.5	1051.7	1061.5	1051.8	1066.1	1042.4	1061.5	1058.4	1051.0
90	1050.2	1056.9	1063.5	1060.6	1067.1	1048.7	1063.5	1058.4	1056.4

South Holston Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1701.0	1710.2	1713.1	1676.0	1708.4	1700.7	1717.7	1711.7	1705.6
25	1701.7	1712.7	1718.7	1695.1	1714.1	1701.6	1722.2	1718.3	1709.8
50	1704.0	1715.1	1723.7	1707.3	1720.2	1703.8	1724.7	1725.2	1711.5
75	1708.1	1720.8	1725.4	1715.2	1723.0	1707.5	1725.6	1729.0	1714.2
90	1715.3	1725.3	1726.7	1722.9	1724.0	1714.0	1727.3	1729.0	1719.6

Reservoir Elevation (feet above MSL) at end of October (cont.)

Watauga Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1936.6	1945.4	1947.9	1929.0	1945.3	1936.5	1936.9	1946.9	1948.4
25	1937.2	1945.8	1952.7	1940.0	1950.5	1937.1	1942.0	1951.7	1949.8
50	1940.0	1948.6	1955.8	1943.3	1953.7	1940.0	1946.5	1956.5	1951.1
75	1942.4	1951.1	1956.9	1949.4	1953.8	1942.4	1952.6	1959.0	1953.6
90	1948.6	1955.1	1958.2	1955.0	1954.5	1948.0	1954.9	1959.0	1956.4

Average Reservoir Releases (cfs) during Weeks 12 through 22

Wilson Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	21644	22573	22706	21951	25680	24264	23923	23918	22676
25	30068	31266	32116	31082	35127	32337	33350	32849	30678
50	39894	42482	43766	40293	45606	41567	44068	41983	40544
75	64160	66829	68706	66686	69729	65503	68855	66650	65455
90	81509	84266	86088	84425	88088	82843	86380	83965	79668

Guntersville Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	15899	16887	17523	16771	19524	18718	18812	19023	17402
25	22077	23278	24384	23178	25985	23989	25415	24331	22881
50	29090	30812	31808	30753	34899	30215	32236	30863	29435
75	45003	47238	49093	48179	51303	45882	49313	47258	46292
90	57246	59496	60922	59943	63298	58125	61117	59172	57675

Kentucky Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	24737	25677	27435	24828	27048	32491	27924	26137	25249
25	37350	39286	41276	38916	41809	45869	42019	39364	38196
50	50534	52178	54460	51514	55263	57927	54971	53007	50834
75	80257	83242	86343	83029	88243	88228	86603	83506	82006
90	103831	107372	110102	106650	112713	110266	110124	107248	105552

Pickwick Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	21192	23122	23744	21356	25739	24714	24951	24842	22970
25	30808	32621	33486	32484	34857	33981	34586	34045	32421
50	41040	44012	45251	41856	46147	43023	45624	44457	41530
75	66688	69719	71406	68743	73044	68501	71509	69649	67824
90	87390	90627	91962	90012	93103	89194	92316	90514	87636

Wheeler Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	19971	20858	21849	20829	23863	23143	23394	22114	21639
25	27987	29658	30409	29081	33088	30480	31440	31130	28751
50	36341	39106	40344	38891	41683	37711	40952	39551	37066
75	59548	62368	63969	62262	65444	60918	64165	62130	60766
90	77506	80009	81255	79832	82353	78855	81276	79974	78012

Average Reservoir Releases (cfs) during Weeks 12 through 22 (cont.)

Chickamauga Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	12075	13387	13426	13242	15813	14711	14825	14323	13220
25	16881	18016	18859	18026	20466	18760	19602	19144	17664
50	21712	23931	25225	23340	28065	23066	25725	24053	22437
75	33884	36120	38212	37298	40151	34764	38438	36360	35186
90	44338	46647	48024	47110	50056	45217	48052	46578	44693

Watts Bar Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	9092	9305	9850	9563	12484	10847	10558	10576	10298
25	11673	12472	13186	12730	15755	13294	14041	13559	12617
50	16484	17655	19327	18099	22027	17147	19424	18045	16815
75	24910	26656	28695	27763	31135	25494	28892	26429	26021
90	36778	38197	39938	39311	41528	37383	40081	38097	35865

Fort Loudoun Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	5564	5703	6079	6407	8677	6812	6346	6628	5799
25	6610	7160	8194	7916	10877	7861	8295	7741	7405
50	9945	10002	11493	11174	14522	10447	11493	10372	10610
75	15699	16663	18293	18015	20827	15967	18340	16665	16614
90	22382	23444	25156	24878	27691	22650	25160	23444	22446

Nickajack Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	13030	14081	14692	14541	16896	16135	16040	15344	14053
25	18557	19834	20536	19579	22364	20870	21423	20953	19647
50	23522	25463	26752	25450	29926	24492	27383	25656	24151
75	36814	39049	41044	40130	43058	37693	41270	39124	38116
90	46873	48733	50699	49785	52706	47752	50749	48986	47477

Tims Ford Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	83	82	80	80	80	83	80	82	85
25	349	349	349	349	193	349	349	349	349
50	596	596	596	596	415	596	596	596	596
75	1068	1069	1068	1068	875	1066	1068	1069	1068
90	1537	1605	1537	1537	1480	1537	1537	1605	1474

Average Reservoir Releases (cfs) during Weeks 12 through 22 (cont.)

Blue Ridge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	282	365	299	180	285	313	310	399	340
25	422	472	408	403	397	450	412	502	433
50	566	611	566	562	570	572	566	647	597
75	771	849	771	771	778	772	771	849	818
90	1057	1136	1057	1057	1074	1057	1057	1138	1112

Hiwassee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	301	297	324	365	564	365	859	521	407
25	514	636	594	600	783	597	984	768	643
50	956	1044	976	1044	1194	1015	1267	1108	1130
75	1575	1763	1747	1747	1927	1604	1803	1757	1713
90	2271	2555	2417	2408	2632	2271	2460	2523	2536

Nottely Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	67	122	123	77	165	68	226	156	97
25	101	170	164	147	225	107	256	197	154
50	180	257	245	243	343	193	308	266	237
75	267	358	345	347	475	281	384	359	355
90	438	522	508	508	652	438	508	518	480

Chatuge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	120	119	124	91	157	121	228	126	160
25	165	169	175	171	211	181	264	176	209
50	236	247	250	244	318	257	324	265	282
75	408	443	444	444	479	417	450	443	439
90	545	567	582	582	635	545	584	577	596

Norris Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1000	1099	1193	1023	1488	1000	1569	1166	1197
25	1453	1592	1718	1767	1998	1777	2073	1634	1633
50	2358	2638	2940	2940	2968	2593	3049	2478	2405
75	3883	4249	4501	4395	4521	3963	4585	4032	3945
90	5646	6236	5896	5896	6346	5644	5978	6241	5627

Average Reservoir Releases (cfs) during Weeks 12 through 22 (cont.)

Fontana Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	634	594	848	858	2230	747	876	824	880
25	979	897	1143	1166	2505	1130	1206	1001	1242
50	1644	1644	2045	2045	3443	1870	2045	1668	2097
75	3010	3032	3434	3434	4725	3010	3434	3032	3236
90	4230	4230	4653	4653	5900	4238	4653	4241	4549

Douglas Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1819	1638	1315	1811	2023	2043	1515	1891	1954
25	2466	2339	2032	2466	3196	2876	2232	2487	2515
50	3865	3865	3805	3856	4345	4170	3805	3865	3866
75	5892	5892	5892	5892	6715	5892	5892	5892	5868
90	8687	8687	8687	8687	9184	8687	8687	8687	8436

Cherokee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	325	357	1066	705	1613	325	1113	891	438
25	452	784	1544	1324	2727	554	1719	1221	811
50	981	1378	2445	2366	3928	1484	2413	1731	1520
75	2149	2838	4017	3835	5445	2153	4017	2866	2607
90	3627	4327	5202	5152	7189	3888	5275	4560	4282

South Holston Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	318	364	663	448	535	318	598	501	471
25	467	518	857	772	826	459	832	610	587
50	712	737	1091	1091	1132	729	1091	813	757
75	962	1000	1344	1342	1387	962	1342	1017	993
90	1218	1297	1662	1647	1748	1213	1649	1300	1303

Watauga Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	374	462	584	337	461	376	646	444	524
25	434	550	666	653	596	442	735	535	590
50	618	658	821	818	807	628	860	670	713
75	856	917	1057	1048	1011	856	1109	907	934
90	1016	1082	1236	1235	1173	998	1263	1068	1116

Average Reservoir Releases (cfs) during Weeks 12 through 22 (cont.)

Great Falls Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	2369	2233	2233	2233	2322	2369	2233	2233	2280
25	3121	2985	2985	2985	3038	3121	2985	2985	2985
50	4181	4065	4065	4065	4087	4181	4065	4065	4065
75	5385	5249	5249	5249	5262	5385	5249	5249	5249
90	6287	6152	6152	6152	6157	6287	6152	6152	6058

Ocoee #1 Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	932	1015	932	828	957	933	929	1086	956
25	1246	1276	1256	1209	1194	1262	1256	1339	1265
50	1642	1667	1641	1612	1635	1619	1641	1710	1655
75	2090	2163	2092	2092	2063	2092	2092	2170	2121
90	2594	2652	2594	2594	2682	2600	2594	2668	2627

Boone Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1132	1232	1667	1251	1451	1143	1718	1353	1463
25	1492	1760	2207	2002	2213	1517	2237	1841	1820
50	2199	2305	2762	2762	2808	2309	2778	2453	2379
75	2885	2960	3549	3465	3630	2885	3591	2956	2998
90	3570	3787	4350	4264	4422	3570	4373	3787	3708

Ocoee #2 Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	864	958	897	766	928	830	870	987	911
25	1124	1167	1117	1088	1094	1149	1107	1199	1135
50	1499	1536	1499	1459	1491	1459	1499	1541	1504
75	1818	1880	1820	1820	1820	1820	1820	1898	1841
90	2340	2430	2345	2345	2375	2340	2345	2437	2326

Melton Hill Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1613	1611	1634	1710	1934	1685	2082	1668	1711
25	1969	2174	2263	2353	2542	2390	2623	2232	2173
50	3243	3523	3740	3801	3783	3486	3888	3346	3196
75	4851	5463	5475	5473	5532	4950	5583	5207	4899
90	7330	7929	7702	7702	7826	7330	7810	7626	6960

Average Reservoir Releases (cfs) during Weeks 12 through 22 (cont.)

Ocoee #3 Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	738	843	765	657	785	760	764	880	810
25	1003	1045	1017	983	994	1019	1015	1091	1026
50	1322	1353	1322	1271	1370	1352	1322	1379	1343
75	1601	1671	1602	1602	1615	1641	1602	1679	1612
90	2144	2224	2144	2144	2197	2146	2144	2224	2185

Apalachia Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	393	395	419	469	666	472	932	618	498
25	640	726	707	709	890	705	1094	880	749
50	1091	1183	1098	1181	1327	1152	1379	1222	1262
75	1742	1930	1914	1914	2084	1768	1969	1929	1886
90	2509	2769	2618	2614	2869	2509	2652	2737	2752

Fort Patrick Henry Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1034	1163	1572	1176	1360	1059	1626	1248	1395
25	1460	1689	2143	1947	2169	1460	2155	1779	1778
50	2175	2258	2719	2719	2748	2266	2731	2406	2331
75	2893	2992	3586	3471	3690	2893	3628	2958	3059
90	3630	3755	4347	4232	4419	3616	4359	3755	3686

Average Reservoir Releases (cfs) during Weeks 23 through 35

Wilson Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	25274	21823	17452	39069	20412	24470	17461	17405	21889
25	28683	23659	19677	40698	22086	28098	19976	20069	24369
50	34203	28285	24871	43386	26971	33787	25004	25404	28943
75	41130	35509	32037	47247	33293	41130	31864	32893	37020
90	51058	45128	43517	53814	43565	51058	43228	43872	46018

Guntersville Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	23133	19940	16320	35948	19304	22275	16383	15823	20610
25	26155	21146	18108	36577	20537	25781	18289	17753	22164
50	30755	24478	21214	37721	23972	29831	21342	21330	25816
75	36585	30377	27153	40034	29584	35757	27174	27929	31778
90	42914	38808	37203	44490	37561	42493	37074	37899	39488

Kentucky Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	27119	23918	21124	36760	22317	28567	21023	21862	25077
25	31168	27010	23939	39119	25638	33192	23984	24683	28219
50	35993	31008	28912	41952	29721	40127	28828	30208	32744
75	42628	38289	35356	46604	36842	46585	35504	36612	40079
90	53160	50692	49135	56650	49183	62438	49063	49865	49952

Pickwick Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	24876	21548	16751	39258	19602	24254	16835	17259	21011
25	28932	23041	18923	41060	21526	28661	19171	19944	24002
50	34853	28744	25066	44228	27482	34793	25285	25773	29139
75	42537	35495	31693	49107	32967	42537	31256	32802	36758
90	51555	46786	44827	55475	45357	51555	44843	45146	46371

Wheeler Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	24822	21740	17099	38800	20405	24170	17199	17192	22102
25	28952	23451	19711	40311	22454	28431	19925	20225	24176
50	34066	27699	24528	42613	26517	33671	24661	25091	28455
75	40350	34424	31644	46191	32542	39905	31419	32278	35859
90	49700	43704	42089	52093	41938	49700	41945	42569	44830

Average Reservoir Releases (cfs) during Weeks 23 through 35 (cont.)

Chickamauga Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	21061	18610	14946	35000	18319	20396	14989	14352	19057
25	24714	19418	16663	35000	19125	23900	16803	16011	21078
50	28129	22236	19602	35000	21833	27634	19674	19232	23918
75	33068	27166	25025	36071	26272	33068	25020	25072	29438
90	38065	33562	32435	40655	32648	38065	32160	32689	35130

Watts Bar Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	16983	14530	11654	27241	14308	16519	11932	11044	15440
25	20213	15708	13059	28140	15294	19478	13097	12512	16989
50	23183	17882	15821	28966	17345	23089	16065	15458	19991
75	26951	21322	20229	29997	20846	26936	19851	19602	23281
90	30932	27643	26965	32307	25891	30578	26850	26603	28229

Fort Loudoun Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	13440	11509	9215	20181	11556	12849	9194	8402	11848
25	15762	12472	10394	21176	12313	15338	10498	9915	12942
50	17868	14070	12543	21952	14067	17630	12517	11582	15044
75	20700	16766	15569	22741	16955	20486	15670	15453	17706
90	22713	19423	19067	23670	19654	22713	19018	18473	20325

Nickajack Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	21033	18720	15367	34797	18510	20519	15471	14499	19424
25	24928	19653	16493	35255	19151	24195	16610	16095	21093
50	28695	22969	19929	35606	22372	28435	19808	19504	24569
75	34194	28048	25724	36688	27155	33715	25753	25881	30420
90	39646	33945	33385	40936	33716	39494	33130	33593	35536

Tims Ford Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	219	220	80	830	80	232	80	220	229
25	328	328	174	938	80	336	174	328	328
50	454	454	292	1061	80	454	292	454	454
75	633	634	472	1243	173	633	472	634	634
90	897	898	736	1482	439	897	736	898	882

Average Reservoir Releases (cfs) during Weeks 23 through 35 (cont.)

Blue Ridge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	369	362	301	589	388	340	319	315	402
25	510	429	354	683	442	492	359	352	446
50	594	513	446	756	530	595	446	443	535
75	715	603	559	832	610	712	559	556	647
90	916	871	801	936	871	903	804	798	903

Hiwassee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1271	1058	967	2206	1284	1213	1016	1049	1299
25	1733	1350	1093	2389	1551	1656	1039	1079	1523
50	2082	1634	1380	2624	1842	2055	1166	1302	1829
75	2414	1963	1717	2792	2207	2374	1567	1676	2217
90	2628	2546	2458	2839	2672	2602	2393	2413	2858

Nottely Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	235	170	155	453	289	240	174	199	249
25	390	289	238	485	352	374	207	235	332
50	479	349	281	569	396	464	254	281	393
75	535	428	357	614	485	531	330	353	465
90	634	541	530	647	592	623	523	525	623

Chatuge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	267	212	194	431	308	259	191	225	269
25	375	281	249	490	355	369	229	253	346
50	449	342	298	536	421	447	270	298	403
75	525	412	366	579	491	510	341	361	485
90	600	560	529	637	644	599	523	523	621

Norris Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	2216	1407	1407	3221	1407	2167	1767	1407	1840
25	2697	1762	1407	3973	1407	2571	1767	1443	2249
50	3310	2295	1908	4547	1580	3297	1891	1792	3078
75	4010	2911	2460	5238	2009	4006	2407	2520	3615
90	4585	3690	3441	5654	2775	4585	3386	3356	4233

Average Reservoir Releases (cfs) during Weeks 23 through 35 (cont.)

Fontana Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	2873	2597	2260	4132	2660	2836	2212	2054	2756
25	3439	2935	2574	4371	3004	3410	2566	2463	3007
50	4005	3423	3177	4560	3398	3956	3172	3073	3407
90	5385	5251	5256	5452	4809	5205	5249	5105	4317
75	4632	4092	4013	4920	3980	4632	4017	3929	5362

Douglas Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	4657	4478	3477	6995	4989	4462	3340	3111	4344
25	5556	4921	3839	7631	5662	5287	3810	3646	5012
50	6372	5492	4684	8059	6472	6335	4644	4512	5629
75	7386	6409	5792	8627	7553	7340	5738	5663	6883
90	8231	7561	7370	9284	8799	8073	7370	7260	7827

Cherokee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	3407	2199	1451	4931	1825	3330	1352	1216	2468
25	4321	2797	2087	5629	2178	4194	2093	1808	3116
50	5602	3300	2721	6574	2506	5518	2754	2354	3847
75	6305	3858	3382	7156	3009	6214	3412	3109	4559
90	7105	4812	4452	7933	3884	7071	4341	4280	5261

South Holston Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	730	548	528	770	529	716	490	480	564
25	838	621	592	911	584	830	550	567	670
50	976	717	720	1078	719	970	682	678	782
75	1144	826	824	1205	809	1144	798	785	904
90	1301	1025	1000	1341	1009	1301	977	926	1011

Watauga Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	620	392	385	532	532	579	583	366	414
25	720	453	428	654	609	706	583	403	494
50	846	509	503	740	675	832	583	479	573
75	960	613	595	845	784	958	608	577	675
90	1137	809	785	971	994	1113	818	764	887

Average Reservoir Releases (cfs) during Weeks 23 through 35 (cont.)

Great Falls Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	267	381	381	483	343	267	381	381	418
25	545	659	659	760	604	545	659	659	659
50	868	900	900	1002	891	868	900	900	900
75	1460	1570	1570	1671	1570	1460	1570	1570	1570
90	2265	2312	2312	2414	2312	2265	2312	2312	2300

Ocoee #1 Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	766	741	644	1025	766	749	675	682	755
25	964	907	822	1194	923	959	819	815	932
50	1147	1066	996	1328	1065	1134	996	993	1102
75	1411	1319	1250	1462	1314	1399	1255	1256	1345
90	1932	1861	1838	1918	1865	1932	1843	1829	1854

Boone Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1799	1471	1429	2305	1387	1816	1535	1414	1524
25	2100	1551	1522	2533	1475	2089	1607	1503	1629
50	2445	1697	1662	2810	1629	2433	1728	1630	1823
75	2790	2164	2080	3041	2151	2768	2191	2043	2311
90	3207	2814	2765	3451	2706	3207	2749	2739	2795

Ocoee #2 Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	731	695	608	980	711	673	633	640	717
25	880	832	746	1132	841	867	750	747	848
50	1056	966	900	1238	963	1050	898	909	1001
75	1347	1213	1192	1364	1220	1347	1190	1187	1275
90	1756	1646	1657	1723	1666	1756	1664	1631	1727

Melton Hill Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	2564	1667	1541	3605	1585	2503	1887	1552	2178
25	2892	1986	1669	4229	1700	2751	1980	1713	2568
50	3813	2645	2196	4999	1963	3717	2265	2180	3397
75	4587	3331	2880	5631	2560	4494	2970	3006	4028
90	5417	4652	4210	6116	3423	5417	4301	4261	4939

Average Reservoir Releases (cfs) during Weeks 23 through 35 (cont.)

Ocoee #3 Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	680	650	580	929	669	648	602	601	684
25	823	779	685	1059	791	798	683	676	785
50	981	884	812	1155	883	962	817	808	922
75	1205	1125	1050	1269	1138	1205	1048	1058	1147
90	1654	1556	1525	1638	1557	1654	1525	1525	1584

Apalachia Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1324	1100	1013	2248	1347	1261	1066	1100	1358
25	1783	1401	1154	2456	1607	1705	1087	1135	1579
50	2150	1693	1446	2681	1898	2110	1223	1364	1891
75	2514	2047	1799	2870	2281	2456	1656	1768	2308
90	2769	2665	2573	2882	2787	2723	2511	2525	2973

Fort Patrick Henry Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1698	1363	1310	2230	1265	1740	1415	1304	1395
25	1996	1444	1418	2431	1387	1974	1500	1401	1525
50	2356	1651	1586	2710	1554	2348	1660	1534	1774
75	2723	2125	2070	3026	2137	2702	2141	1961	2224
90	3165	2741	2695	3418	2633	3155	2676	2676	2723

Average Reservoir Releases (cfs) during Weeks 36 through 48

Wilson Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	25548	25938	23631	18203	17039	24778	23596	25066	24399
25	29914	31150	28218	19620	21714	28724	27871	30292	28967
50	37528	39018	33243	24436	29042	36246	33478	35753	37252
75	42253	44826	40986	31104	38174	41161	40907	44041	44673
90	53612	56405	52948	43087	51538	52766	52812	57761	54591

Guntersville Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	23606	23589	20954	16982	14190	23090	20880	23017	21079
25	26576	28299	24291	17872	17611	25638	24303	26470	25490
50	32763	35223	29512	21161	23437	31717	29150	31967	32160
75	37183	39121	34547	26728	29558	36613	34480	39356	37683
90	46132	48015	44059	36790	42019	45466	44008	49317	46932

Kentucky Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	23821	24871	23820	18915	20491	25450	23757	24992	23963
25	27791	29876	27123	20116	24649	27696	27004	28427	27522
50	33106	34413	31689	24238	29740	32289	31718	32890	32386
75	40610	41981	39796	32764	39138	41573	39638	42253	40663
90	52817	55586	53558	44475	51393	54759	53269	57572	52716

Pickwick Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	25155	25524	23513	17411	17273	24301	23406	24293	24584
25	30031	31890	28580	19265	22361	28714	28296	30116	29829
50	37216	38757	33922	24513	29736	35699	33592	35439	37520
75	43045	44576	41780	32690	39053	41706	41663	45227	45497
90	54386	57014	53963	43267	52842	53167	53758	58369	57126

Wheeler Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	25355	25956	23328	18212	17611	24675	23376	25153	24257
25	29589	31399	28150	19550	21496	28645	27803	29249	29029
50	36596	38254	33414	23858	28535	34814	32946	35289	36432
75	41628	44521	40185	30743	36896	40815	40210	43151	44322
90	52786	55445	52009	42527	50598	51907	51919	56800	53160

Average Reservoir Releases (cfs) during Weeks 36 through 48 (cont.)

Chickamauga Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	22562	21846	19588	15914	12785	22209	19388	21578	19176
25	24711	26740	22631	16872	16027	23890	22521	25483	23780
50	30242	32908	27202	19154	20818	29498	27194	29950	29607
75	35610	36756	31451	24688	26128	35090	31296	35789	34902
90	38949	40891	37532	31334	34990	38155	36826	42459	39746

Watts Bar

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	18179	17580	15308	12744	9397	17759	15407	18100	15171
25	20645	22905	18296	13603	12360	20091	18428	21728	19721
50	24956	27789	21919	15381	16511	24711	21935	25301	24291
75	28676	30443	24820	19758	21081	28424	24588	29270	28814
90	32272	34281	29840	24370	27179	32011	29537	35899	33025

Fort Loudoun

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	13530	14237	12663	9014	6703	13410	12740	14431	11536
25	15100	17089	14439	9844	8745	14965	14569	16327	14785
50	17869	20324	17091	11986	12027	17735	17228	18757	18116
75	21278	22970	19608	14892	15577	21095	19428	21903	21342
90	23224	24684	22067	17787	19350	23161	22135	25871	23911

Nickajack Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	22001	22149	19549	16009	12858	21851	19398	21744	19287
25	25130	27154	22659	16985	16142	24406	22721	25564	23787
50	30592	33630	27528	19453	21375	29976	27419	30298	29687
75	36225	37283	32242	25043	26571	35718	32087	37334	35535
90	39875	41456	38850	32047	36127	39257	38232	43529	40897

Tims Ford Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	557	527	751	194	798	557	751	527	559
25	643	592	782	229	949	643	782	592	641
50	737	687	870	319	1105	737	870	681	734
75	913	854	1016	531	1338	929	1016	842	899
90	1212	1196	1346	877	1634	1220	1346	1196	1217

Average Reservoir Releases (cfs) during Weeks 36 through 48 (cont.)

Blue Ridge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	475	306	460	325	173	482	460	218	334
25	536	443	528	397	256	538	529	294	416
50	609	561	605	456	360	609	605	379	503
75	699	666	675	570	461	699	675	460	585
90	839	737	780	694	630	839	779	665	725

Hiwassee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1610	1666	1522	1006	526	1673	1057	1331	1298
25	1797	2075	1838	1209	802	1851	1649	1756	1671
50	2051	2381	2125	1464	1212	2063	2105	2048	1900
75	2379	2624	2415	1885	1701	2384	2357	2383	2202
90	2701	2891	2903	2397	2259	2701	2917	2961	2611

Nottely Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	326	325	292	210	162	339	203	244	253
25	376	412	363	248	203	379	330	367	326
50	430	498	429	306	265	433	418	428	389
75	511	562	483	391	326	512	469	496	439
90	578	617	599	512	457	578	599	632	550

Chatuge Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	311	355	322	258	143	311	252	223	235
25	348	418	378	293	190	352	357	309	309
50	413	502	447	357	284	417	435	370	386
75	475	545	506	424	343	477	485	430	436
90	540	598	654	558	504	540	654	617	573

Norris Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	3229	2627	1614	1910	1307	3259	1695	2918	1670
25	3511	3817	2173	2041	1307	3521	1949	3670	2781
50	4117	4545	2603	2365	1703	4091	2455	4182	3647
75	4744	5334	3028	3196	3290	4717	2955	4839	4184
90	5622	5992	4002	3966	4456	5644	3989	5973	5278

Average Reservoir Releases (cfs) during Weeks 36 through 48 (cont.)

Fontana Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	3375	3834	2941	2316	1360	3300	2940	3252	2657
25	3827	4311	3317	2650	1851	3831	3334	3705	3414
50	4433	4837	3930	3174	2616	4442	3933	4375	4250
75	4883	5175	4795	4210	4251	4906	4797	5194	4885
90	5650	5898	5600	5072	4969	5650	5613	5967	5684

Douglas Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	4731	4569	4597	2094	1640	4893	4560	4630	4341
25	5369	5976	5470	3284	2503	5490	5475	5793	5509
50	6473	7163	6327	4259	3910	6450	6320	6665	6644
75	7699	8219	7445	5690	5357	7664	7444	8025	7973
90	8829	9426	9118	7024	6977	8829	9128	10240	9201

Cherokee Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	3687	3927	3481	2089	1588	3691	3516	4552	3040
25	4056	5066	3996	2512	2144	4056	4071	5171	3974
50	4667	5980	4363	2943	2685	4728	4458	5878	4669
75	5587	6994	4814	3500	3564	5633	4846	6475	5834
90	6954	7772	5886	4205	4800	6935	5726	7992	6498

South Holston Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	713	588	382	506	417	717	353	481	604
25	829	800	451	586	484	825	459	621	746
50	981	999	524	691	571	981	538	804	935
75	1216	1168	635	884	652	1224	644	996	1120
90	1461	1357	882	1064	861	1461	945	1227	1265

Watauga Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	318	347	286	321	301	338	399	304	202
25	377	499	328	420	366	403	399	338	294
50	544	612	392	482	441	564	406	451	429
75	734	770	518	588	526	746	499	605	589
90	927	912	677	865	648	927	659	754	725

Average Reservoir Releases (cfs) during Weeks 36 through 48 (cont.)

Great Falls Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	317	317	317	216	317	317	317	317	319
25	504	504	504	402	504	504	504	504	504
50	935	935	935	834	935	935	935	935	935
75	1577	1577	1577	1485	1577	1577	1577	1577	1577
90	2529	2529	2529	2427	2529	2529	2529	2529	2502

Ocoee #1 Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	721	606	694	646	477	732	694	506	592
25	864	791	861	742	575	855	860	631	744
50	1039	1001	1050	886	799	1039	1050	806	952
75	1232	1204	1216	1079	984	1232	1217	983	1108
90	1531	1368	1478	1354	1288	1531	1478	1341	1393

Boone Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1606	1510	1349	1378	1245	1645	1425	1409	1469
25	1758	1865	1412	1465	1325	1796	1505	1554	1622
50	2252	2251	1640	1586	1429	2261	1693	1901	2030
75	2778	2684	1965	1843	1742	2806	1983	2404	2499
90	3215	3197	2658	2331	2327	3236	2649	3023	2950

Ocoee #2 Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	707	571	696	580	437	722	696	471	580
25	806	761	789	701	529	819	797	572	692
50	973	935	975	802	718	973	975	738	876
75	1181	1099	1130	1021	921	1181	1130	934	1064
90	1489	1339	1363	1270	1169	1489	1363	1230	1279

Melton Hill Reservoir

Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	3321	2676	1762	2058	1382	3350	1777	2937	1878
25	3622	4021	2383	2204	1505	3629	2149	3842	2920
50	4445	4889	2791	2720	1876	4409	2632	4361	3967
75	4965	5612	3376	3629	3568	4994	3250	5248	4563
90	6096	6659	4716	4172	5220	6199	4558	6682	5711

Average Reservoir Releases (cfs) during Weeks 36 through 48 (cont.)

Ocoee #3 Reservoir

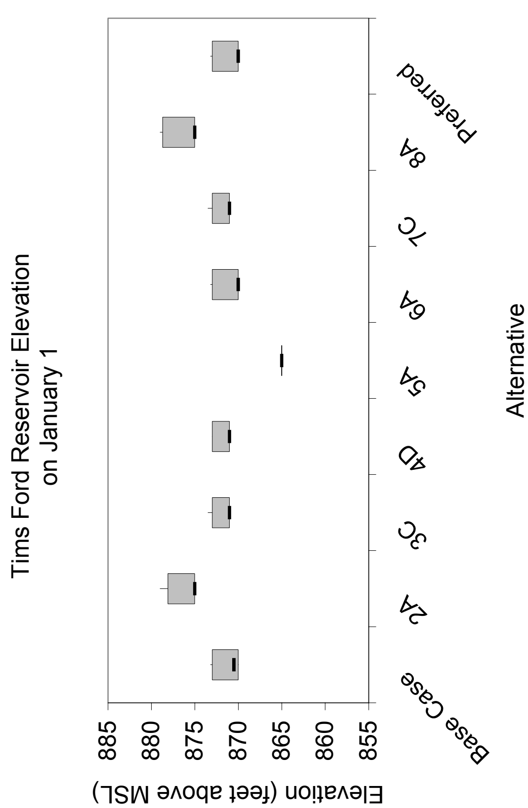
Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	675	511	639	552	391	703	638	429	534
25	768	680	756	636	466	759	756	517	644
50	891	831	889	755	635	892	889	650	761
75	1089	1017	1044	907	824	1089	1044	832	963
90	1339	1207	1286	1203	1111	1339	1289	1154	1233

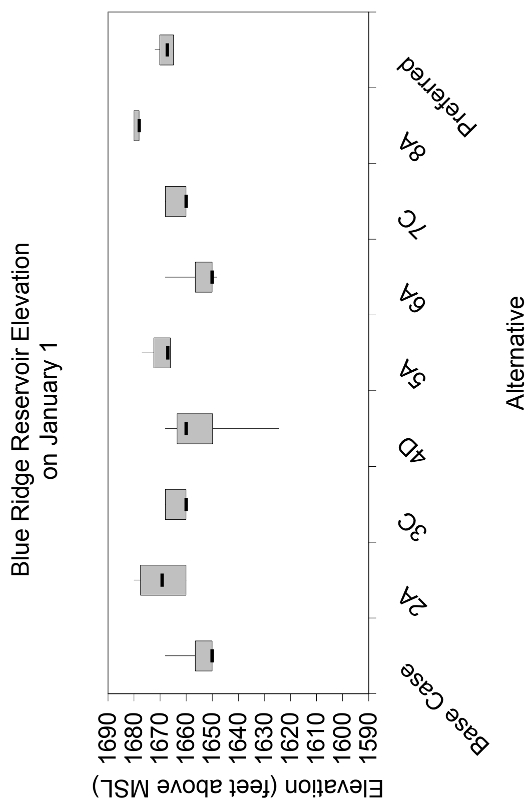
Apalachia Reservoir

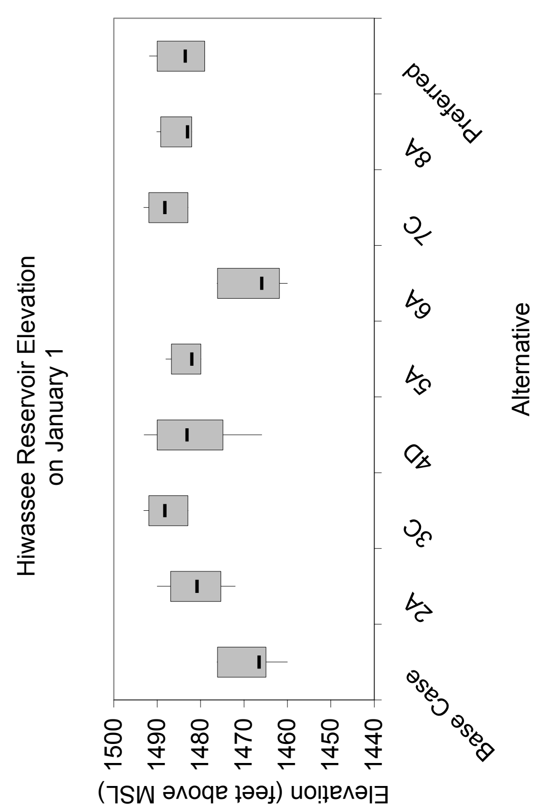
Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1638	1692	1559	1039	548	1700	1090	1366	1324
25	1831	2115	1874	1242	835	1886	1688	1783	1703
50	2093	2418	2167	1491	1238	2110	2160	2088	1937
75	2445	2681	2475	1942	1756	2445	2419	2440	2258
90	2760	2968	2985	2455	2344	2760	3000	3044	2697

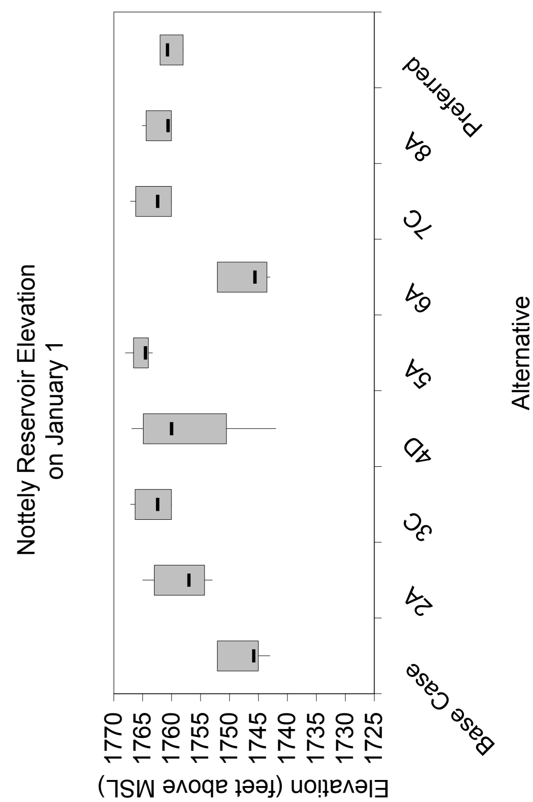
Fort Patrick Henry Reservoir

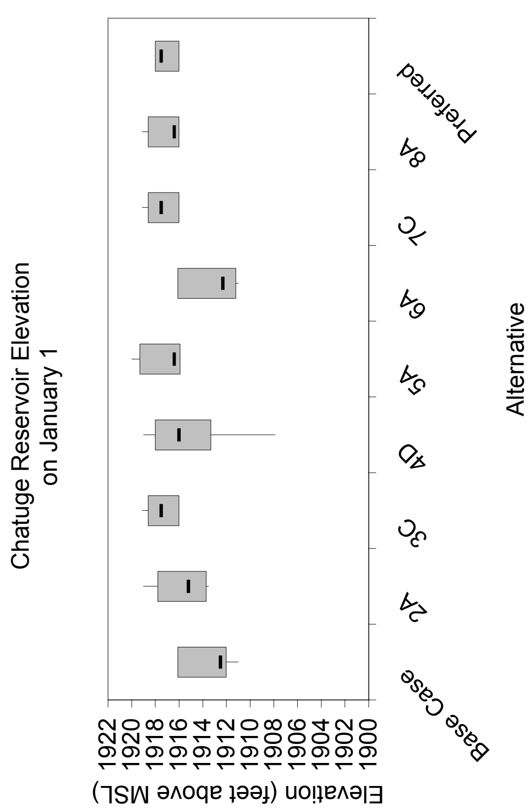
Percentile	Base	2A	3C	4D	5A	6A	7C	8A	Preferred
10	1476	1377	1210	1254	1132	1500	1286	1264	1325
25	1641	1753	1298	1360	1199	1667	1363	1424	1512
50	2153	2139	1521	1479	1314	2147	1593	1786	1905
75	2667	2580	1903	1729	1644	2687	1881	2286	2416
90	3147	3189	2679	2276	2447	3177	2590	3017	2974

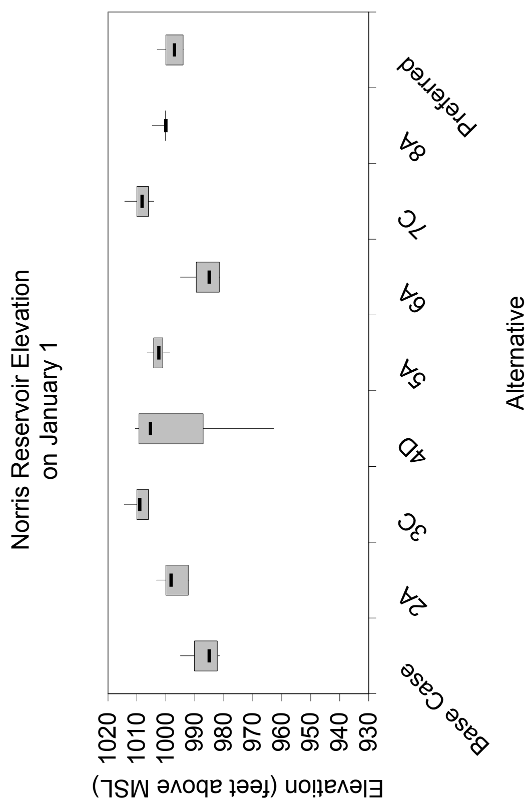

Tims Ford Reservoir Elevation
on January 1
Elevation (feet above MSL)
Alternative
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred

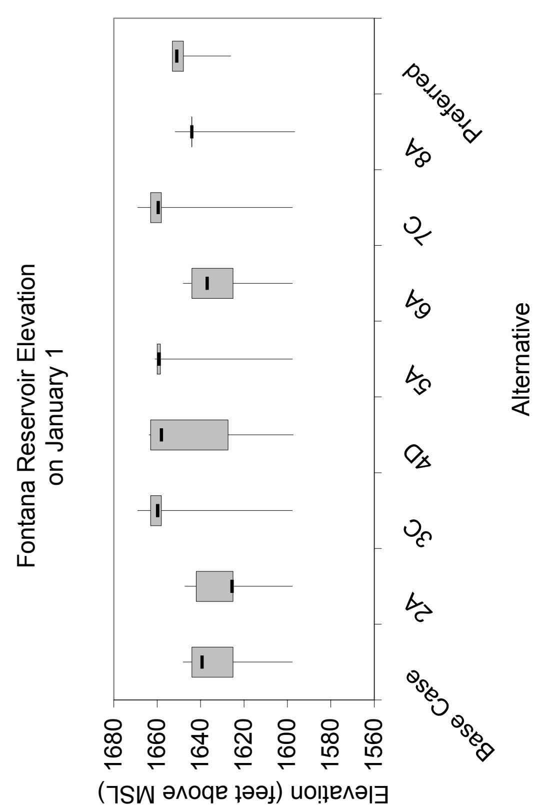

Blue Ridge Reservoir Elevation
on January 1
Elevation (feet above MSL)
Alternative
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred

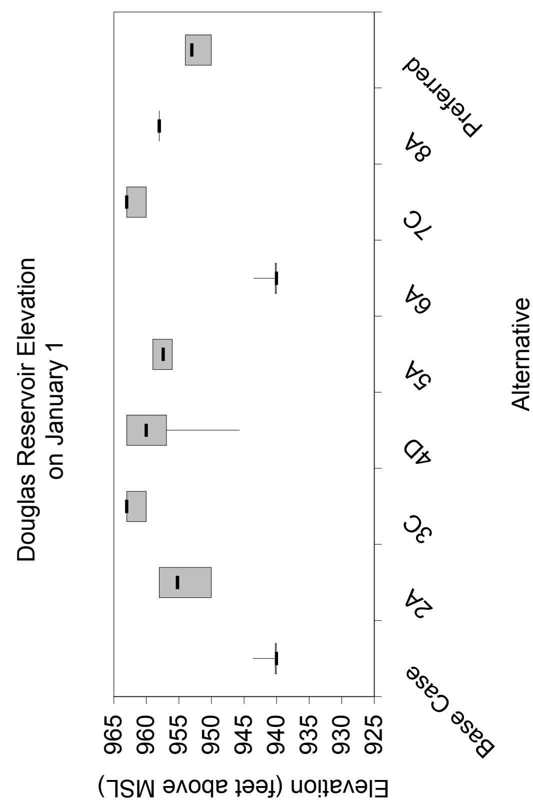

Hiwassee Reservoir Elevation
on January 1
Elevation (feet above MSL)
Alternative
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred

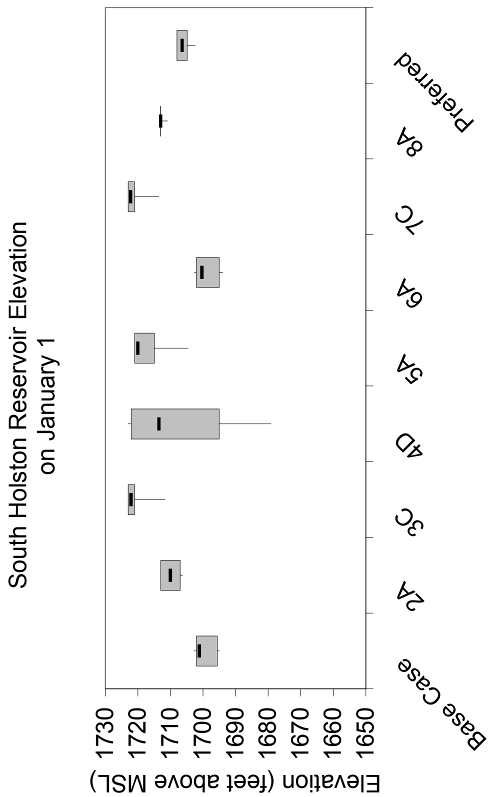

Nottely Reservoir Elevation
on January 1
Elevation (feet above MSL)
Alternative
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred

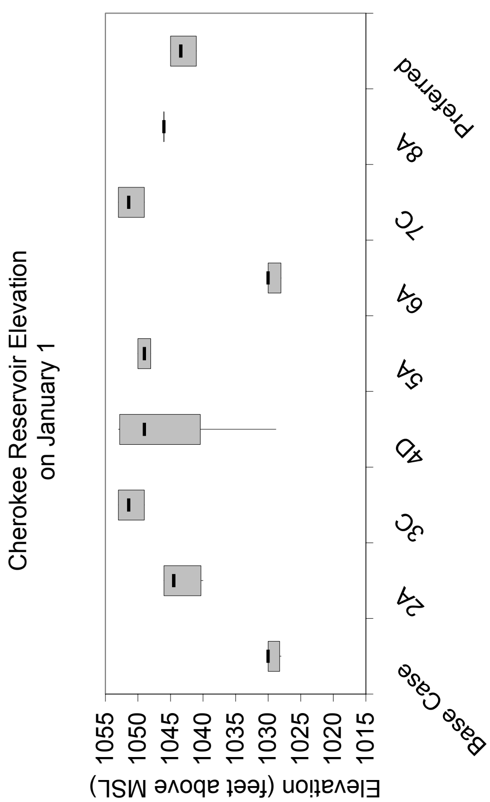

Chatuge Reservoir Elevation on January 1
Elevation (feet above MSL)
1922
1920
1918
1916
1914
1912
1910
1908
1906
1904
1902
1900
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

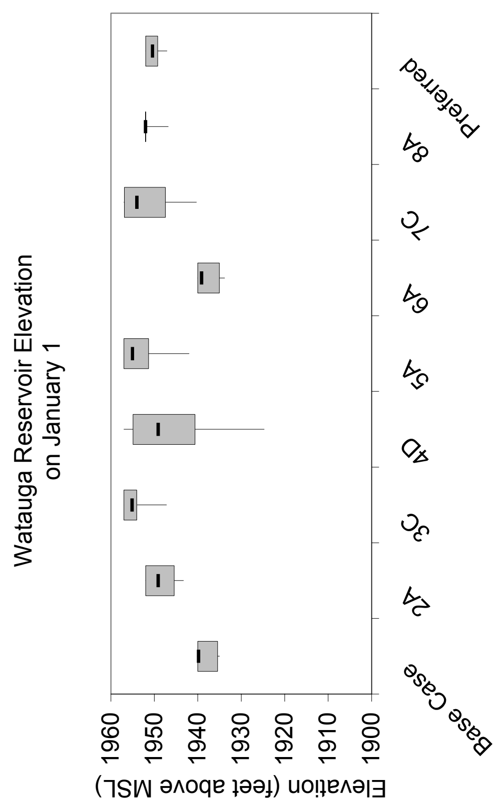

Norris Reservoir Elevation on January 1
Elevation (feet above MSL)
1020
1010
1000
990
980
970
960
950
940
930
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

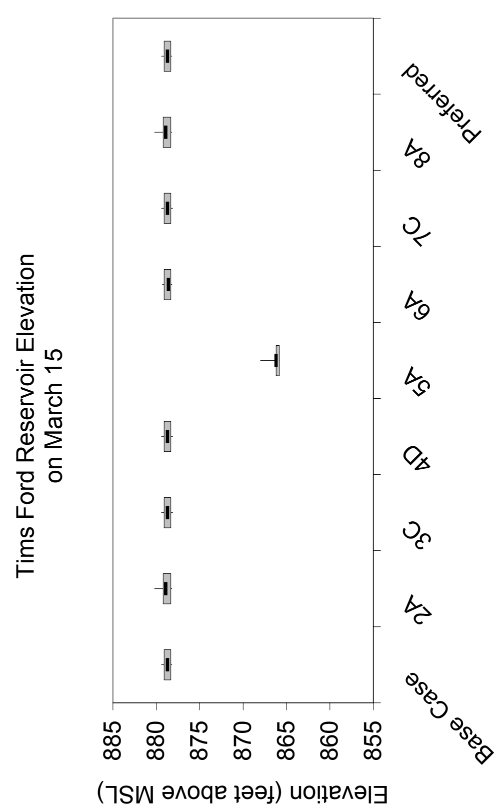

Fontana Reservoir Elevation on January 1
Elevation (feet above MSL)
1680
1660
1640
1620
1600
1580
1560
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

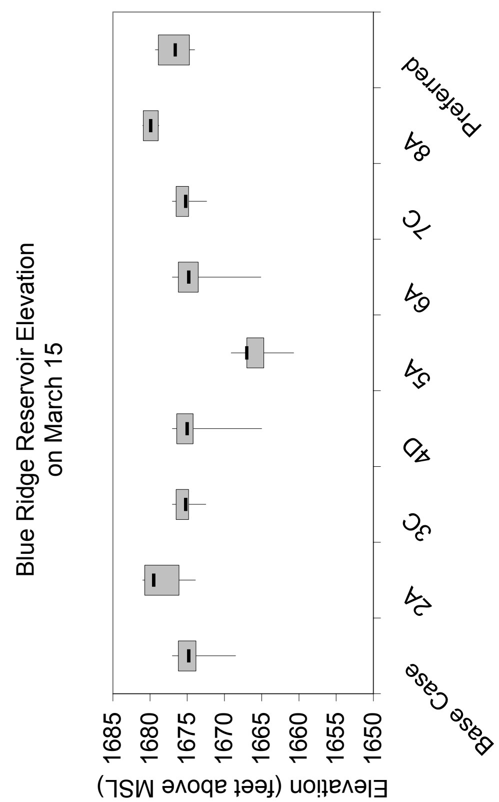

Douglas Reservoir Elevation on January 1
Elevation (feet above MSL)
965
960
955
950
945
940
935
930
925
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

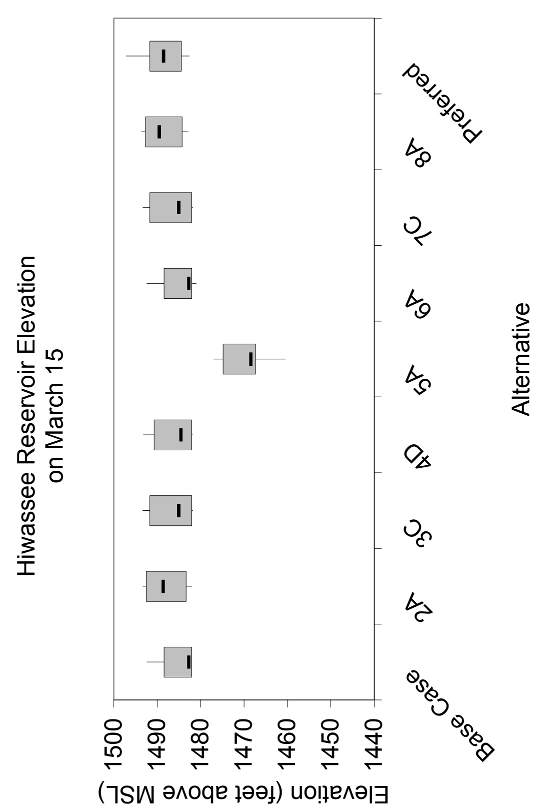

South Holston Reservoir Elevation
on January 1
Elevation (feet above MSL)
1730
1720
1710
1700
1690
1680
1670
1660
1650
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

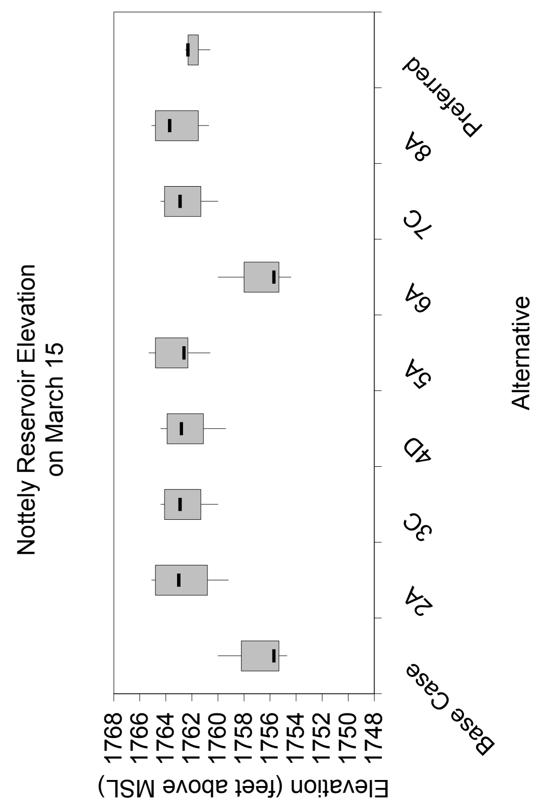

Cherokee Reservoir Elevation
on January 1
Elevation (feet above MSL)
1055
1050
1045
1040
1035
1030
1025
1020
1015
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

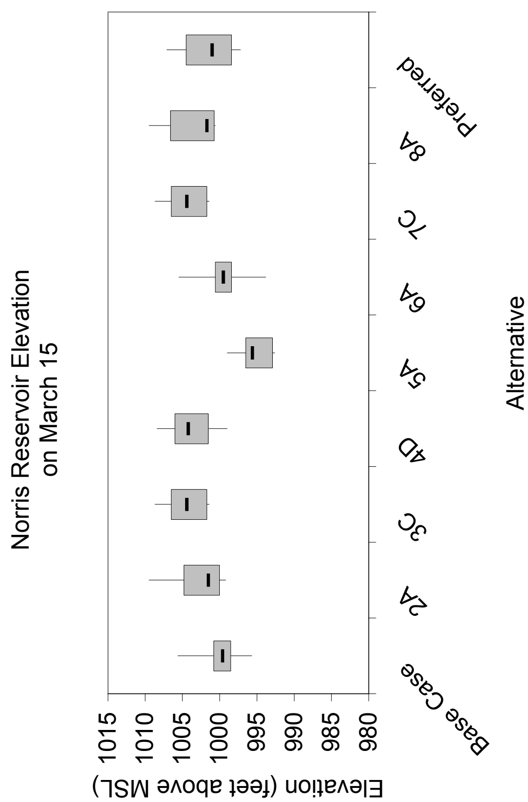

Watauga Reservoir Elevation
on January 1
Elevation (feet above MSL)
1960
1950
1940
1930
1920
1910
1900
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

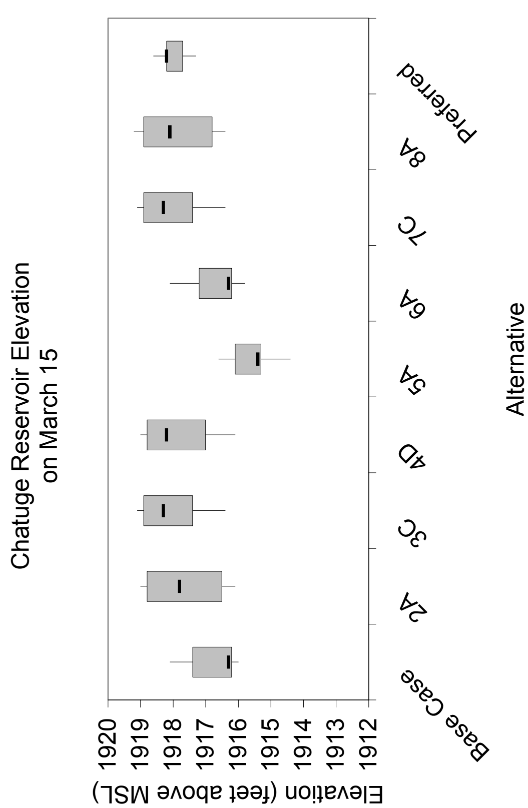

Tims Ford Reservoir Elevation
on March 15
Elevation (feet above MSL)
885
880
875
870
865
860
855
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

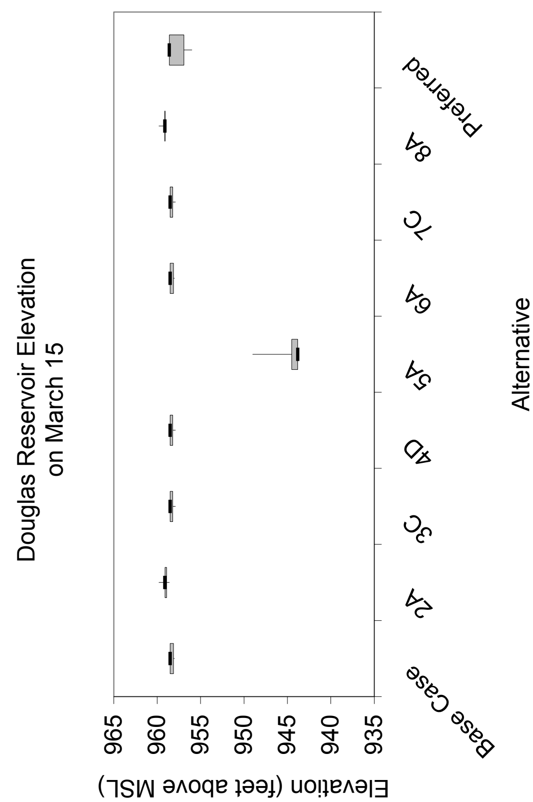

Blue Ridge Reservoir Elevation
on March 15
Elevation (feet above MSL)
1685
1680
1675
1670
1665
1660
1655
1650
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

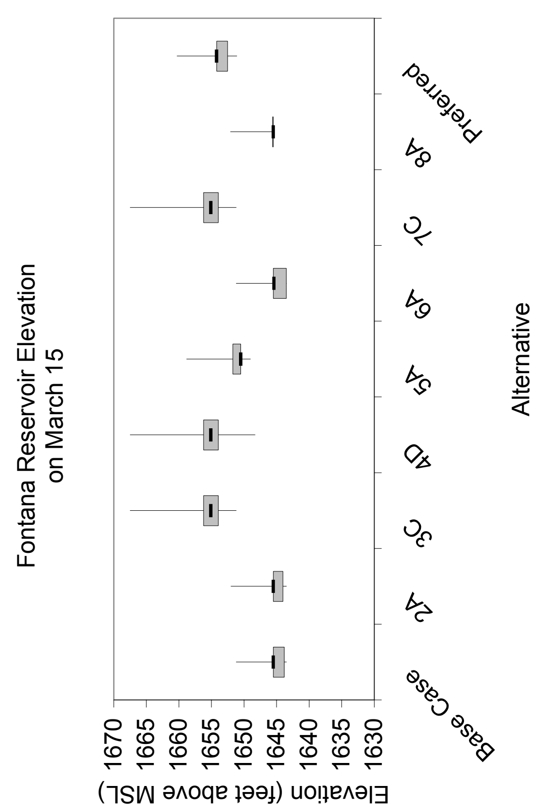

Hiwassee Reservoir Elevation
on March 15
Elevation (feet above MSL)
1500
1490
1480
1470
1460
1450
1440
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

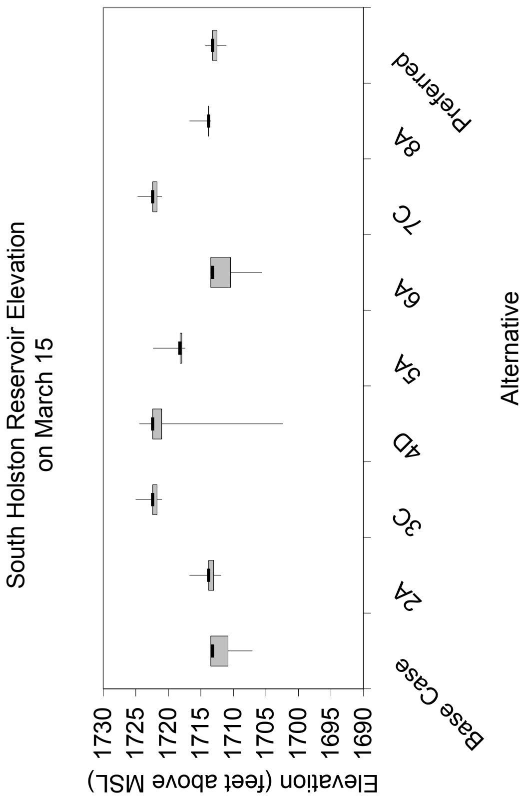

Nottely Reservoir Elevation
on March 15
Elevation (feet above MSL)
1768
1766
1764
1762
1760
1758
1756
1754
1752
1750
1748
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

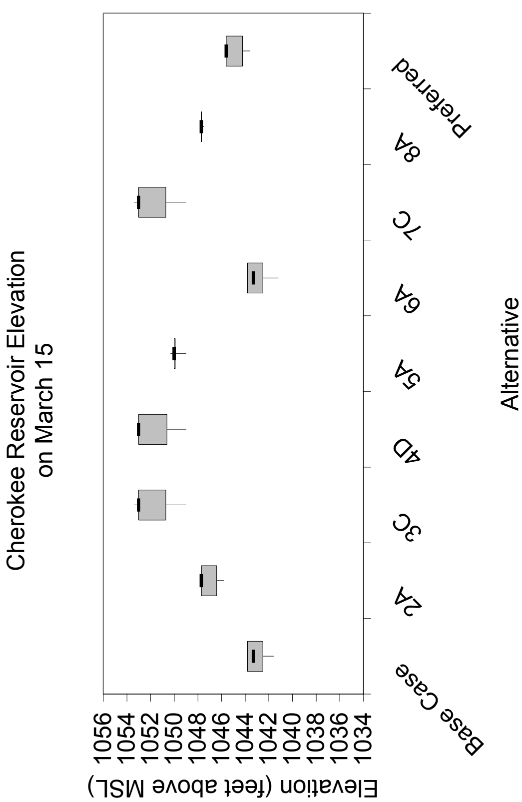

Norris Reservoir Elevation on March 15
Elevation (feet above MSL)
1015
1010
1005
1000
995
990
985
980
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

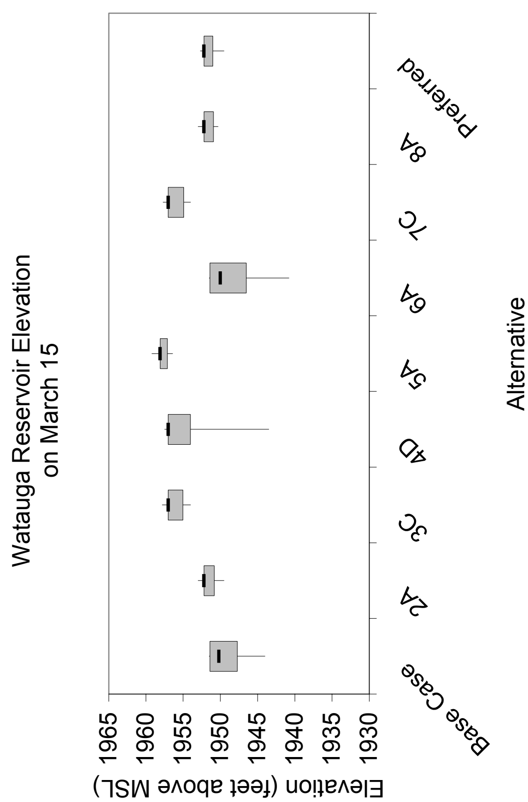

Chatuge Reservoir Elevation on March 15
Elevation (feet above MSL)
1920
1919
1918
1917
1916
1915
1914
1913
1912
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

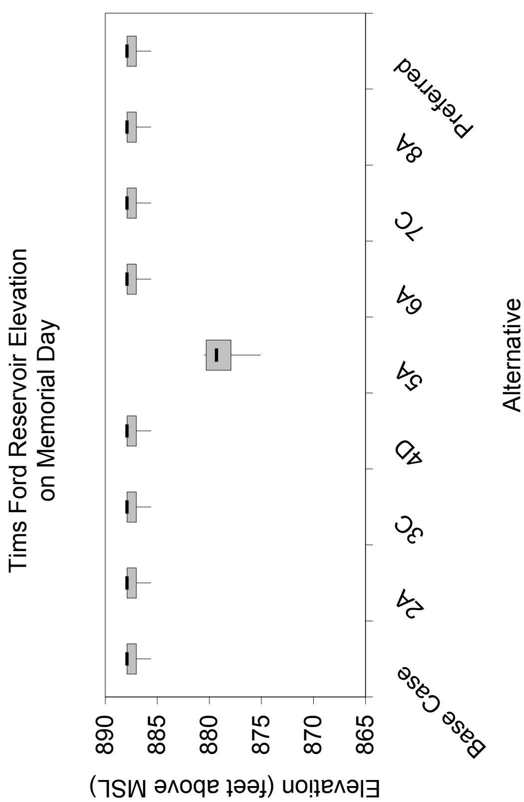

Douglas Reservoir Elevation on March 15
Elevation (feet above MSL)
965
960
955
950
945
940
935
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

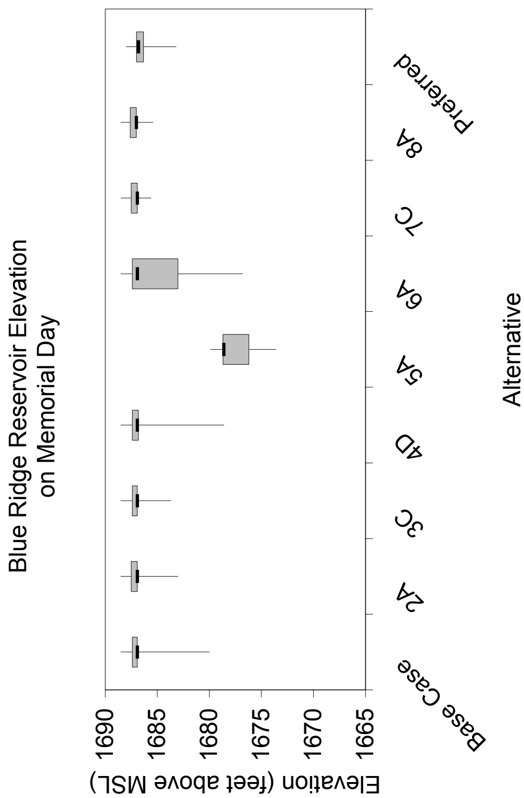

Fontana Reservoir Elevation on March 15
Elevation (feet above MSL)
1670
1665
1660
1655
1650
1645
1640
1635
1630
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

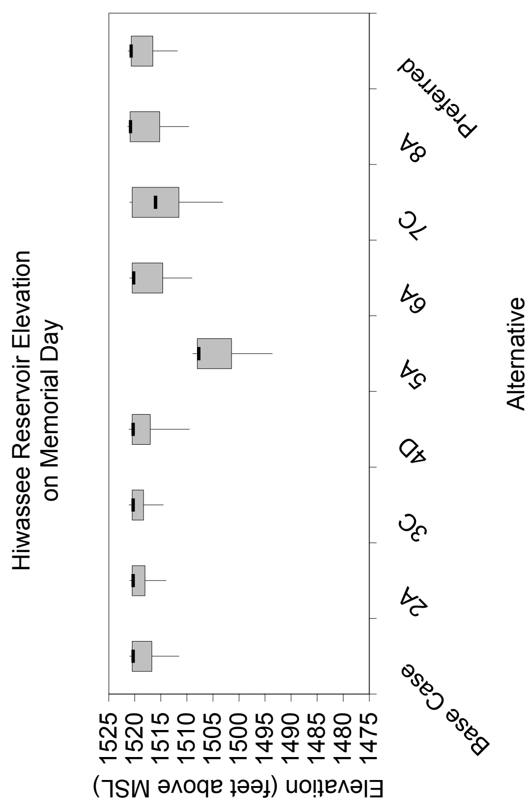

South Holston Reservoir Elevation
on March 15
Elevation (feet above MSL)
1730
1725
1720
1715
1710
1705
1700
1695
1690
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

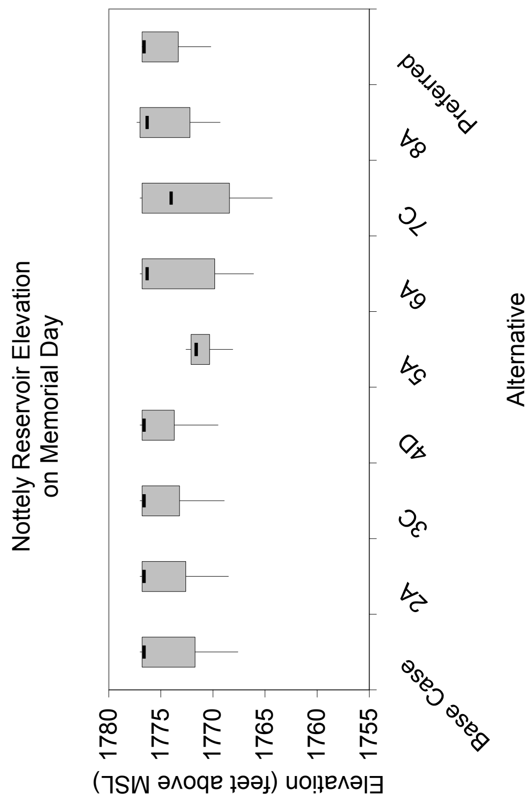

Cherokee Reservoir Elevation
on March 15
Elevation (feet above MSL)
1056
1054
1052
1050
1048
1046
1044
1042
1040
1038
1036
1034
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

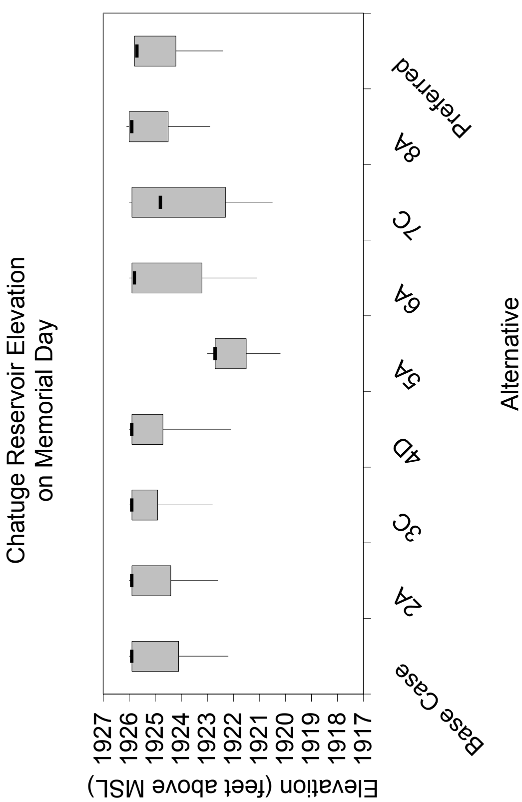

Watauga Reservoir Elevation
on March 15
Elevation (feet above MSL)
1965
1960
1955
1950
1945
1940
1935
1930
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

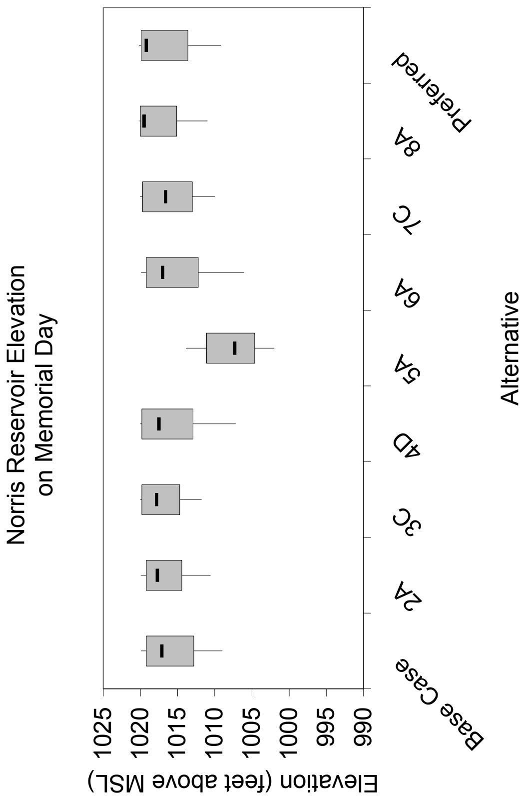

Tims Ford Reservoir Elevation
on Memorial Day
Elevation (feet above MSL)
890
885
880
875
870
865
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

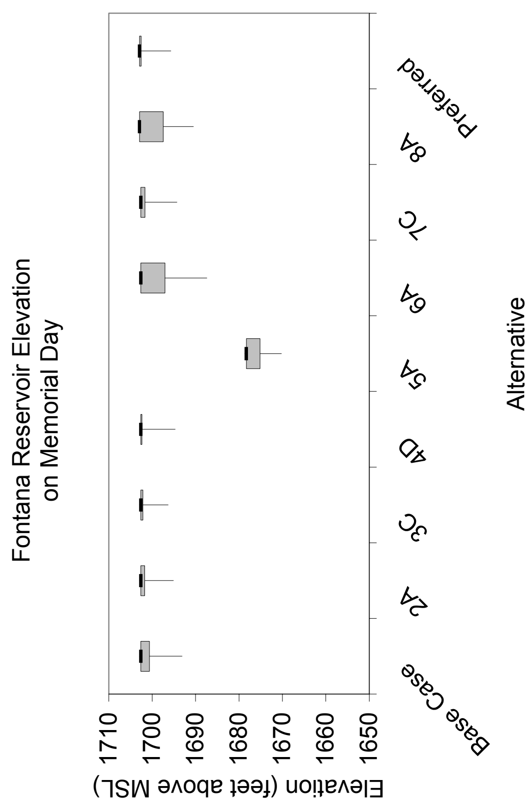

Blue Ridge Reservoir Elevation
on Memorial Day
Elevation (feet above MSL)
1690
1685
1680
1675
1670
1665
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

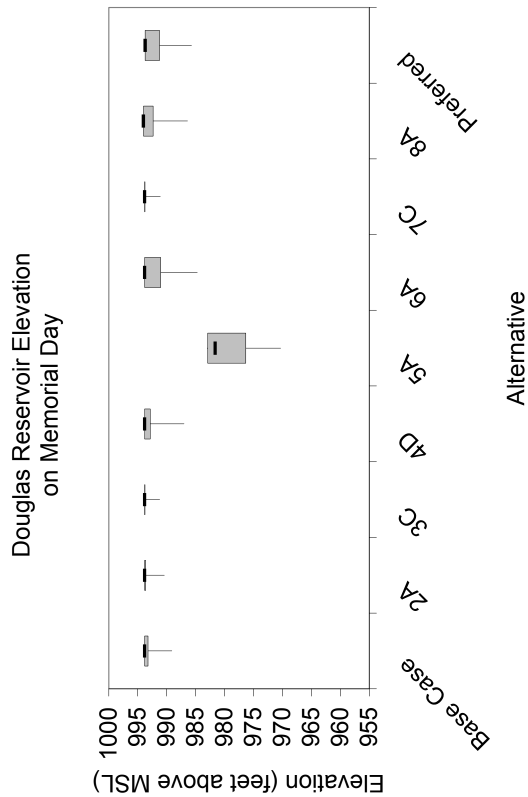

Hiwassee Reservoir Elevation
on Memorial Day
Elevation (feet above MSL)
1525
1520
1515
1510
1505
1500
1495
1490
1485
1480
1475
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

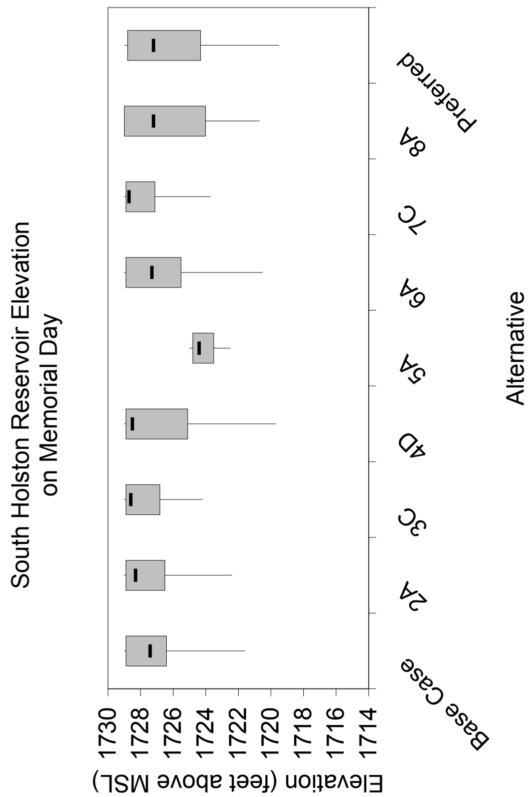

Nottely Reservoir Elevation
on Memorial Day
Elevation (feet above MSL)
1780
1775
1770
1765
1760
1755
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

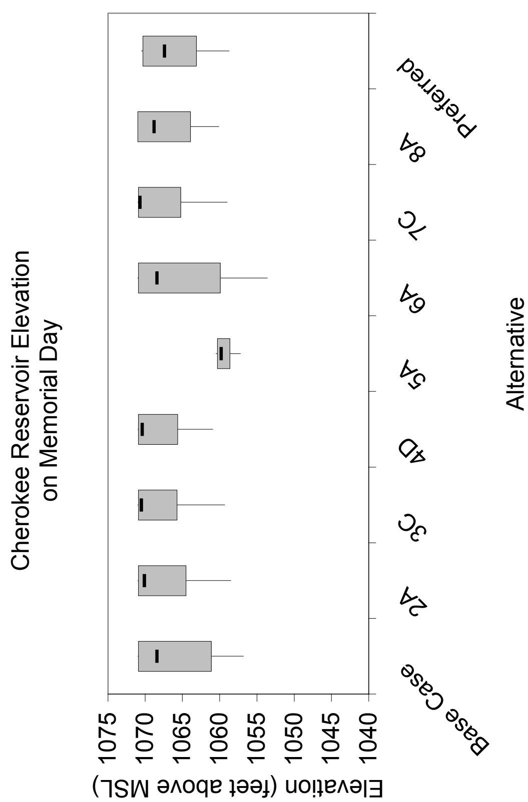

Chatuge Reservoir Elevation
on Memorial Day
Elevation (feet above MSL)
1927
1926
1925
1924
1923
1922
1921
1920
1919
1918
1917
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

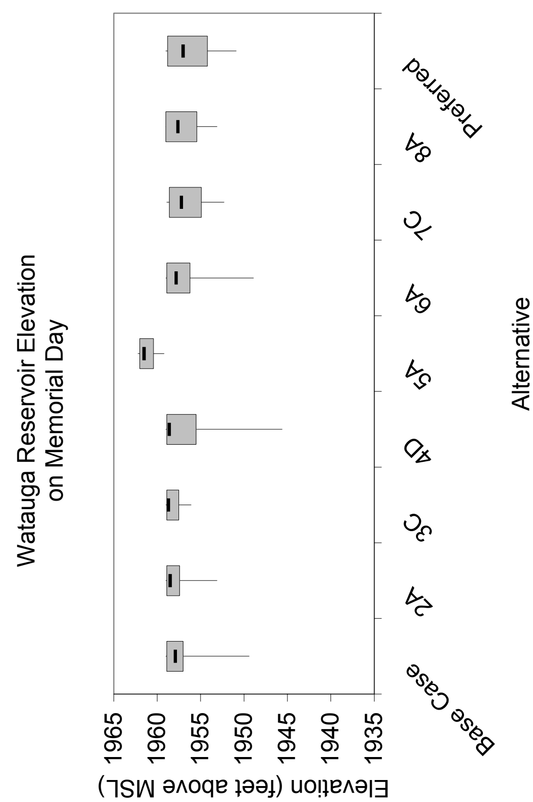

Norris Reservoir Elevation
on Memorial Day
Elevation (feet above MSL)
1025
1020
1015
1010
1005
1000
995
990
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

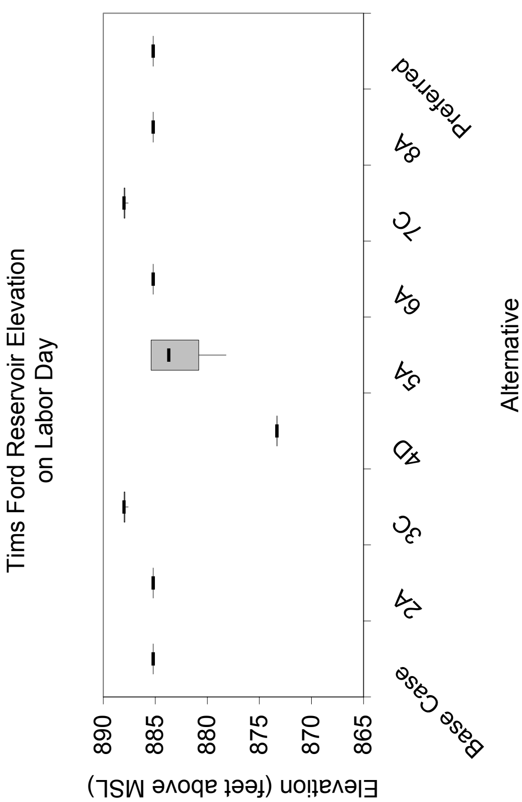

Fontana Reservoir Elevation
on Memorial Day
Elevation (feet above MSL)
1710
1700
1690
1680
1670
1660
1650
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

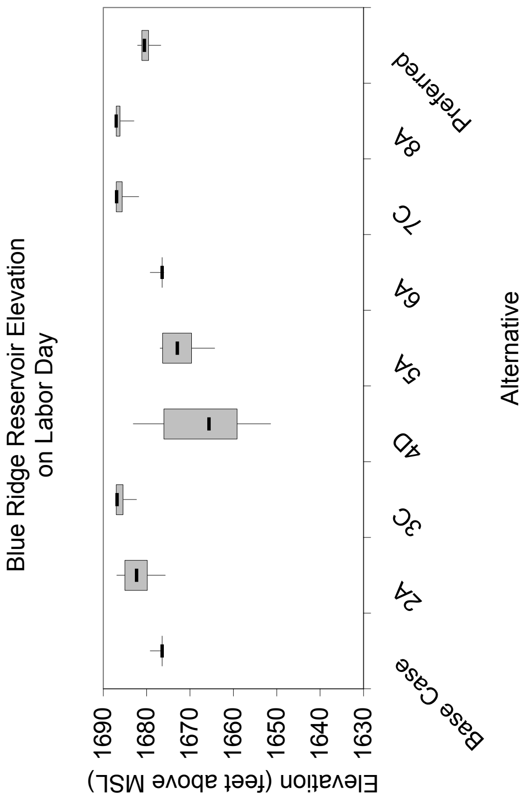

Douglas Reservoir Elevation
on Memorial Day
Elevation (feet above MSL)
1000
995
990
985
980
975
970
965
960
955
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

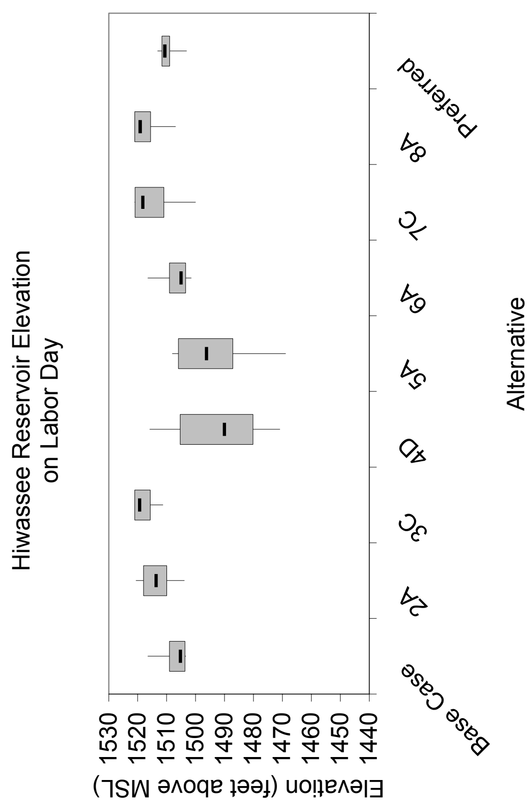

South Holston Reservoir Elevation
on Memorial Day
Elevation (feet above MSL)
1730
1728
1726
1724
1722
1720
1718
1716
1714
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

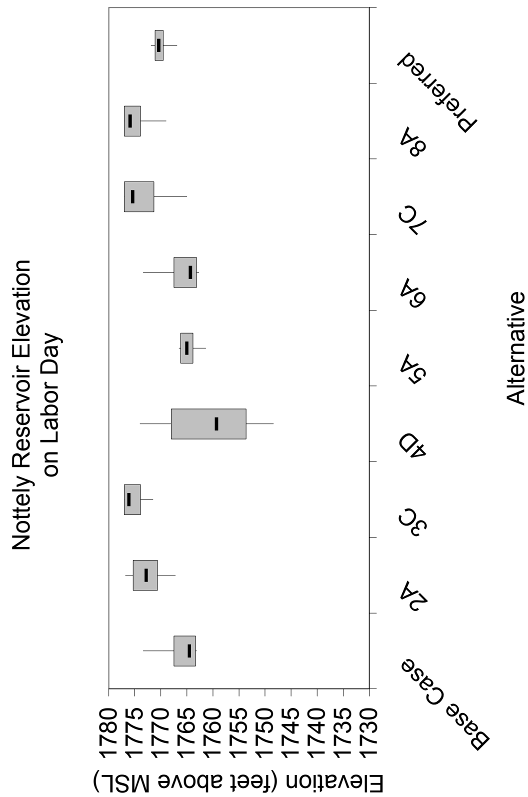

Cherokee Reservoir Elevation
on Memorial Day
Elevation (feet above MSL)
1075
1070
1065
1060
1055
1050
1045
1040
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

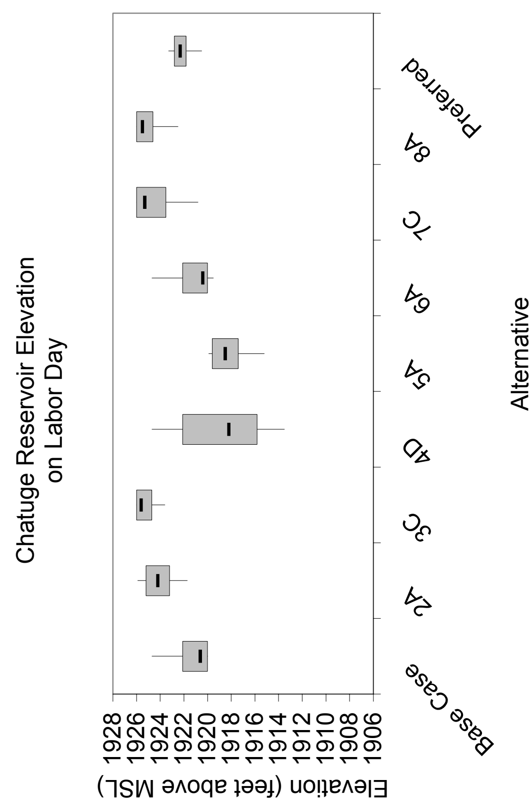

Watauga Reservoir Elevation
on Memorial Day
Elevation (feet above MSL)
1965
1960
1955
1950
1945
1940
1935
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

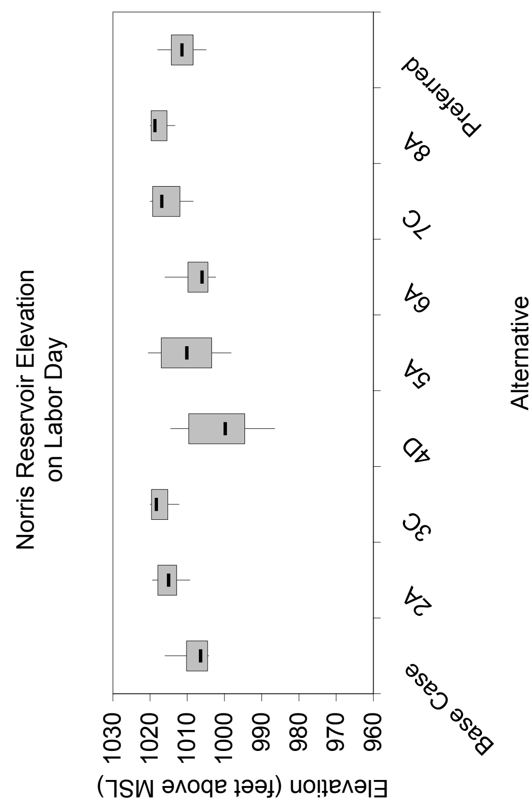

Tims Ford Reservoir Elevation on Labor Day
Elevation (feet above MSL)
890
885
880
875
870
865
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

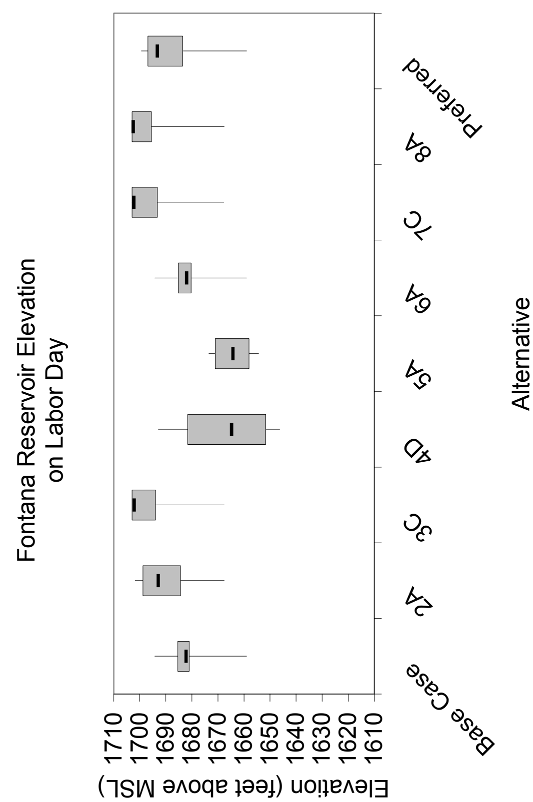

Blue Ridge Reservoir Elevation on Labor Day
Elevation (feet above MSL)
1690
1680
1670
1660
1650
1640
1630
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

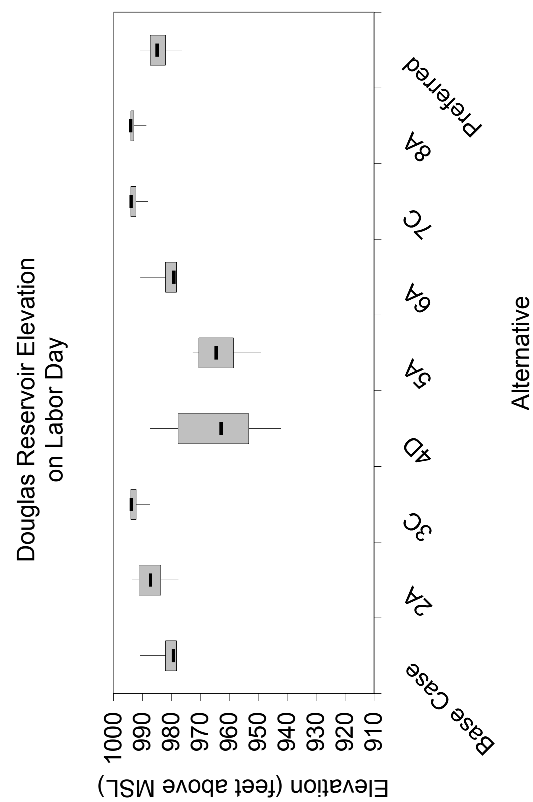

Hiwassee Reservoir Elevation on Labor Day
Elevation (feet above MSL)
1530
1520
1510
1500
1490
1480
1470
1460
1450
1440
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

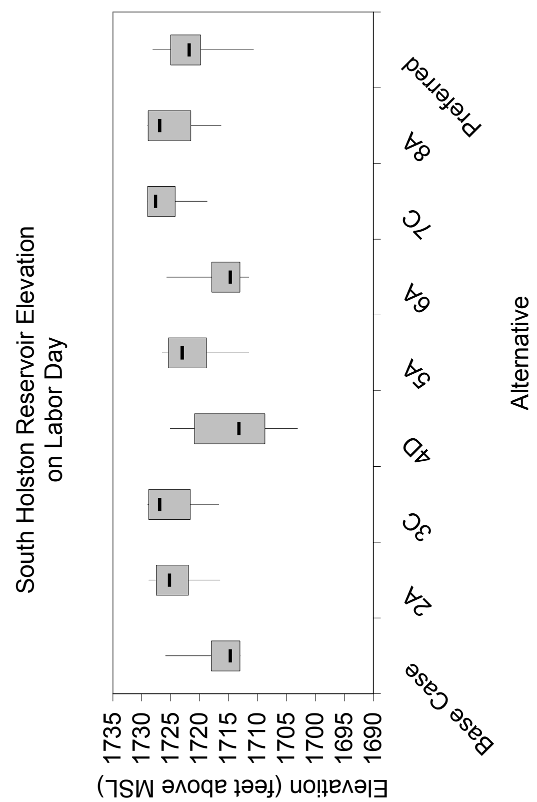

Nottely Reservoir Elevation on Labor Day
Elevation (feet above MSL)
1780
1775
1770
1765
1760
1755
1750
1745
1740
1735
1730
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

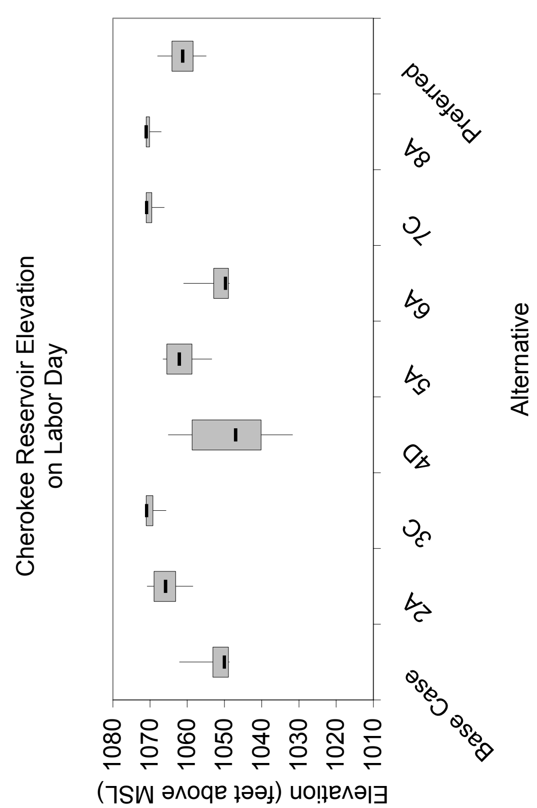

Chatuge Reservoir Elevation
on Labor Day
Elevation (feet above MSL)
1928
1926
1924
1922
1920
1918
1916
1914
1912
1910
1908
1906
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

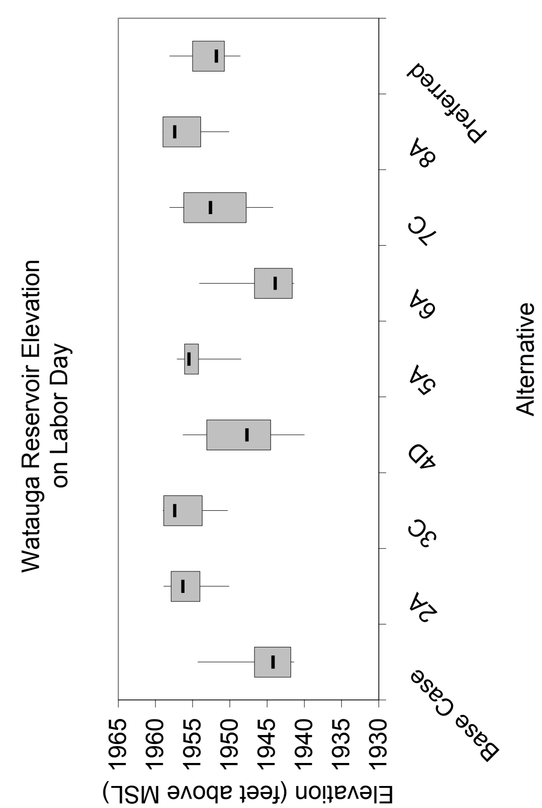

Norris Reservoir Elevation
on Labor Day
Elevation (feet above MSL)
1030
1020
1010
1000
990
980
970
960
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

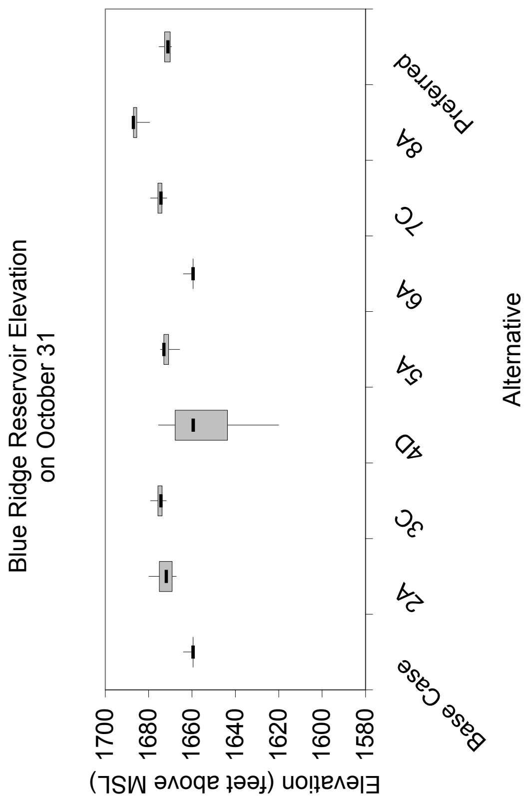

Fontana Reservoir Elevation
on Labor Day
Elevation (feet above MSL)
1710
1700
1690
1680
1670
1660
1650
1640
1630
1620
1610
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

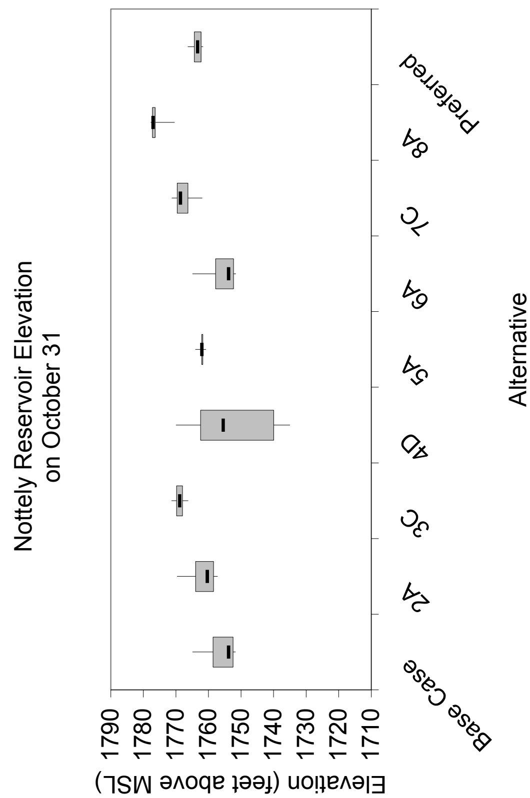

Douglas Reservoir Elevation
on Labor Day
Elevation (feet above MSL)
1000
990
980
970
960
950
940
930
920
910
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

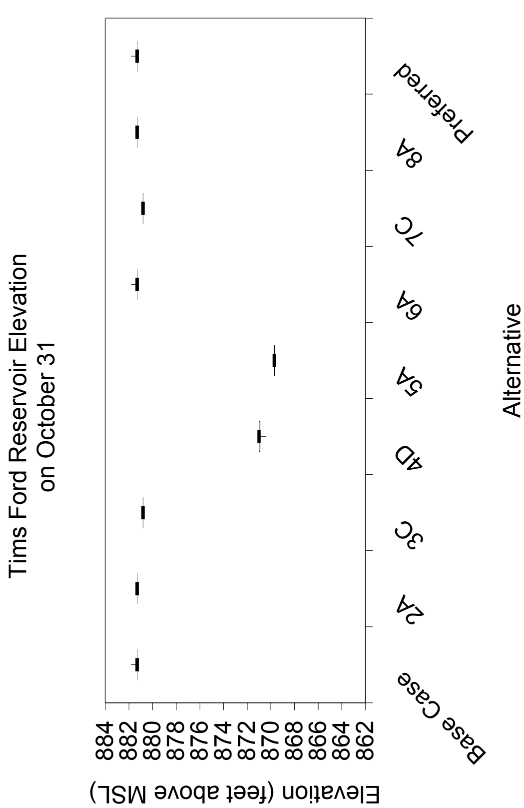

South Holston Reservoir Elevation
on Labor Day
Elevation (feet above MSL)
1735
1730
1725
1720
1715
1710
1705
1700
1695
1690
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

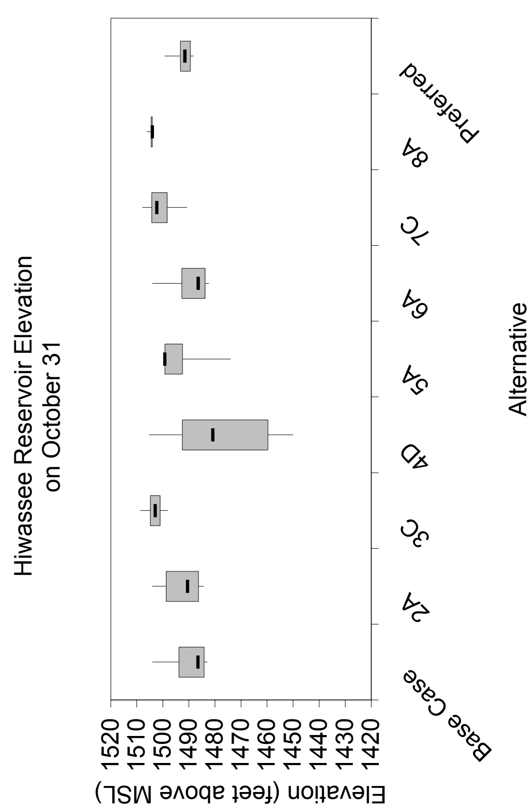

Cherokee Reservoir Elevation
on Labor Day
Elevation (feet above MSL)
1080
1070
1060
1050
1040
1030
1020
1010
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

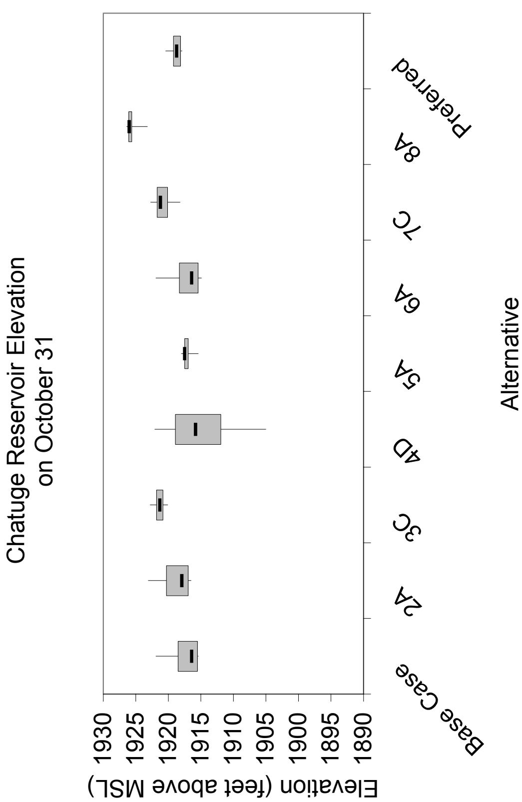

Watauga Reservoir Elevation
on Labor Day
Elevation (feet above MSL)
1965
1960
1955
1950
1945
1940
1935
1930
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative


Blue Ridge Reservoir Elevation
on October 31
Elevation (feet above MSL)
1700
1680
1660
1640
1620
1600
1580
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

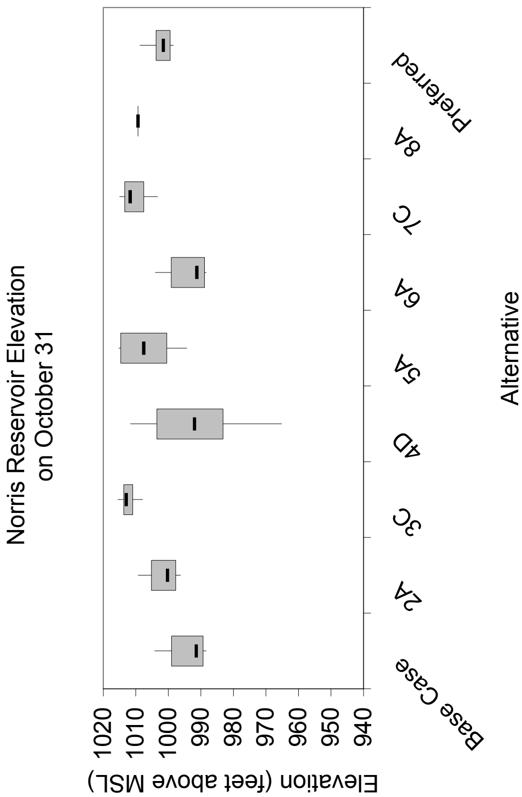

Nottely Reservoir Elevation
on October 31
Elevation (feet above MSL)
1790
1780
1770
1760
1750
1740
1730
1720
1710
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative


Tims Ford Reservoir Elevation
on October 31
Elevation (feet above MSL)
884
882
880
878
876
874
872
870
868
866
864
862
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

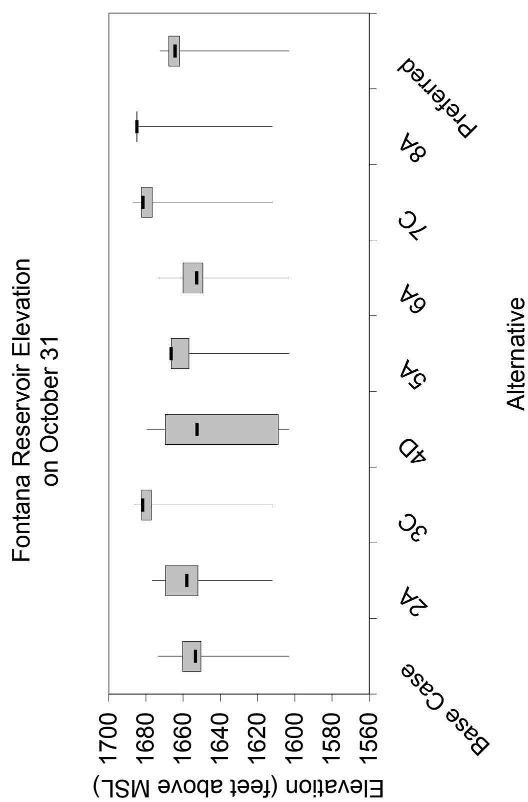

Hiwassee Reservoir Elevation
on October 31
Elevation (feet above MSL)
1520
1510
1500
1490
1480
1470
1460
1450
1440
1430
1420
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative



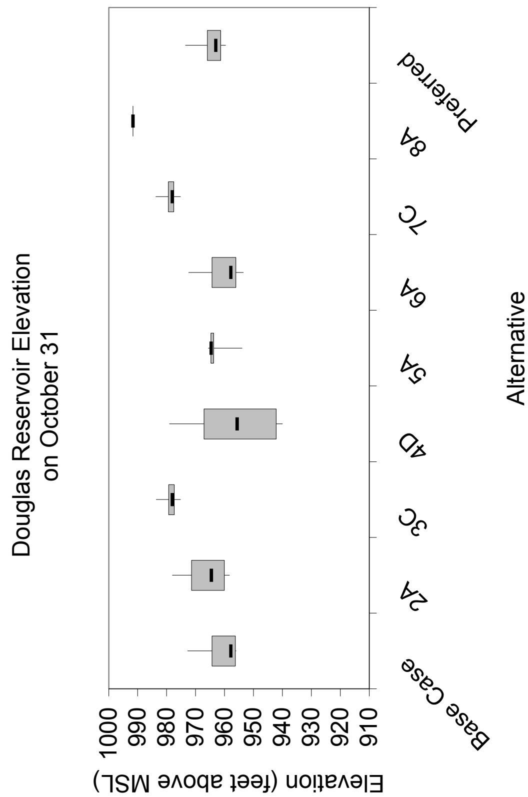
Chatuge Reservoir Elevation
on October 31
Elevation (feet above MSL)
1930
1925
1920
1915
1910
1905
1900
1895
1890
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative



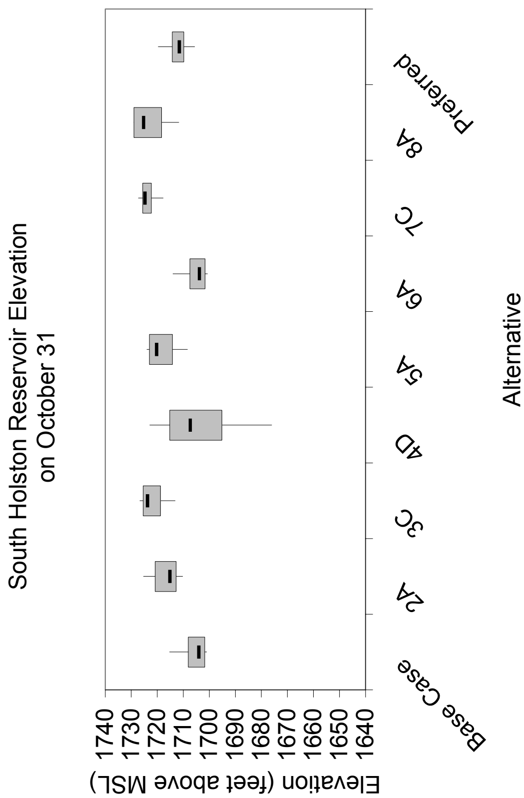
Norris Reservoir Elevation
on October 31
Elevation (feet above MSL)
1020
1010
1000
990
980
970
960
950
940
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

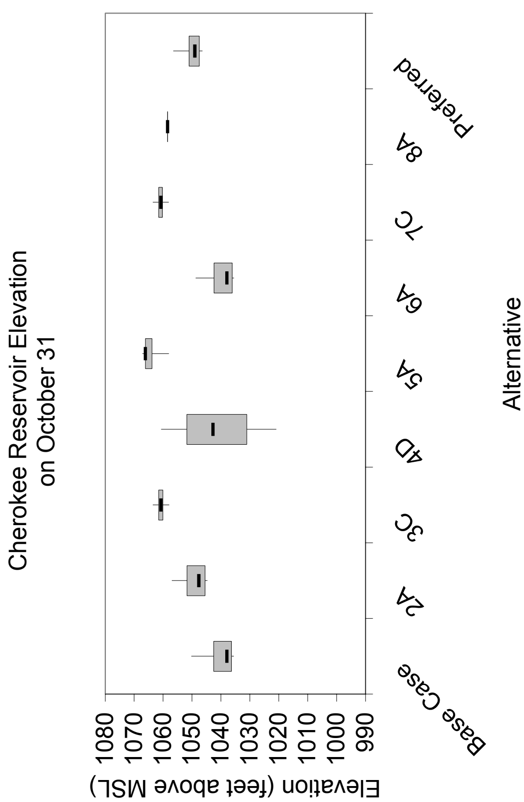


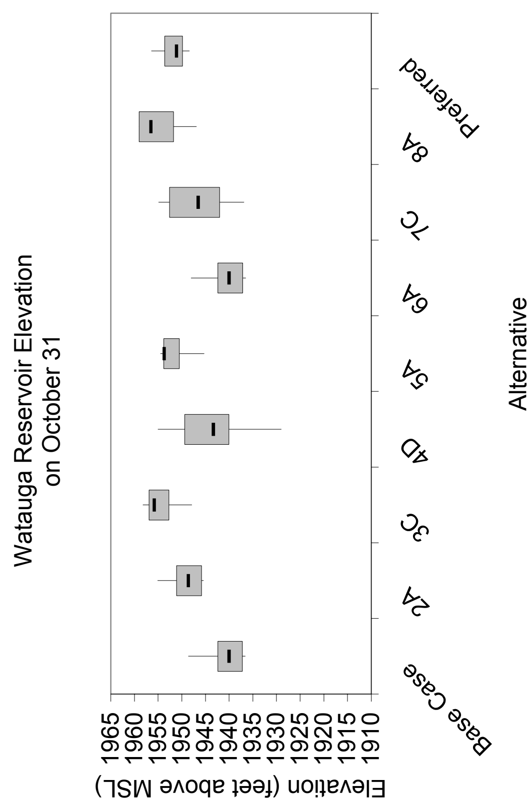
Fontana Reservoir Elevation
on October 31
Elevation (feet above MSL)
1700
1680
1660
1640
1620
1600
1580
1560
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

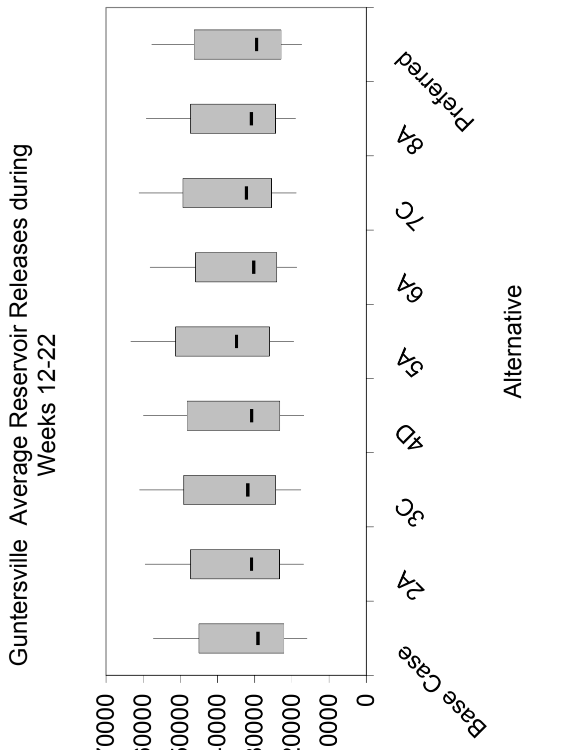


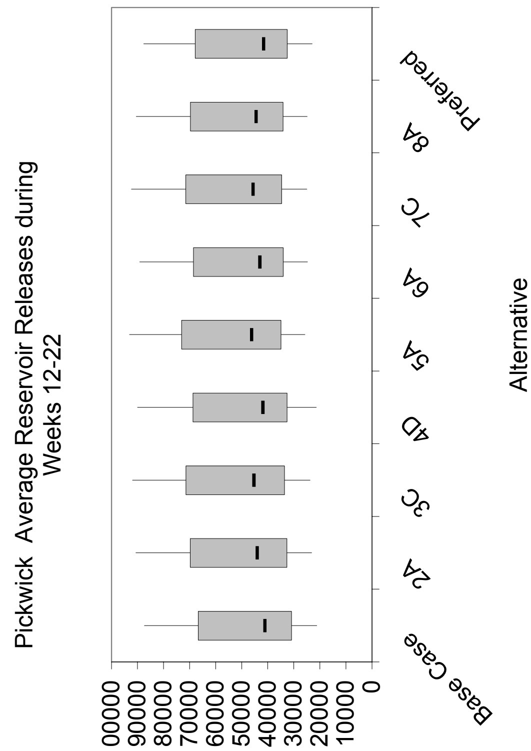
Douglas Reservoir Elevation
on October 31
Elevation (feet above MSL)
1000
990
980
970
960
950
940
930
920
910
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

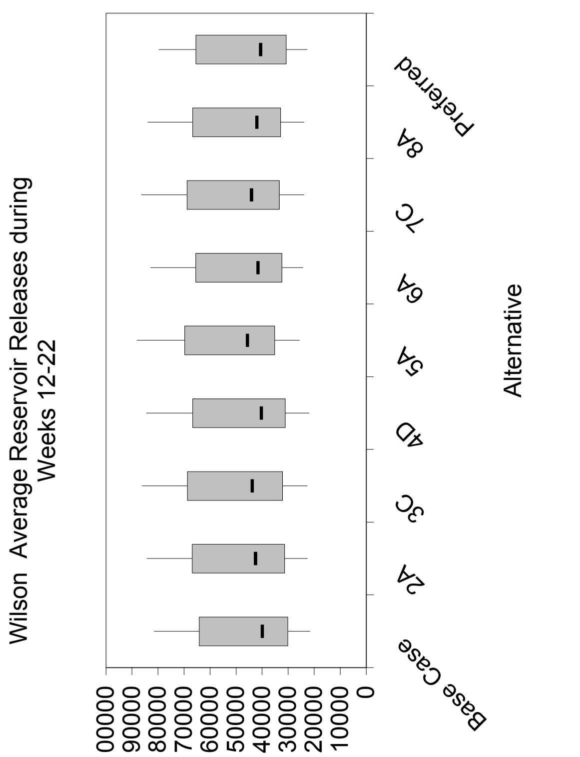

South Holston Reservoir Elevation
on October 31
Elevation (feet above MSL)
1740
1730
1720
1710
1700
1690
1680
1670
1660
1650
1640
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

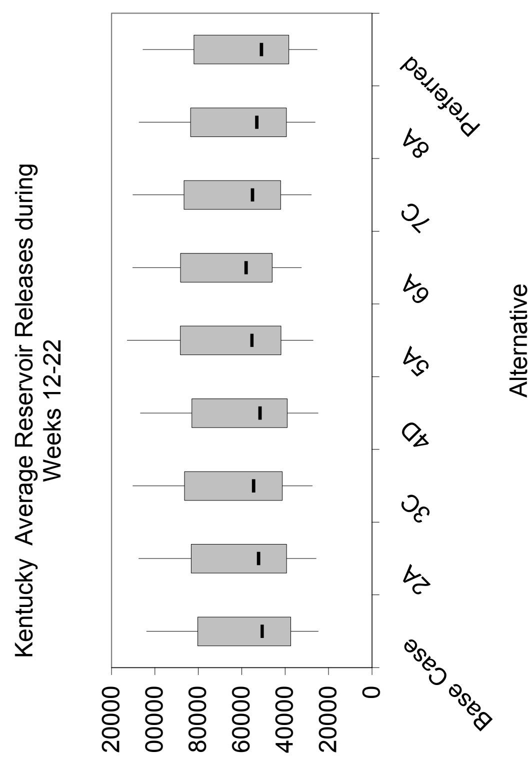

Cherokee Reservoir Elevation
on October 31
Elevation (feet above MSL)
1080
1070
1060
1050
1040
1030
1020
1010
1000
990
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

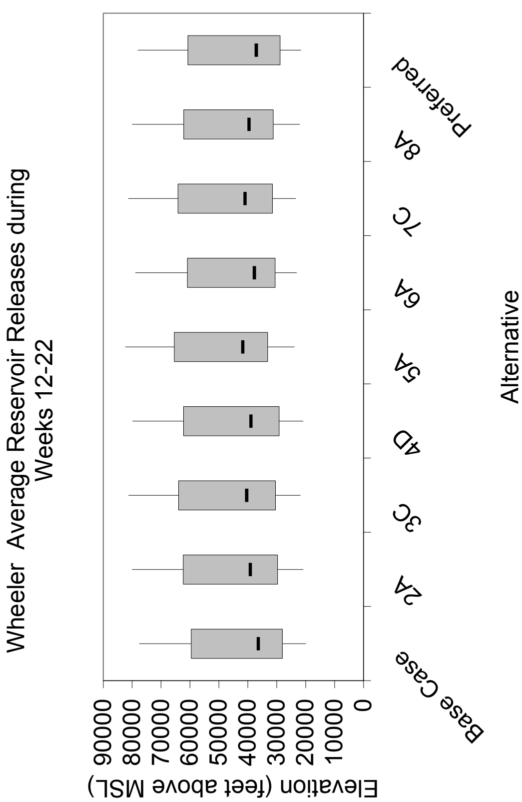

Watauga Reservoir Elevation
on October 31
Elevation (feet above MSL)
1965
1960
1955
1950
1945
1940
1935
1930
1925
1920
1915
1910
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

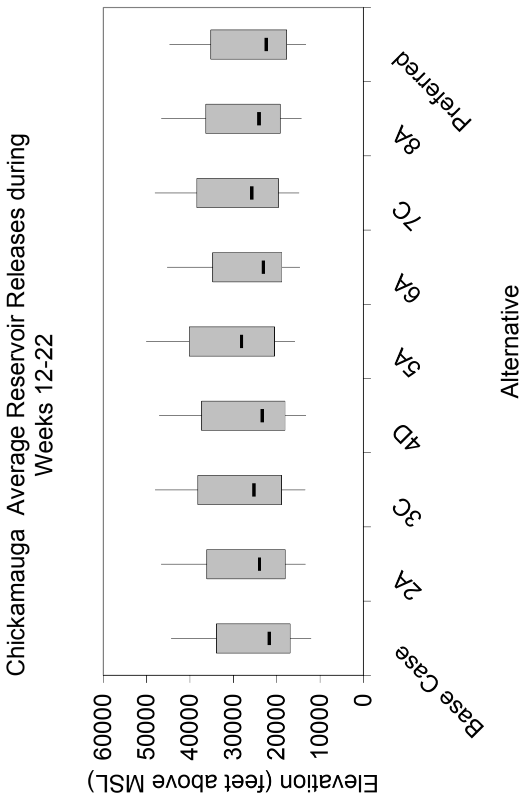

Guntersville Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
70000
60000
50000
40000
30000
20000
10000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

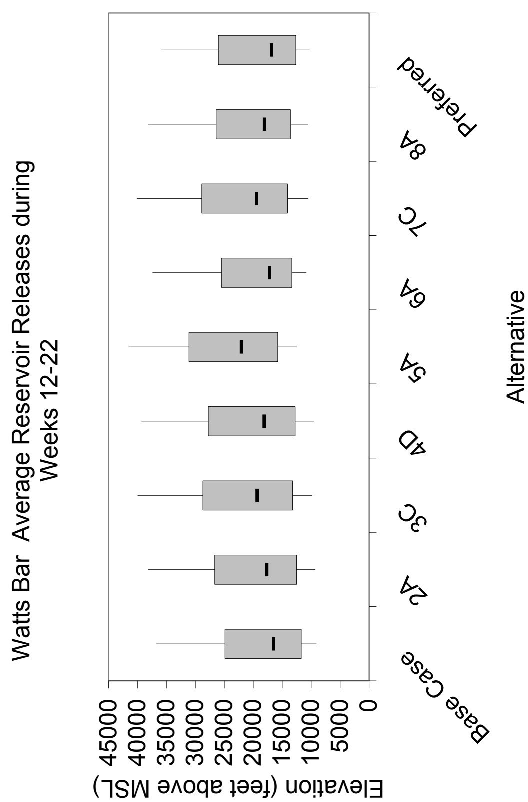

Pickwick Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

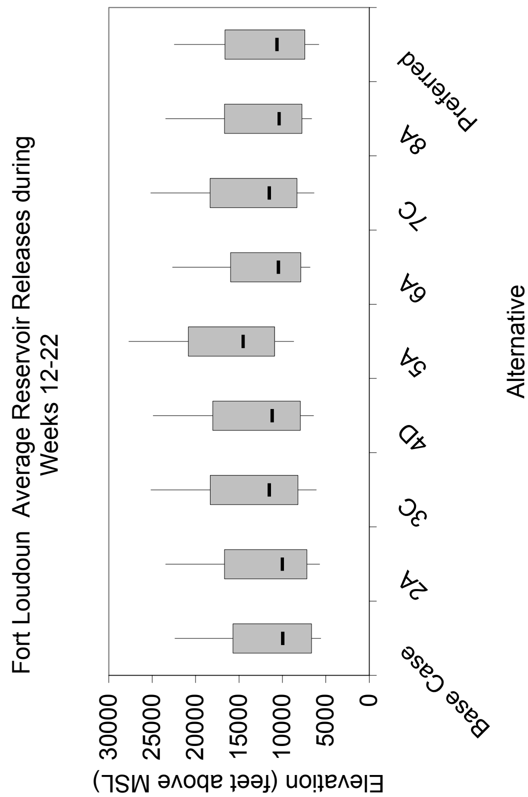

Wilson Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

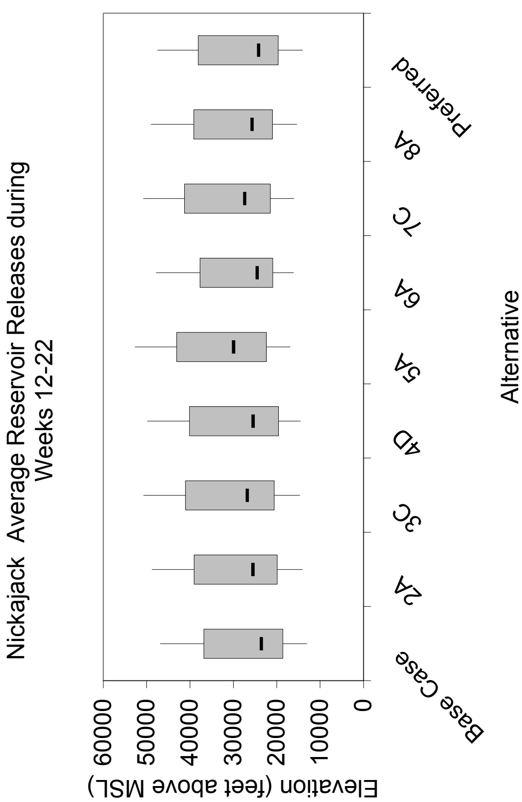

Kentucky Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
120000
100000
80000
60000
40000
20000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

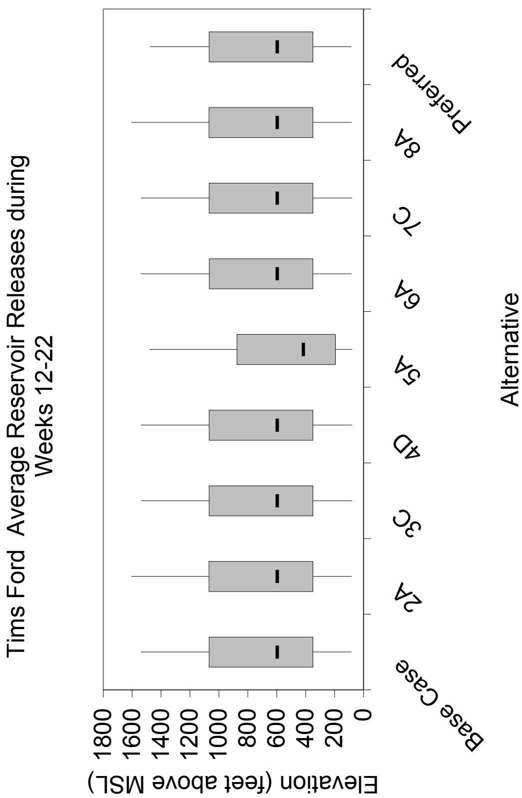

Wheeler Average Reservoir Releases during Weeks 12-22
Elevation (feet above MSL)
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

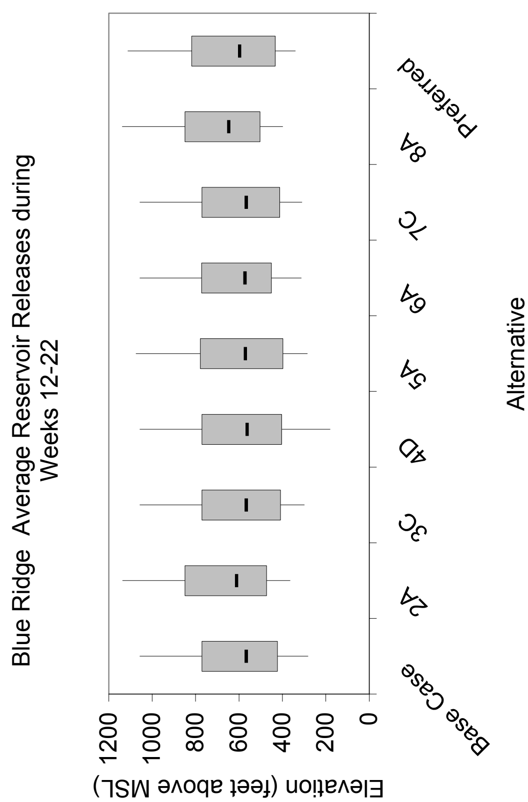

Chickamauga Average Reservoir Releases during Weeks 12-22
Elevation (feet above MSL)
60000
50000
40000
30000
20000
10000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

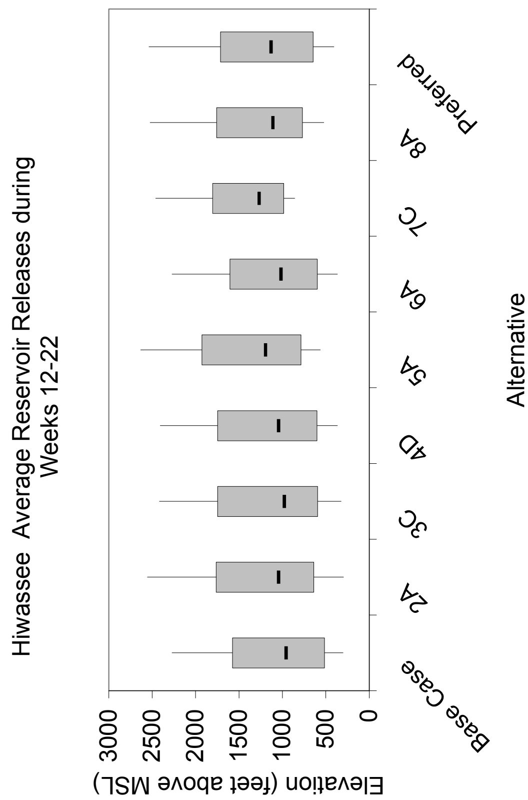

Watts Bar Average Reservoir Releases during Weeks 12-22
Elevation (feet above MSL)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

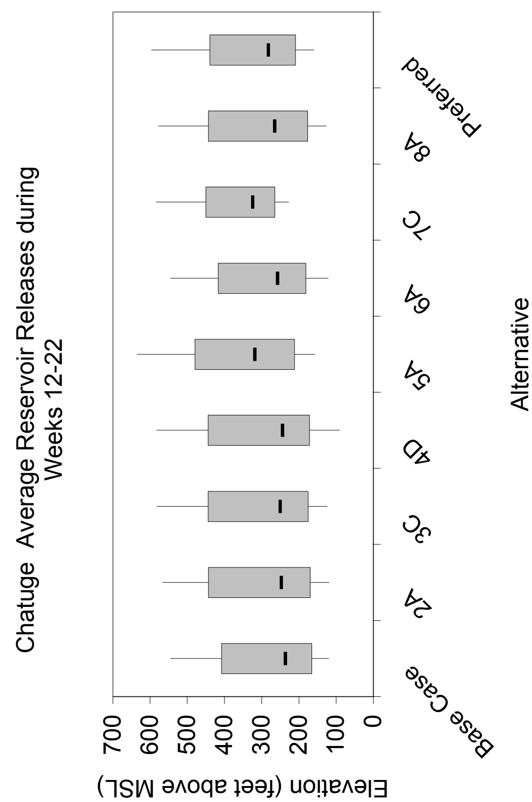

Fort Loudoun Average Reservoir Releases during Weeks 12-22
Elevation (feet above MSL)
30000
25000
20000
15000
10000
5000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

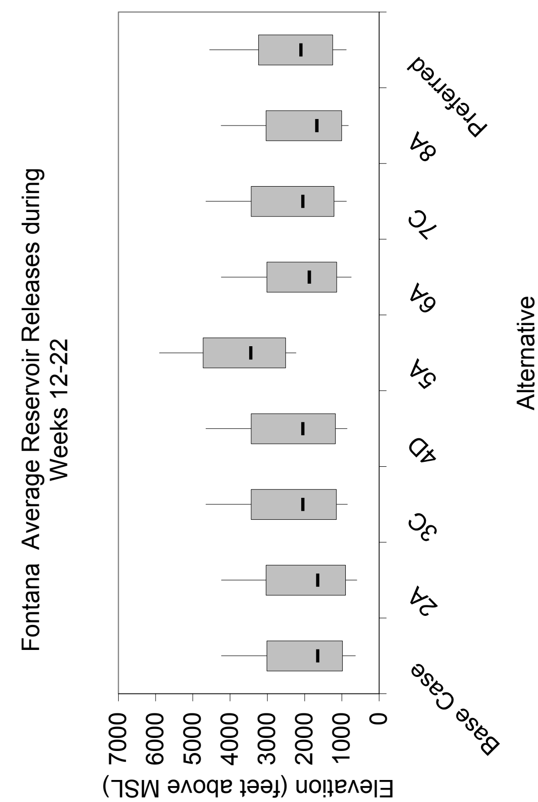

Nickajack Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
60000
50000
40000
30000
20000
10000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

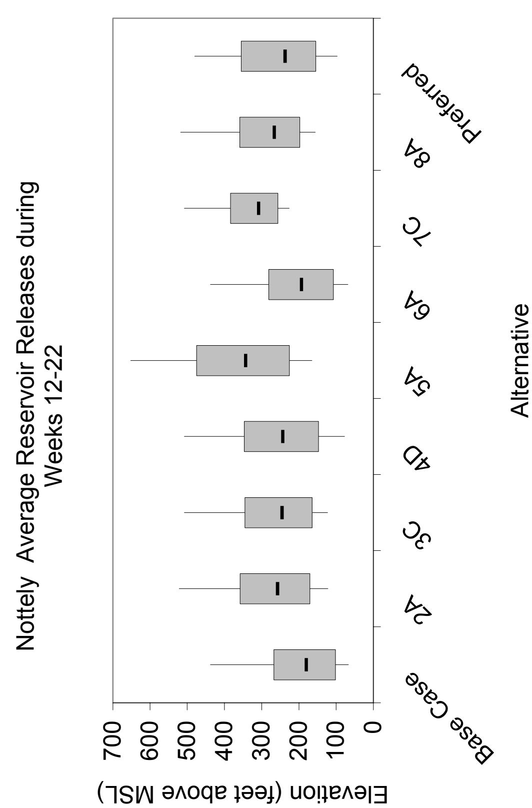

Tims Ford Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
1800
1600
1400
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

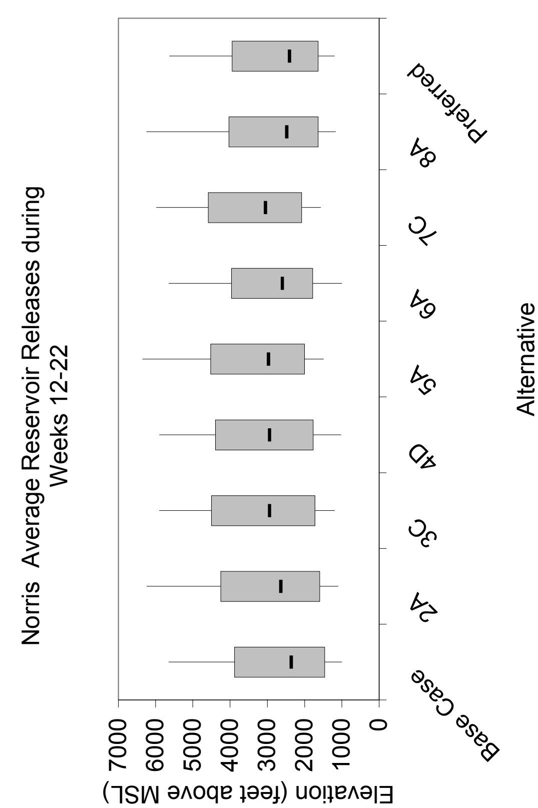

Blue Ridge Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

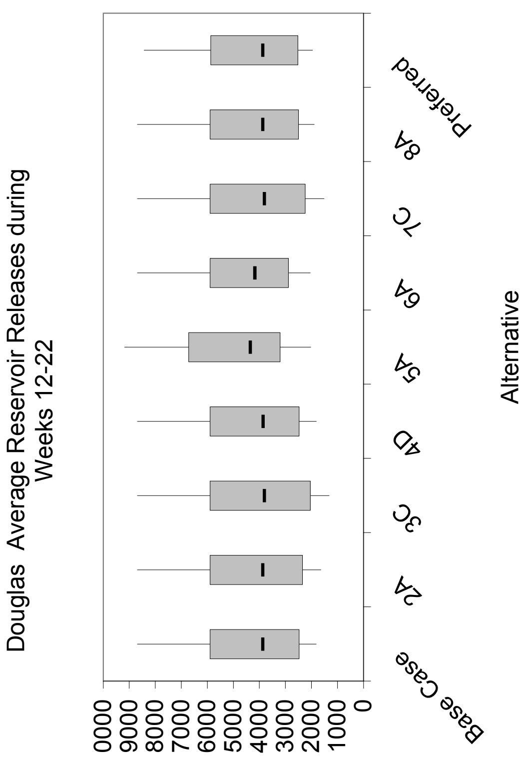

Hiwassee Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

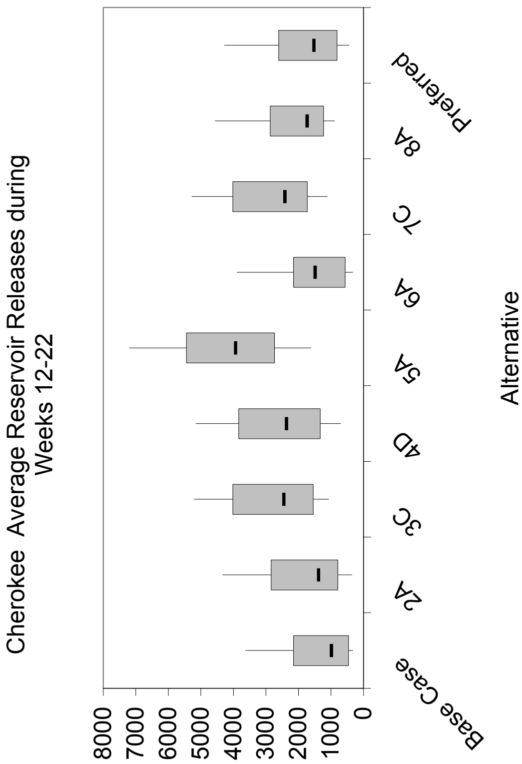

Chatuge Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
700
600
500
400
300
200
100
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

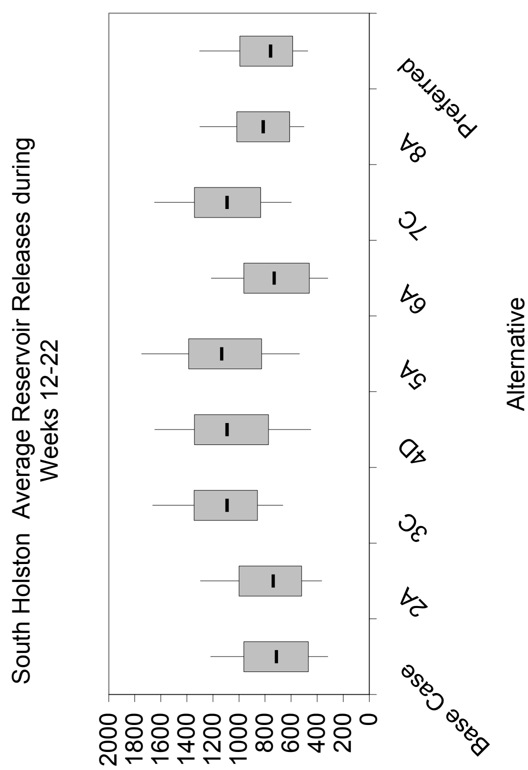

Fontana Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
7000
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

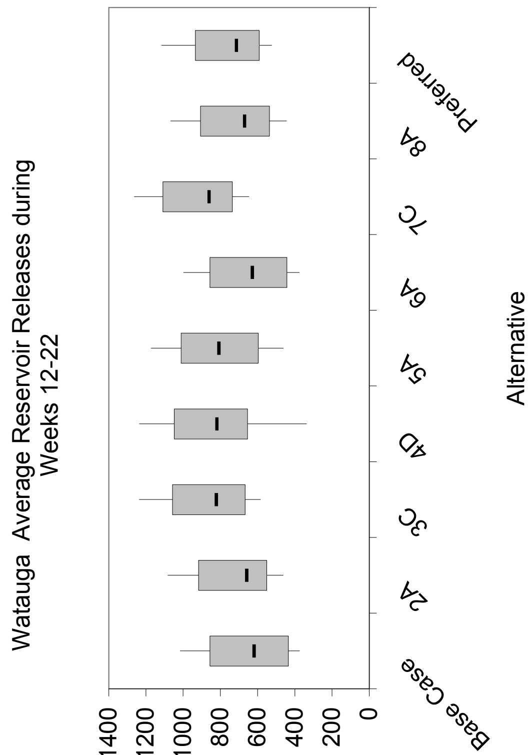

Nottely Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
700
600
500
400
300
200
100
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

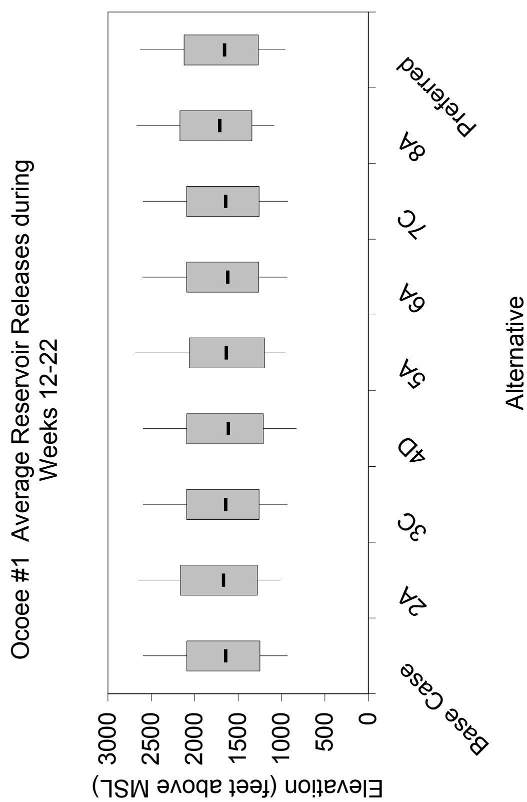

Norris Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
7000
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

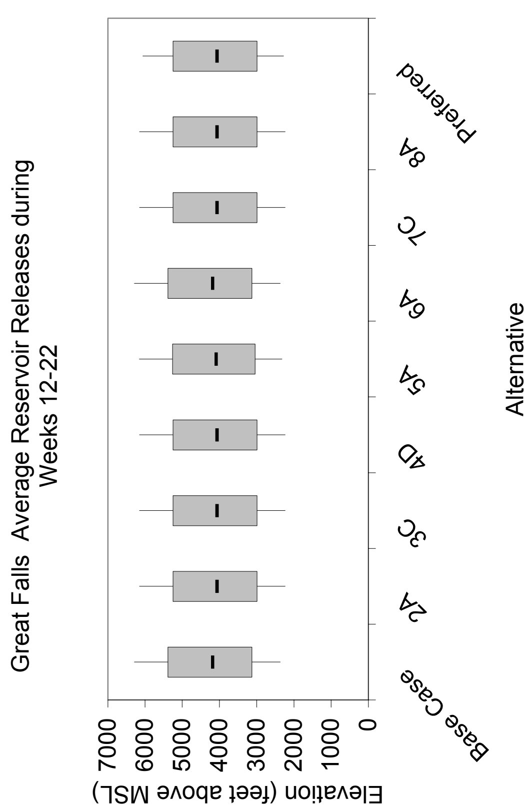

Douglas Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

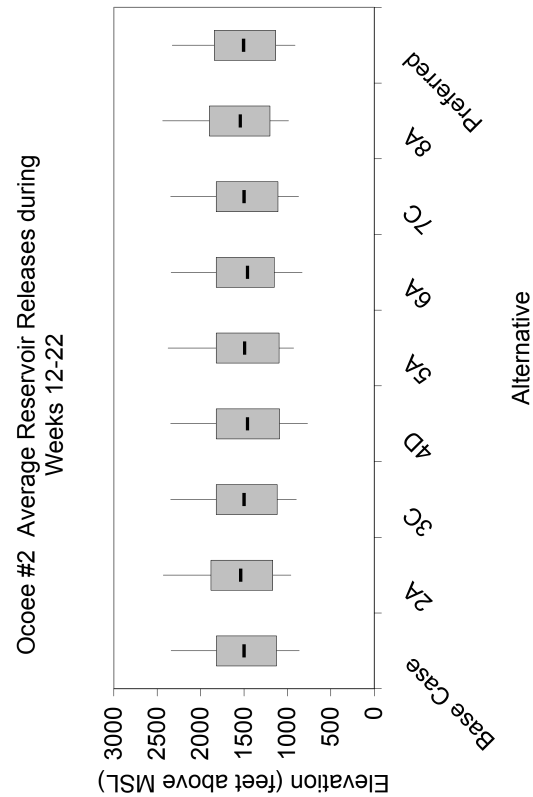

Cherokee Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
8000
7000
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

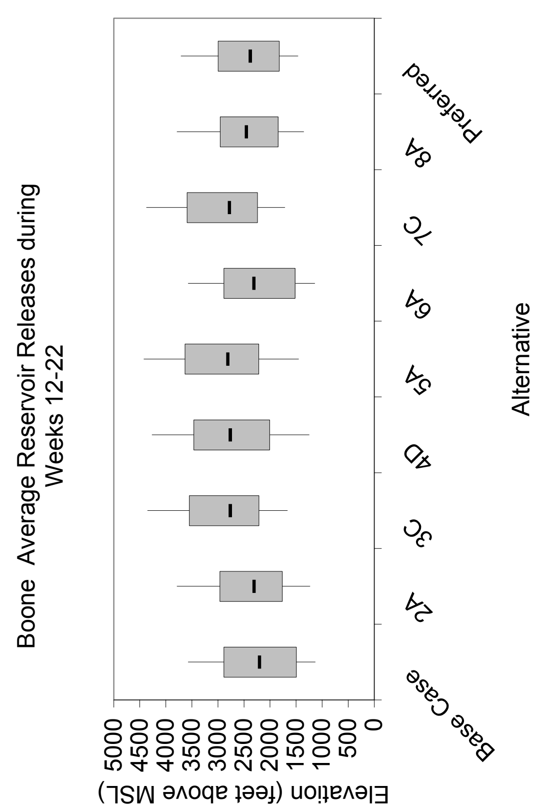

South Holston Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

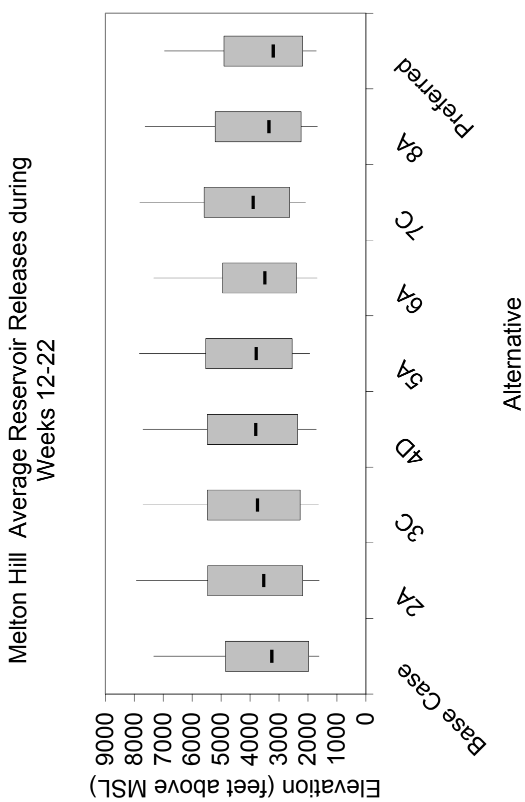

Watauga Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
1400
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

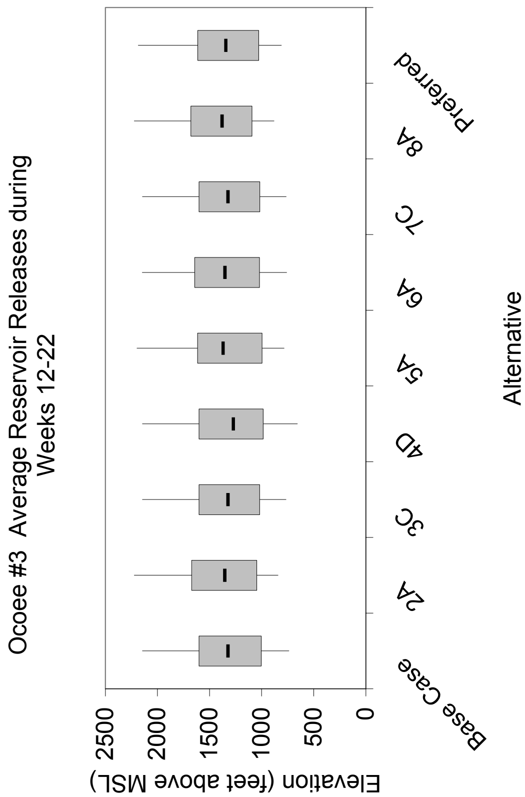

Ocoee #1 Average Reservoir Releases during Weeks 12-22
Elevation (feet above MSL)
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

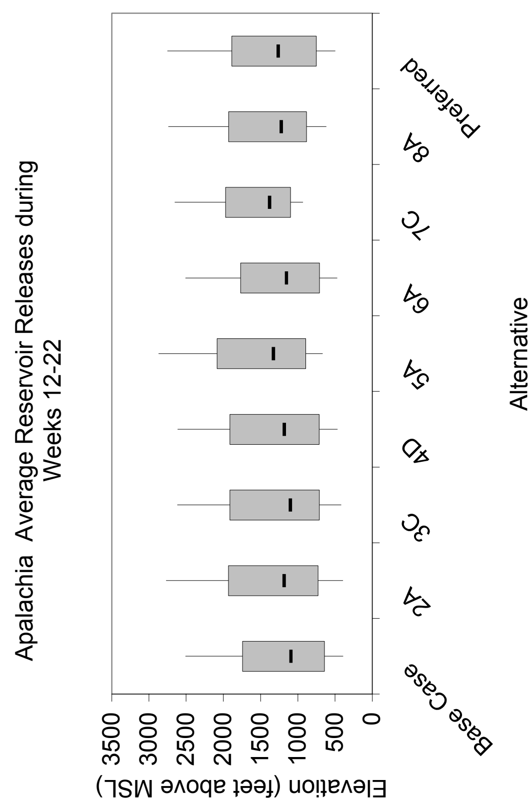

Great Falls Average Reservoir Releases during Weeks 12-22
Elevation (feet above MSL)
7000
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

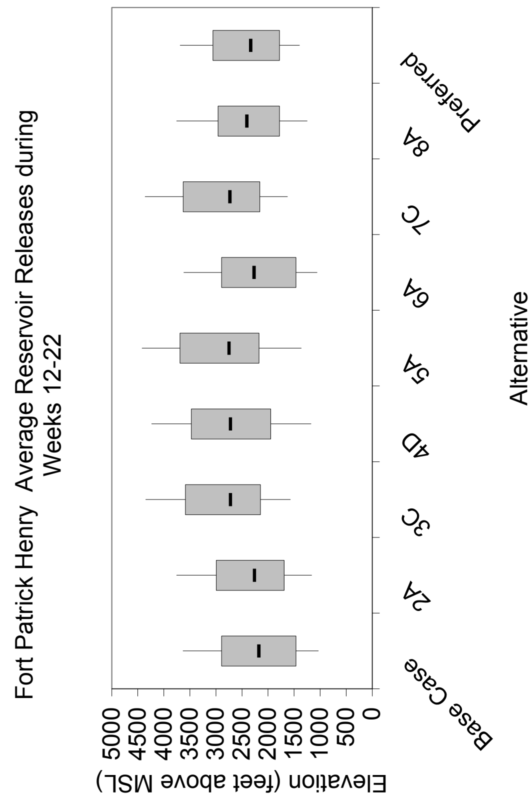

Ocoee #2 Average Reservoir Releases during Weeks 12-22
Elevation (feet above MSL)
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

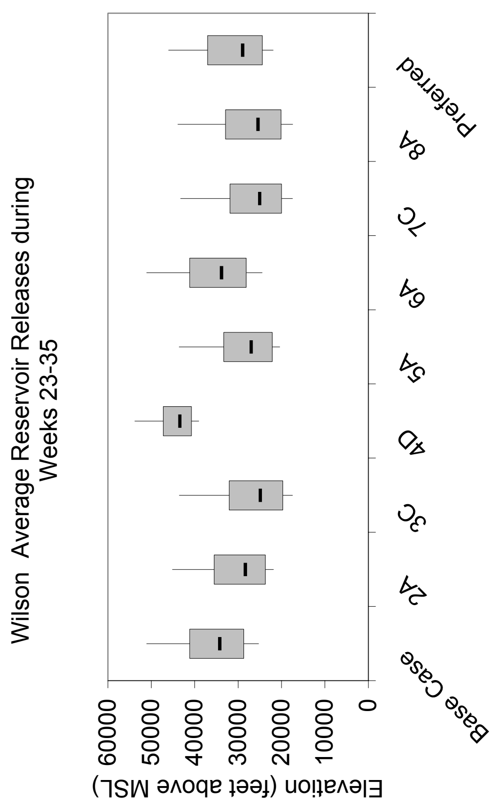

Boone Average Reservoir Releases during Weeks 12-22
Elevation (feet above MSL)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

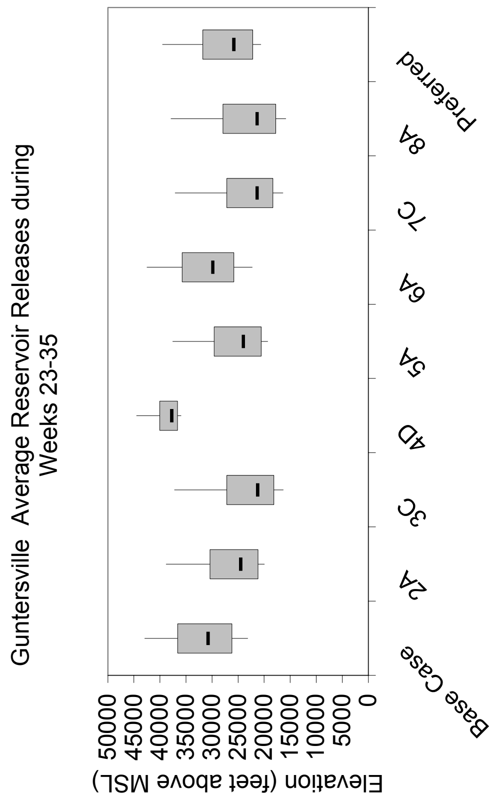

Melton Hill Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

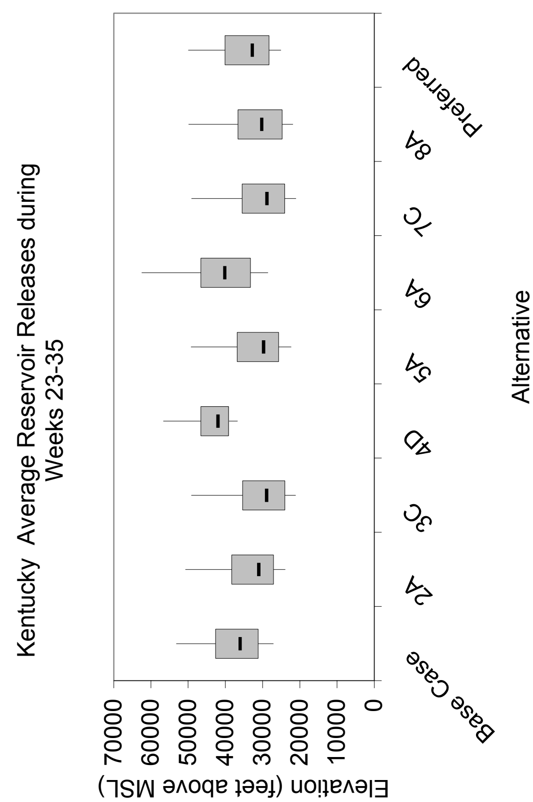

Ocoee #3 Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

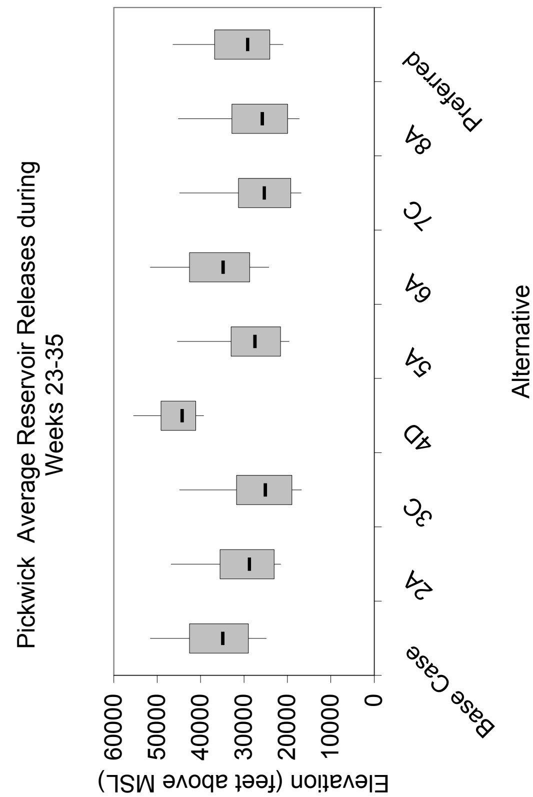

Apalachia Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
3500
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

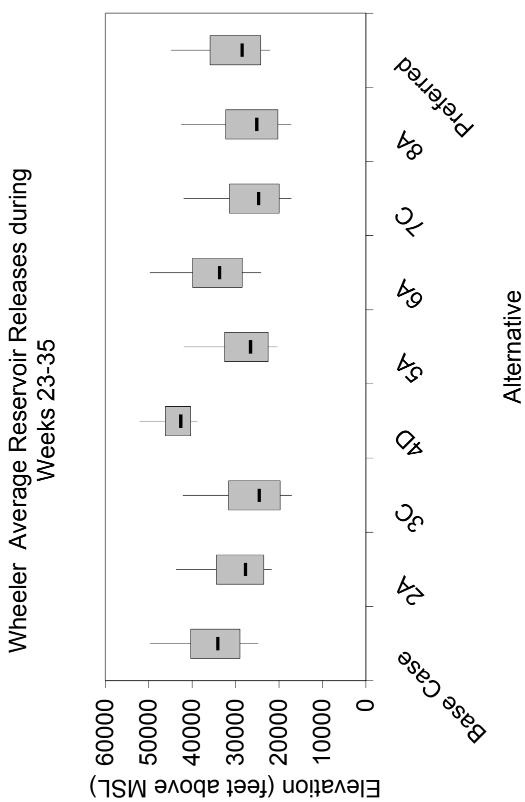

Fort Patrick Henry Average Reservoir Releases during
Weeks 12-22
Elevation (feet above MSL)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

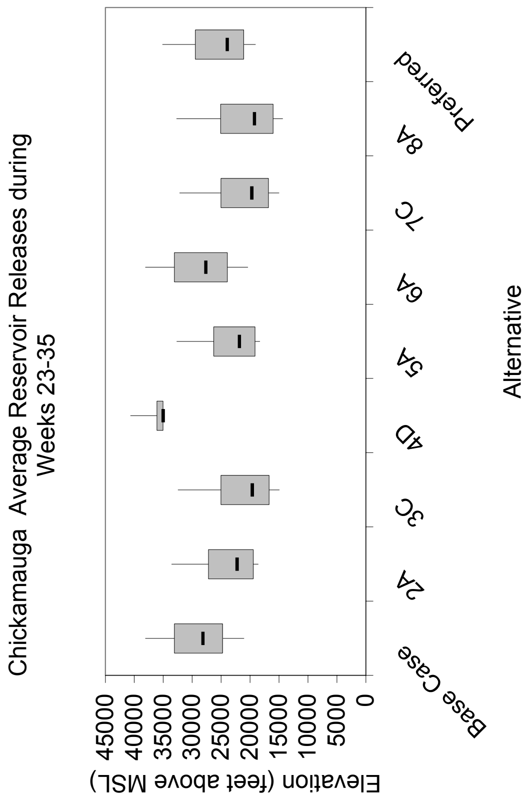

Wilson Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
60000
50000
40000
30000
20000
10000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

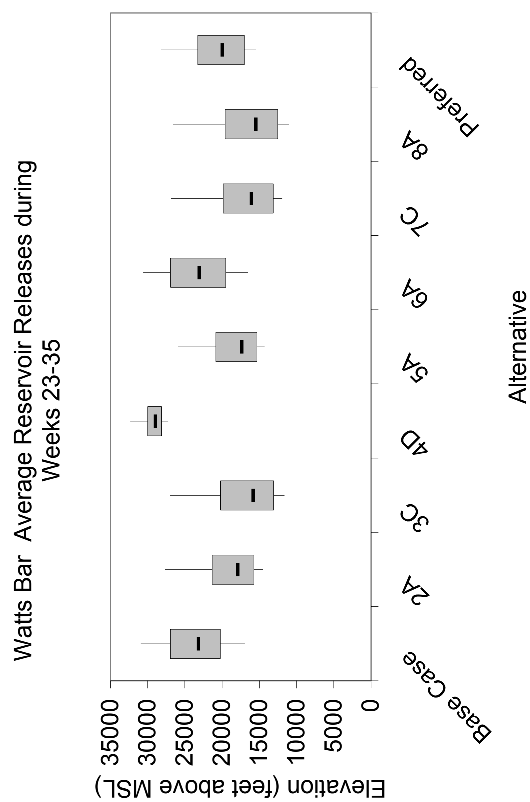

Guntersville Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

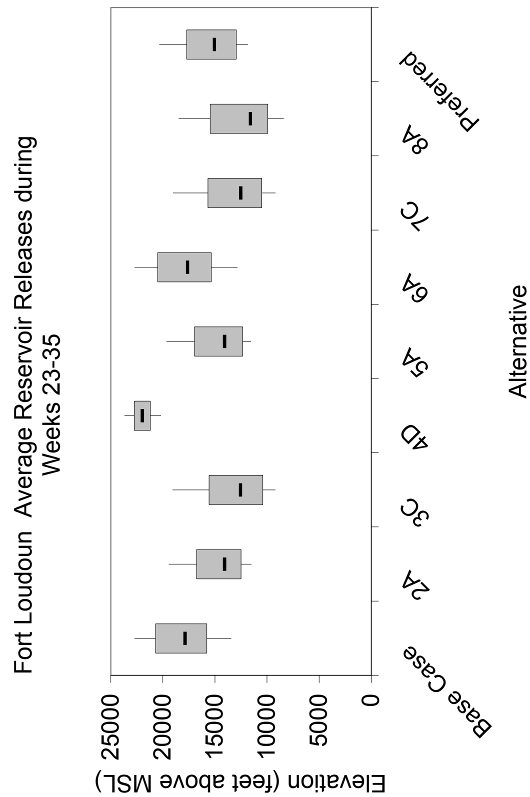

Kentucky Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
70000
60000
50000
40000
30000
20000
10000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

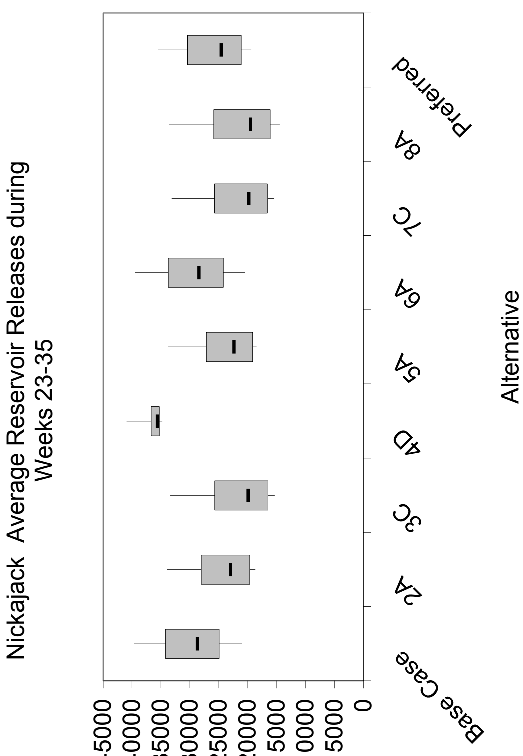

Pickwick Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
60000
50000
40000
30000
20000
10000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

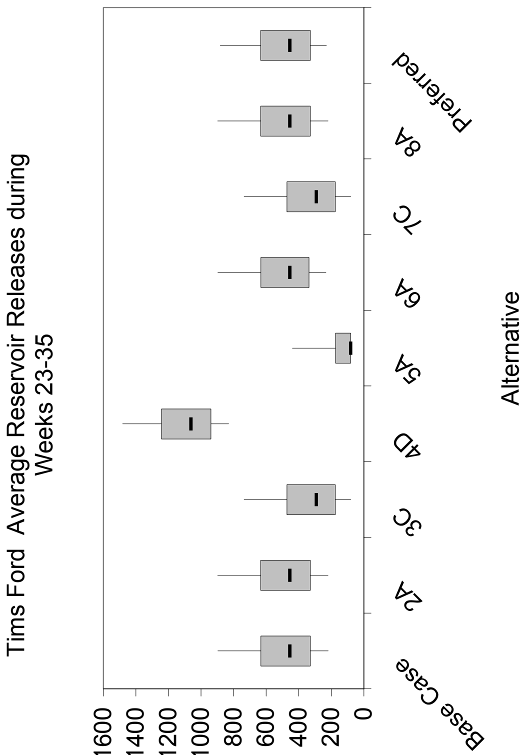

Wheeler Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
60000
50000
40000
30000
20000
10000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

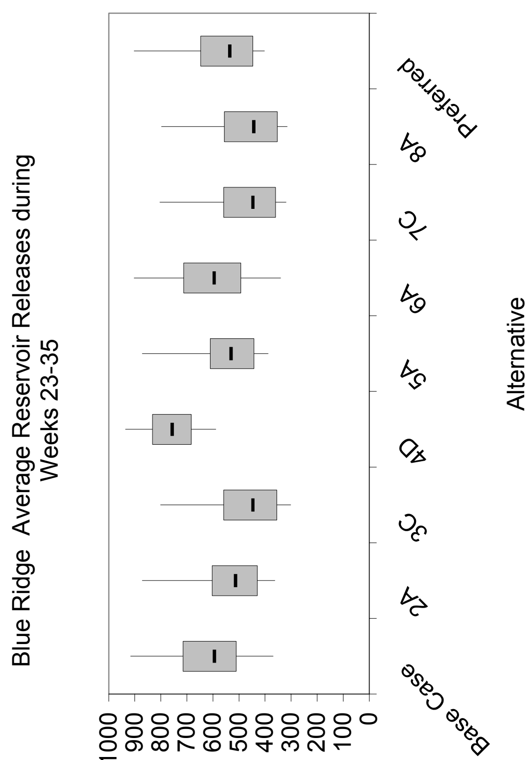

Chickamauga Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

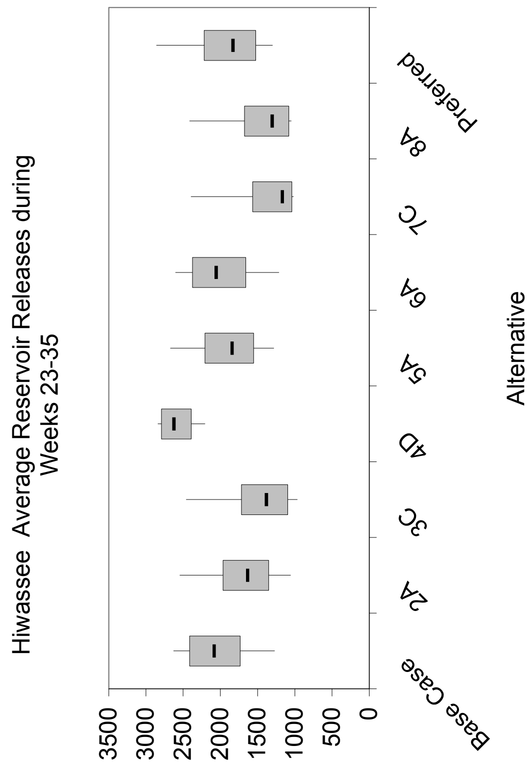

Watts Bar Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
35000
30000
25000
20000
15000
10000
5000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

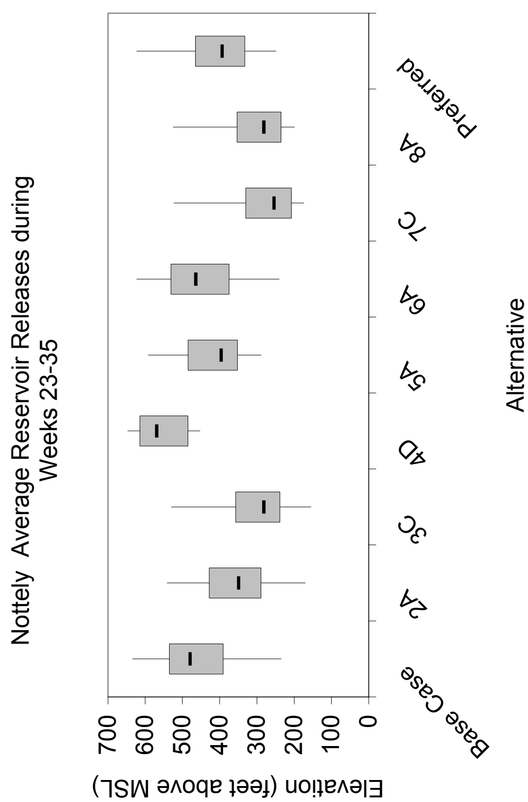

Fort Loudoun Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
25000
20000
15000
10000
5000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

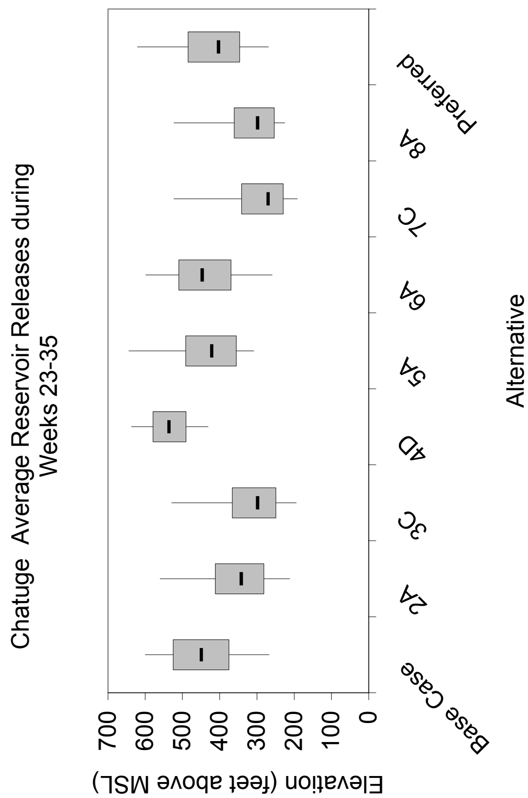

Nickajack Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

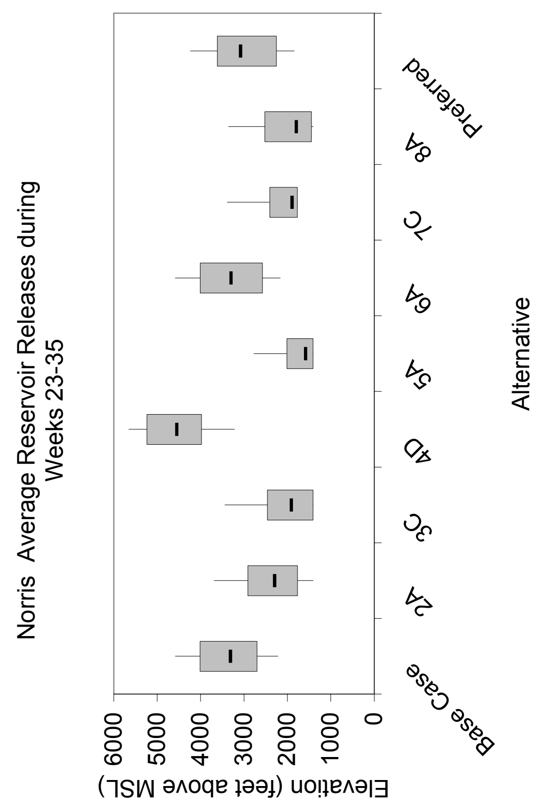

Tims Ford Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
1600
1400
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

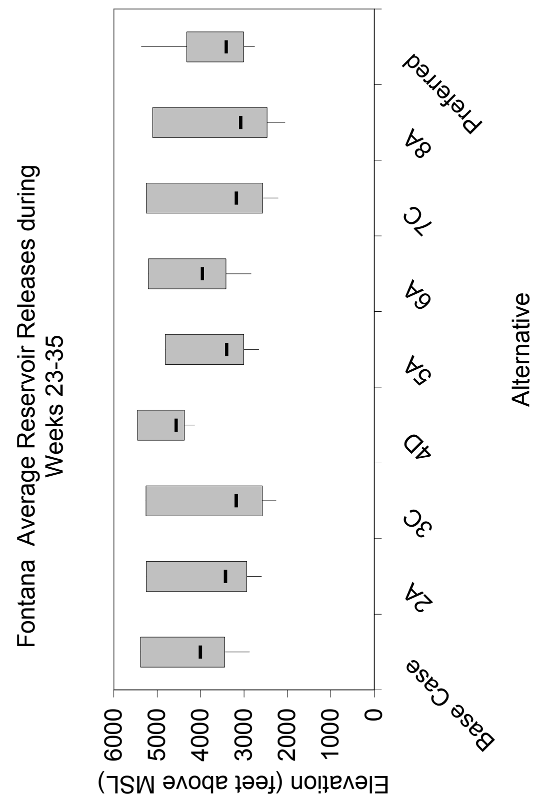

Blue Ridge Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
1000
900
800
700
600
500
400
300
200
100
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

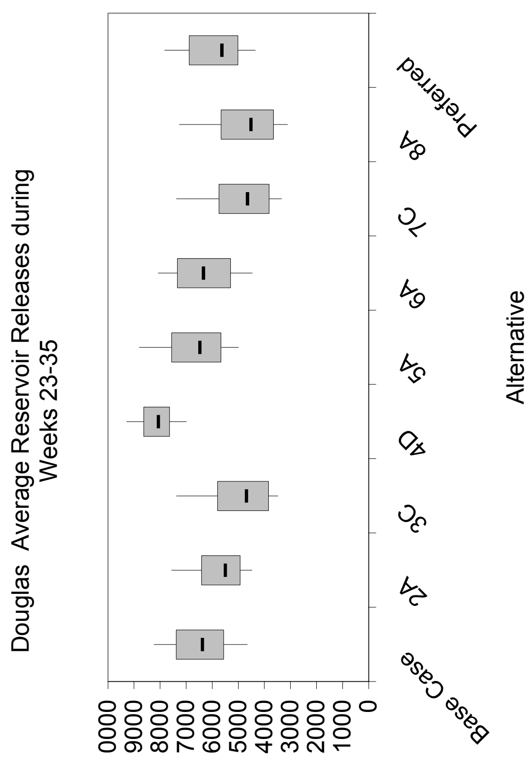

Hiwassee Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
3500
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

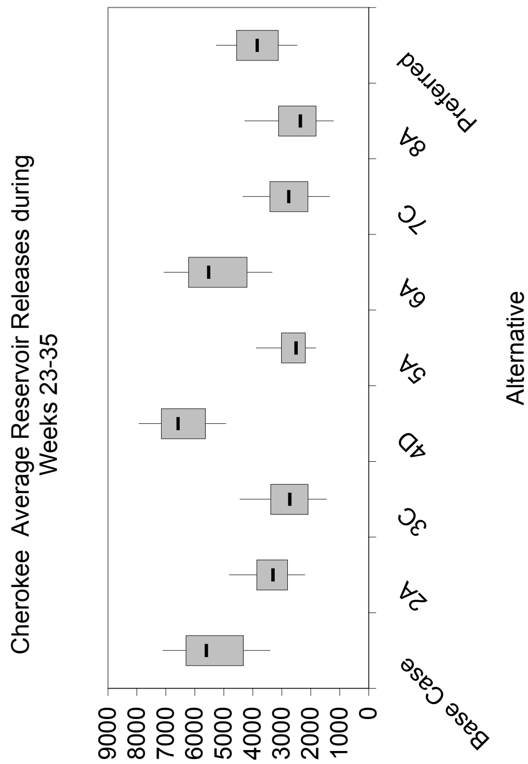

Nottely Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
700
600
500
400
300
200
100
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

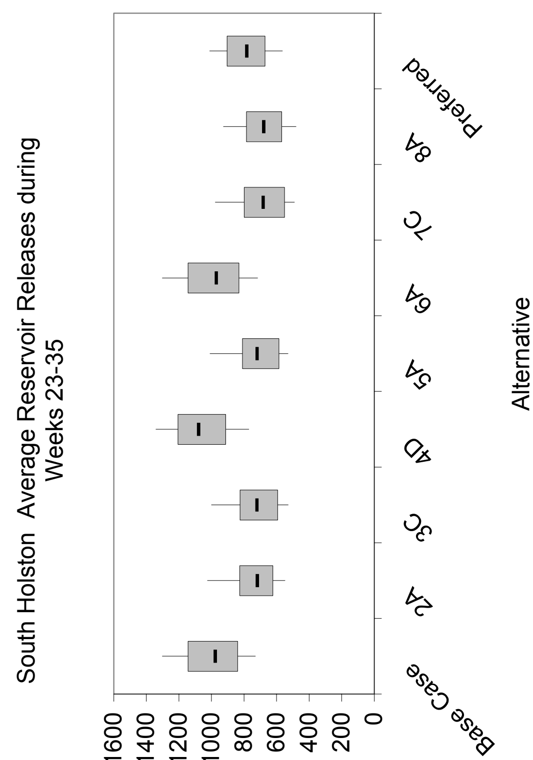

Chatuge Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
700
600
500
400
300
200
100
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

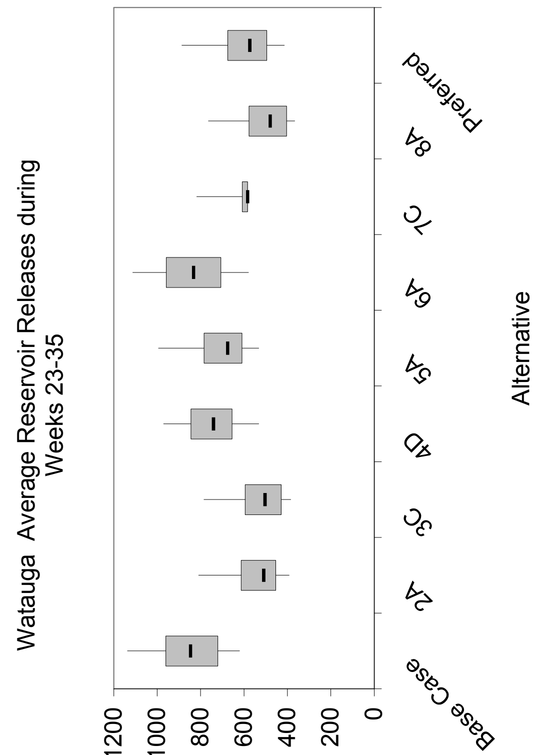

Norris Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

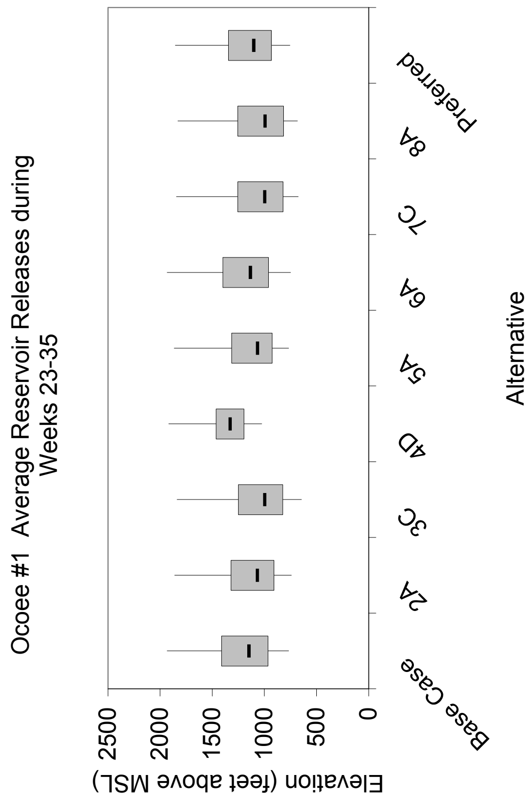

Fontana Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

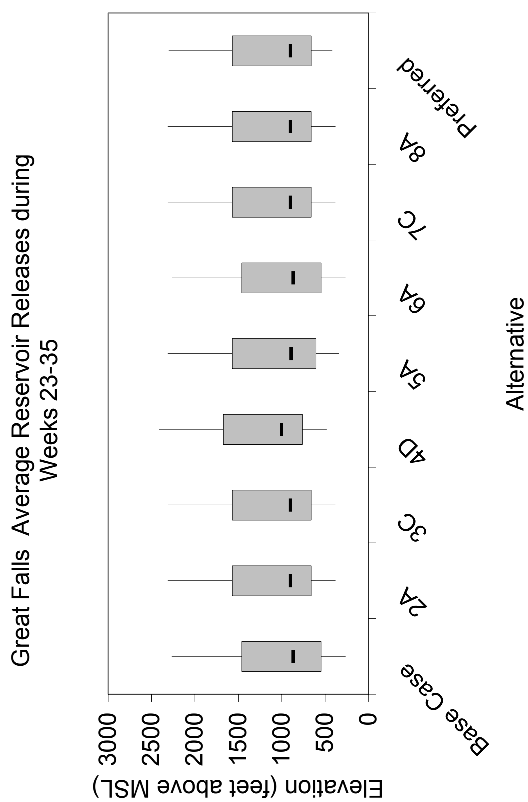

Douglas Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

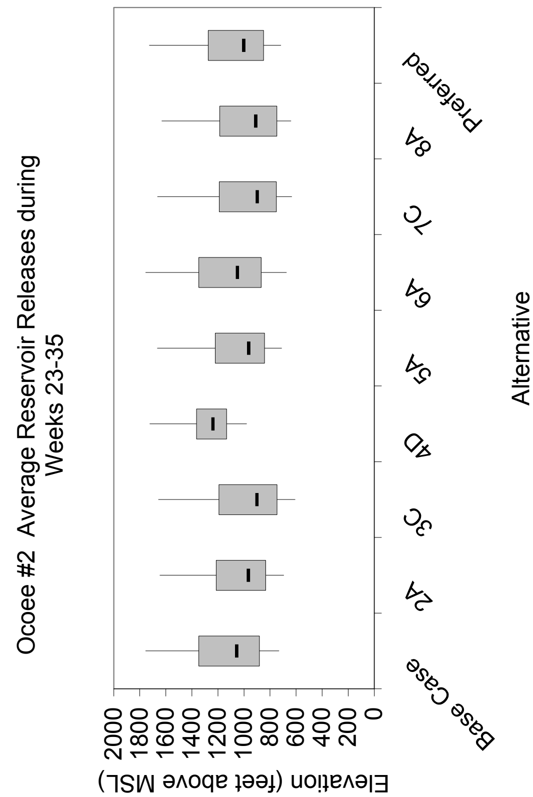

Cherokee Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

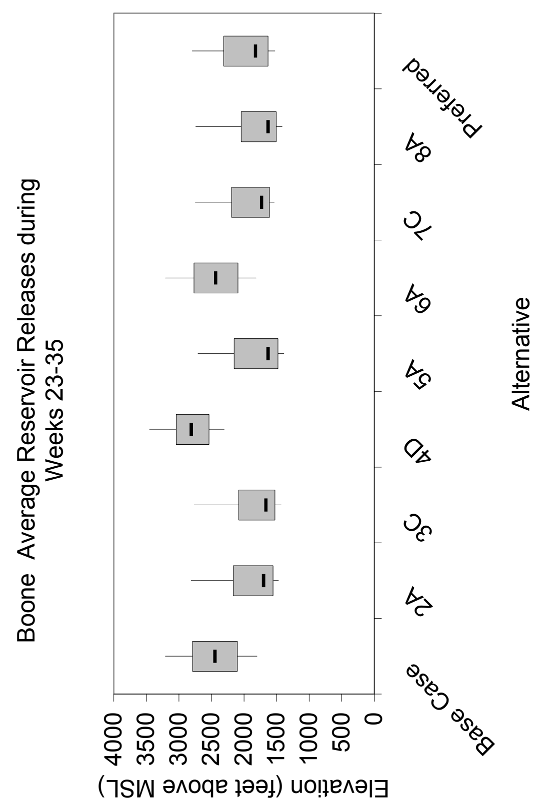

South Holston Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
1600
1400
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

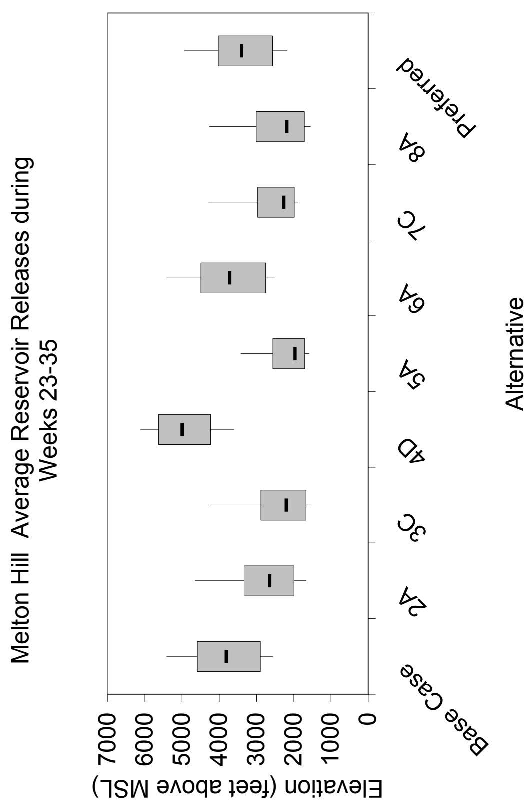

Watauga Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

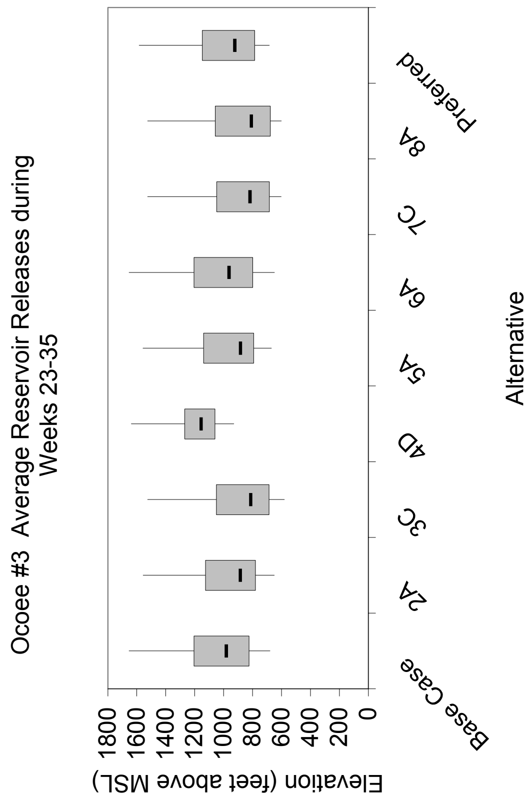

Ocoee #1 Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

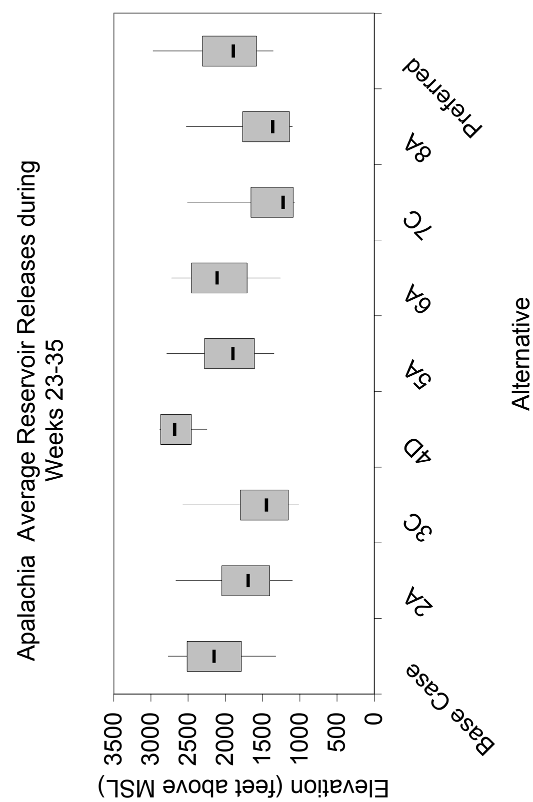

Great Falls Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

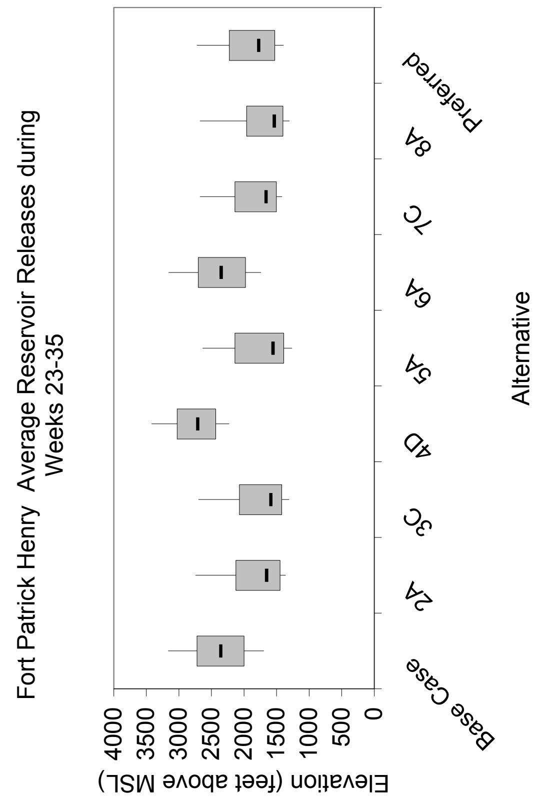

Ocoee #2 Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

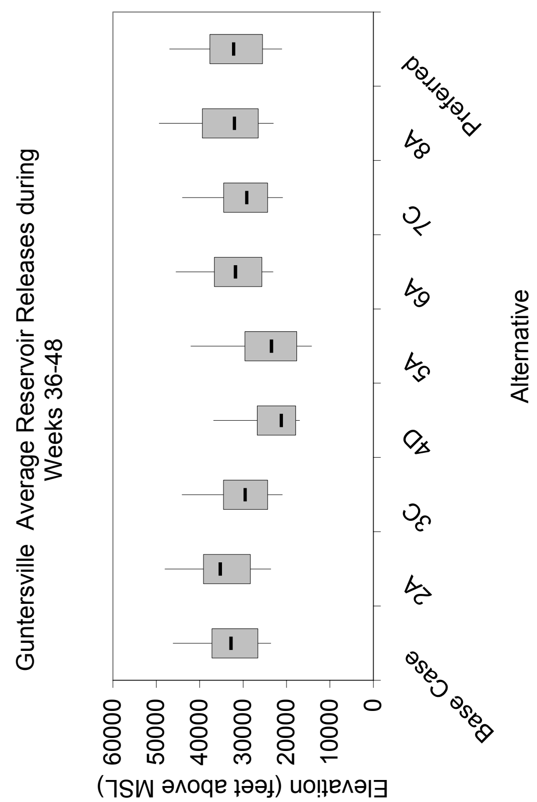

Boone Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
4000
3500
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

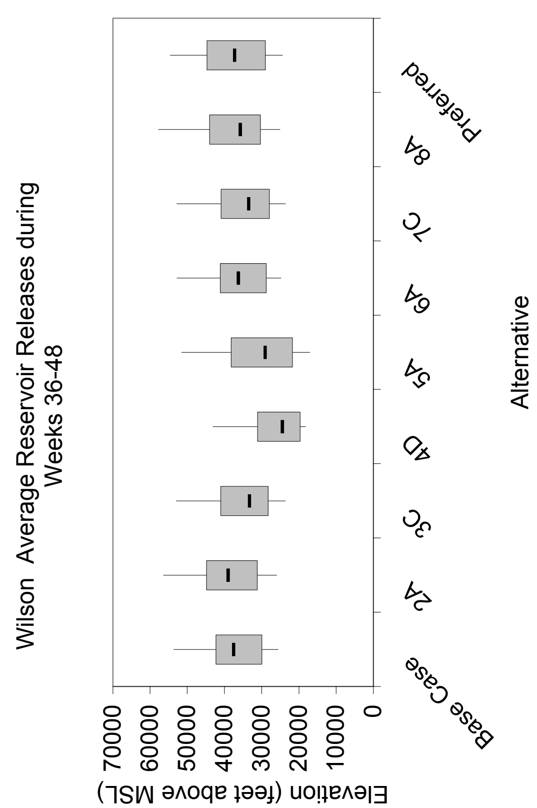

Melton Hill Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
7000
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

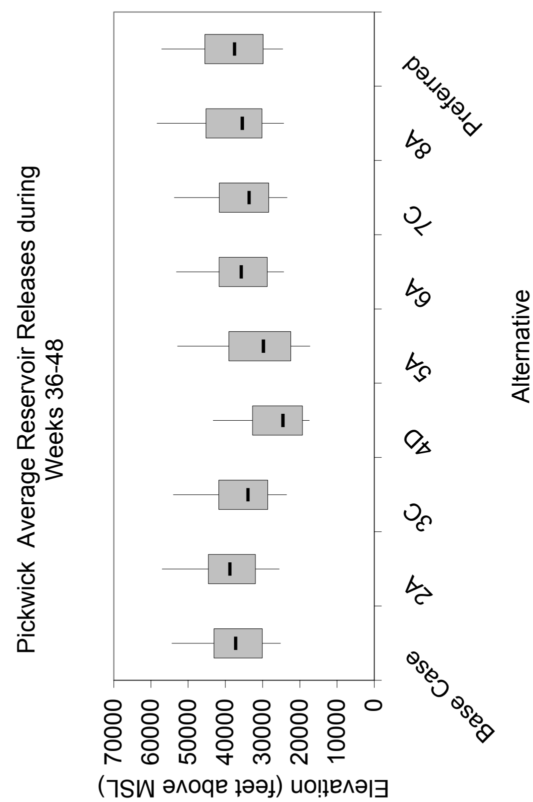

Ocoee #3 Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
1800
1600
1400
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

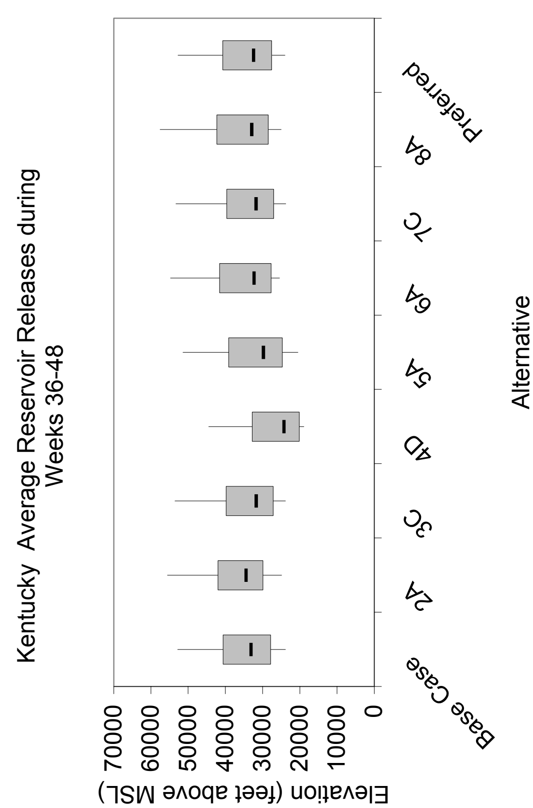

Apalachia Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
3500
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

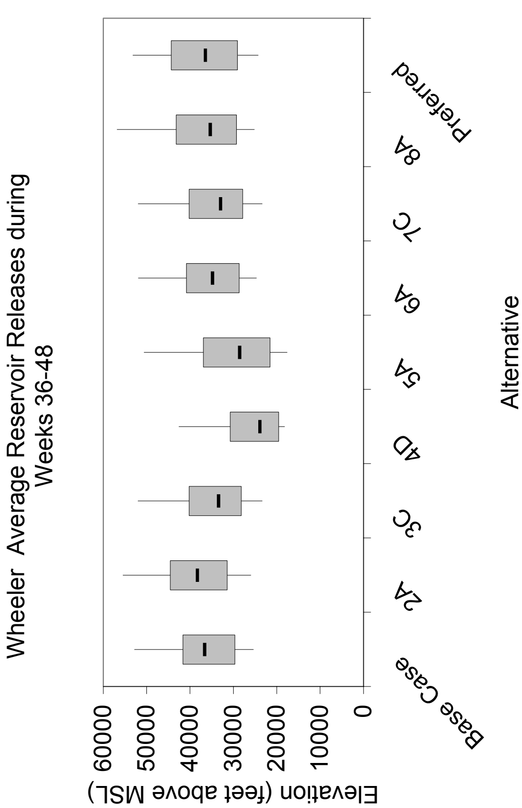

Fort Patrick Henry Average Reservoir Releases during
Weeks 23-35
Elevation (feet above MSL)
4000
3500
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

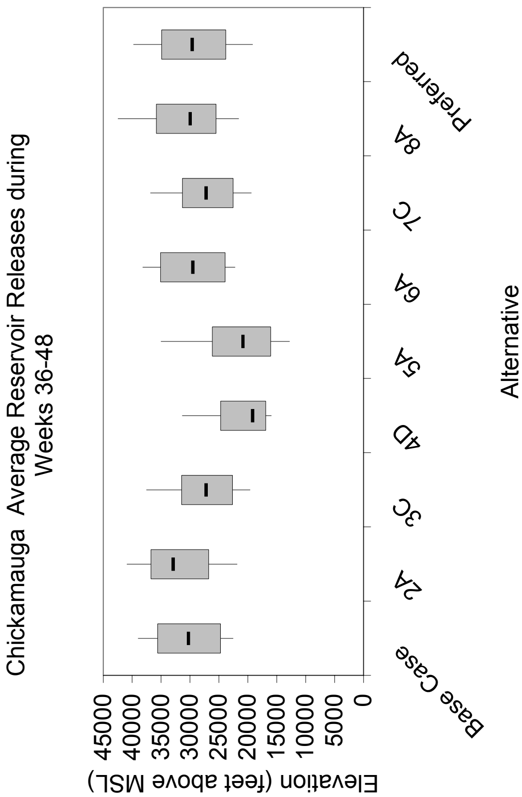

Guntersville Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
0
10000
20000
30000
40000
50000
60000
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

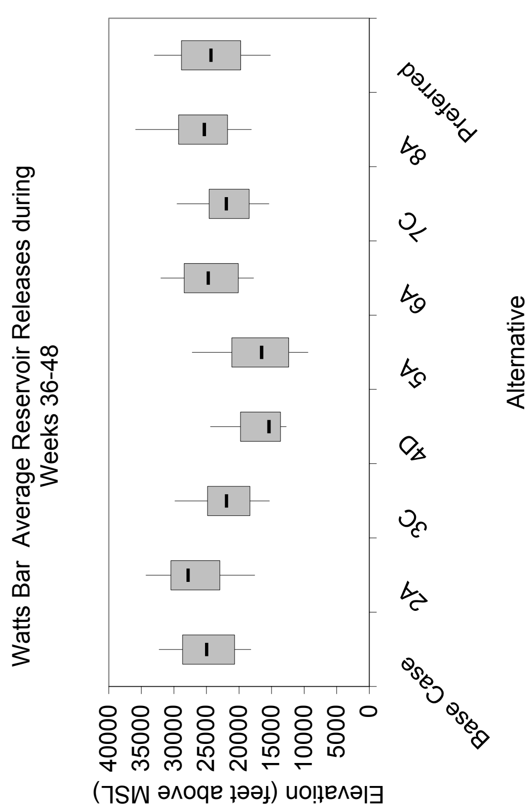

Wilson Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
0
10000
20000
30000
40000
50000
60000
70000
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

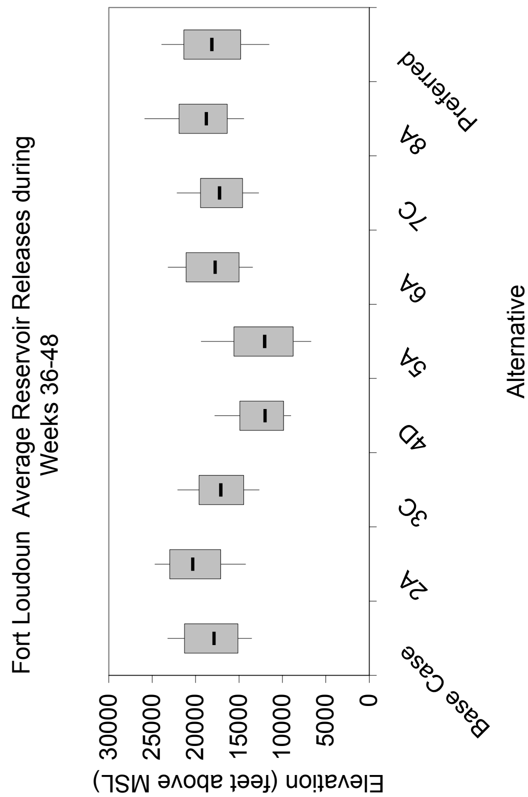

Pickwick Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
0
10000
20000
30000
40000
50000
60000
70000
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

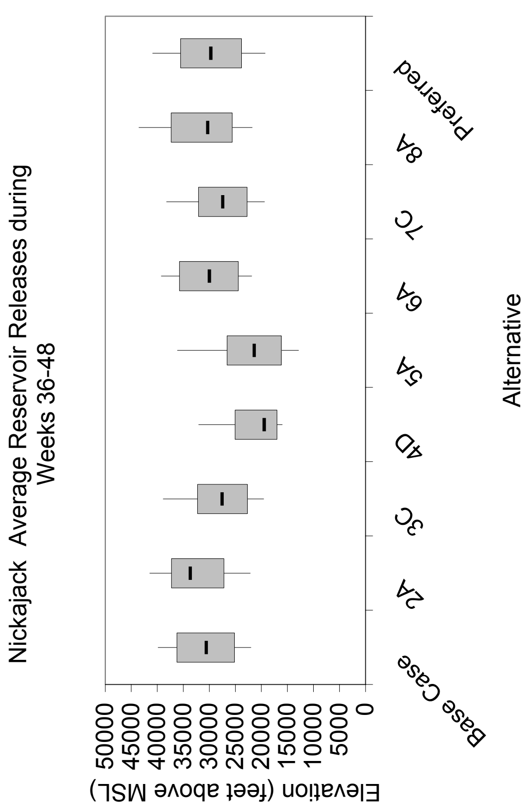

Kentucky Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
0
10000
20000
30000
40000
50000
60000
70000
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

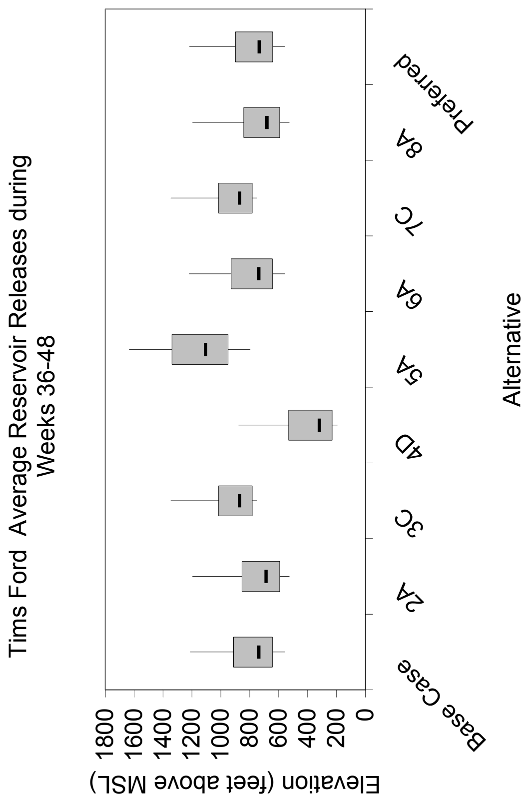

Wheeler Average Reservoir Releases during Weeks 36-48
Elevation (feet above MSL)
60000
50000
40000
30000
20000
10000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

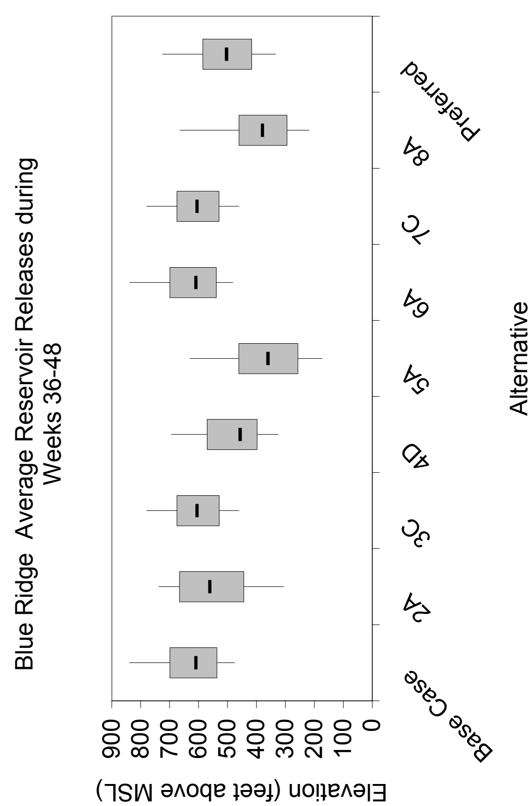

Chickamauga Average Reservoir Releases during Weeks 36-48
Elevation (feet above MSL)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

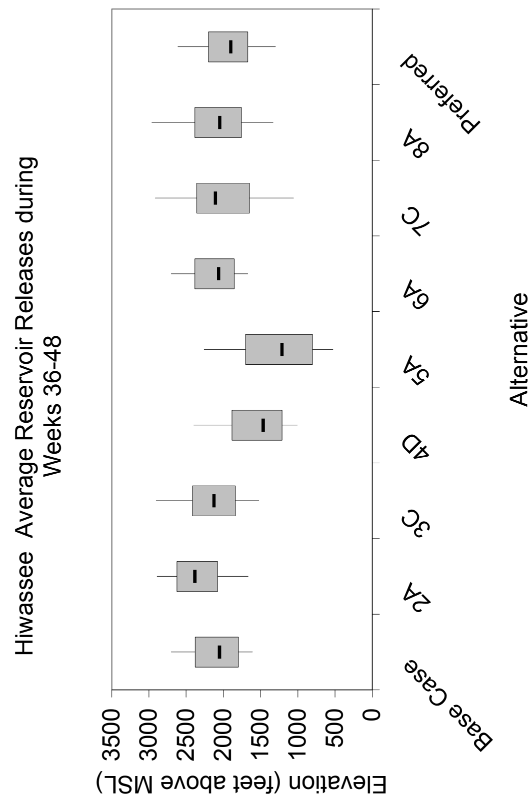

Watts Bar Average Reservoir Releases during Weeks 36-48
Elevation (feet above MSL)
40000
35000
30000
25000
20000
15000
10000
5000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

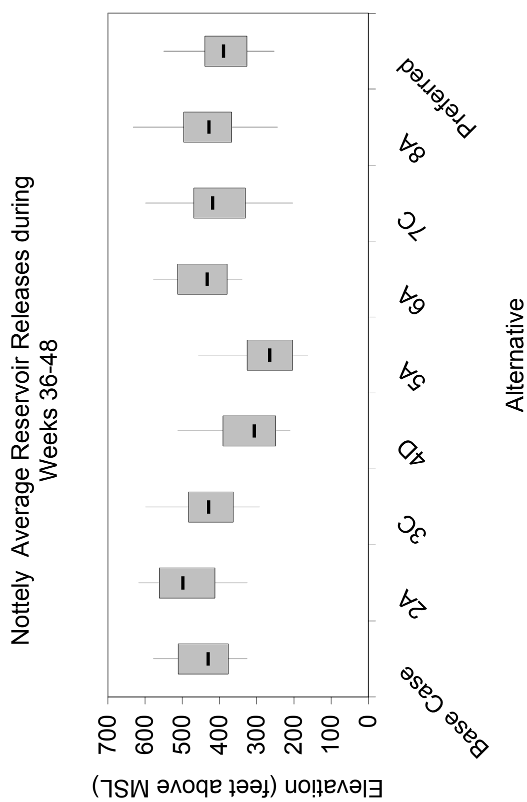

Fort Loudoun Average Reservoir Releases during Weeks 36-48
Elevation (feet above MSL)
30000
25000
20000
15000
10000
5000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

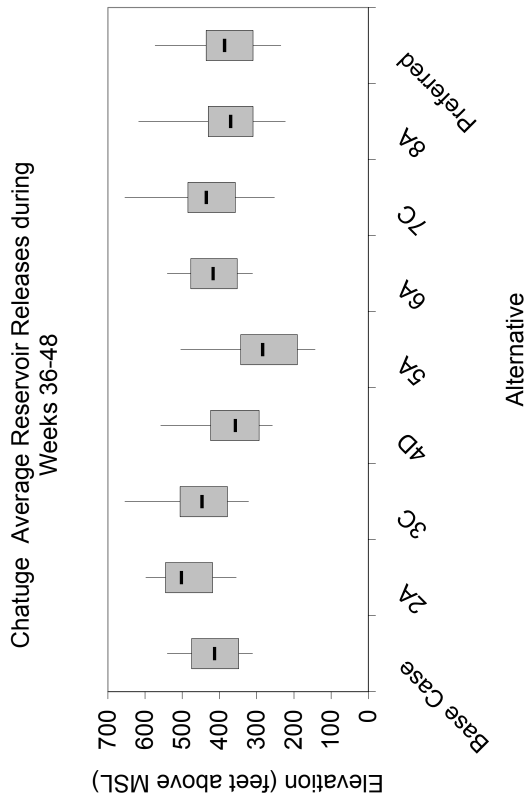

Nickajack Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

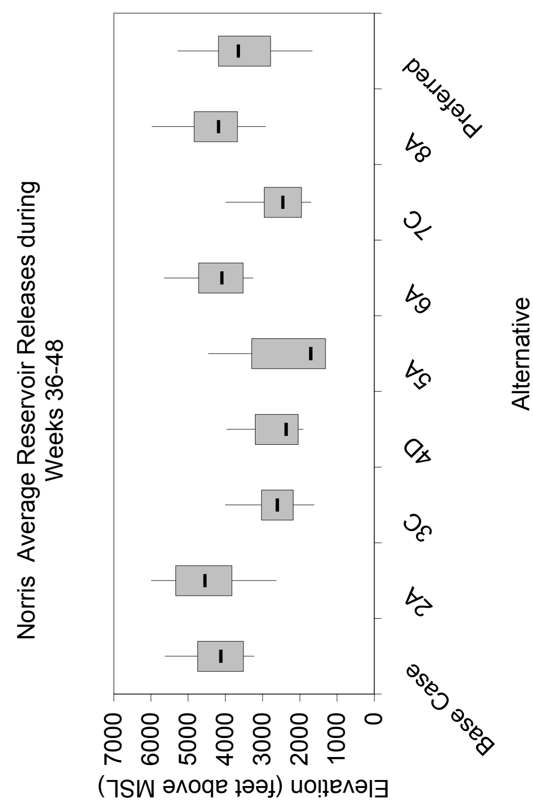

Tims Ford Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
1800
1600
1400
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

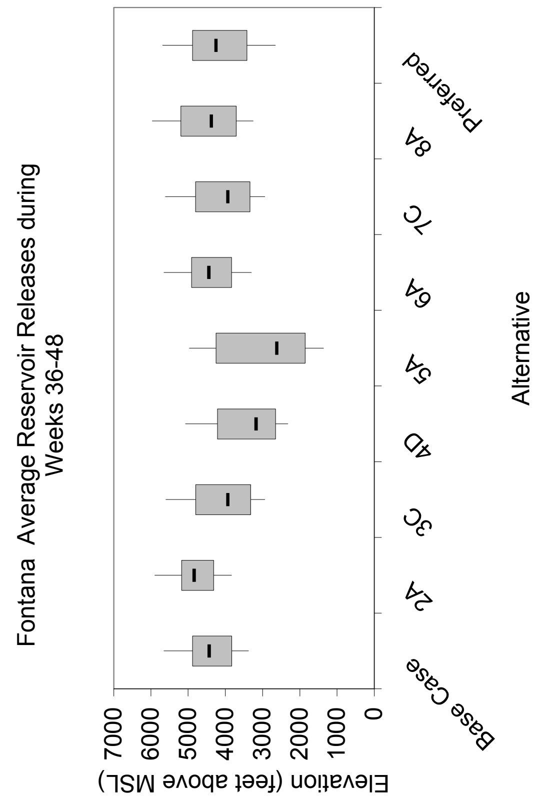

Blue Ridge Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
900
800
700
600
500
400
300
200
100
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

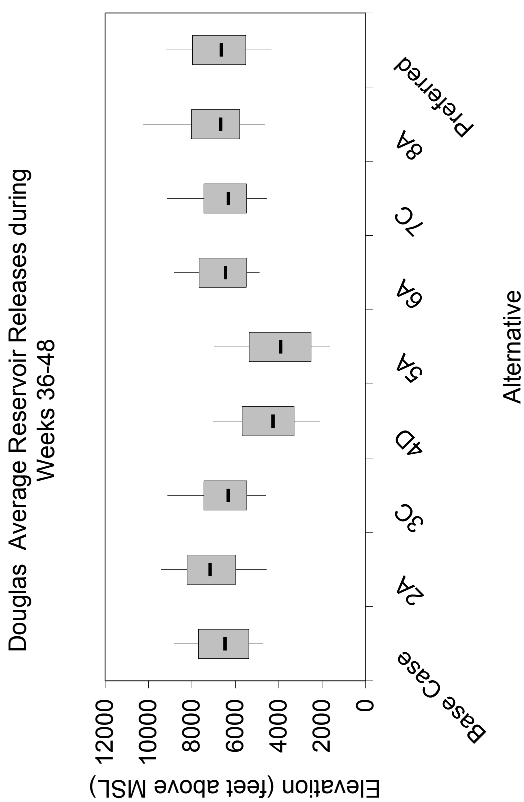

Hiwassee Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
3500
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

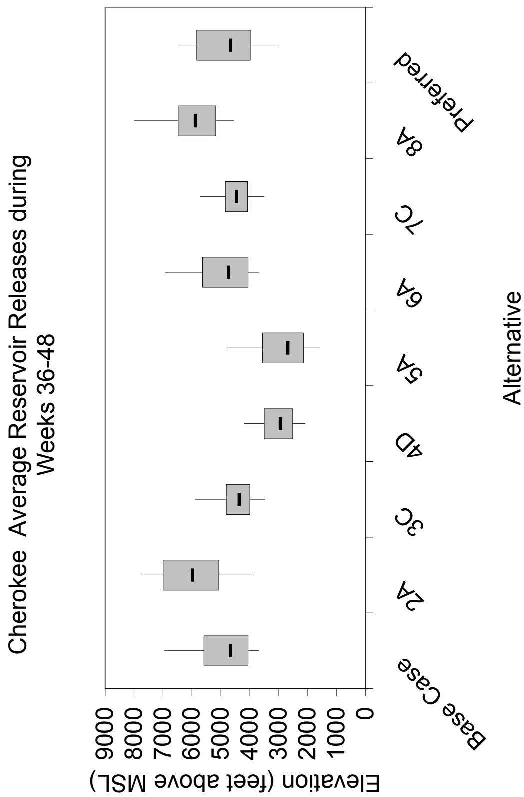

Nottely Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
700
600
500
400
300
200
100
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

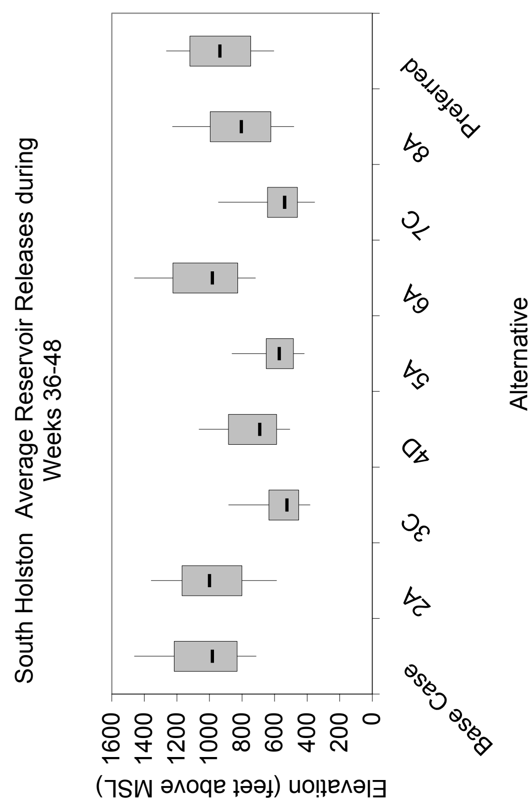

Chatuge Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
700
600
500
400
300
200
100
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

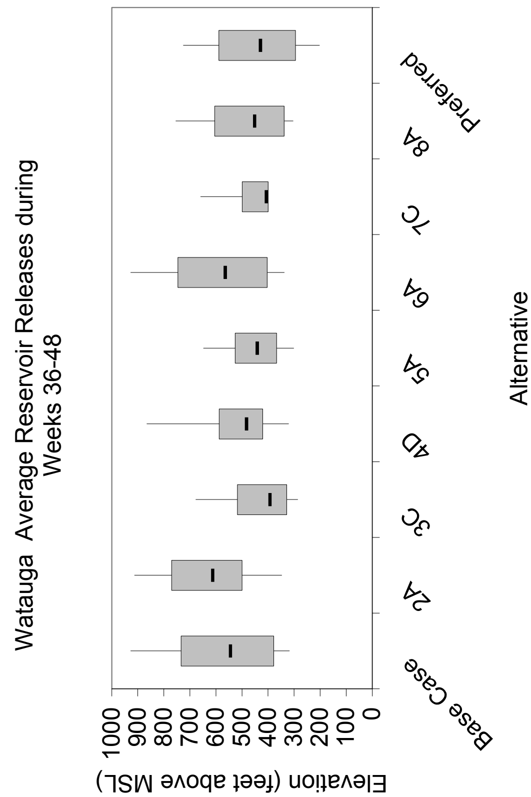

Norris Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
7000
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

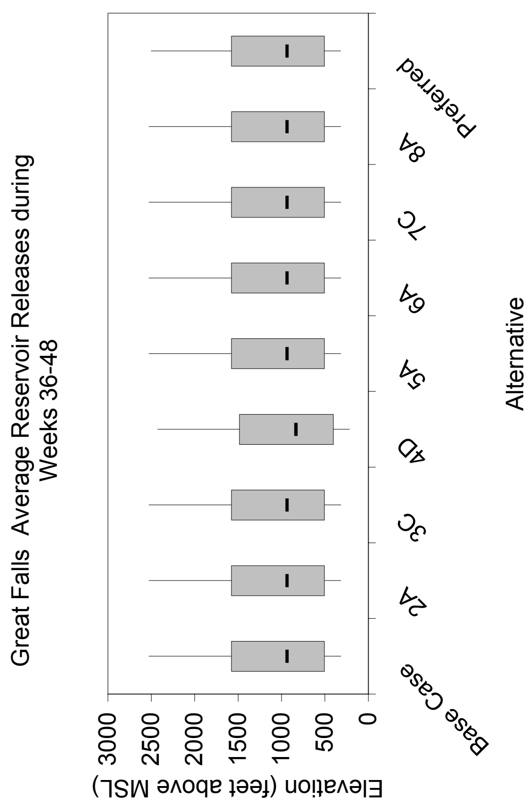

Fontana Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
7000
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

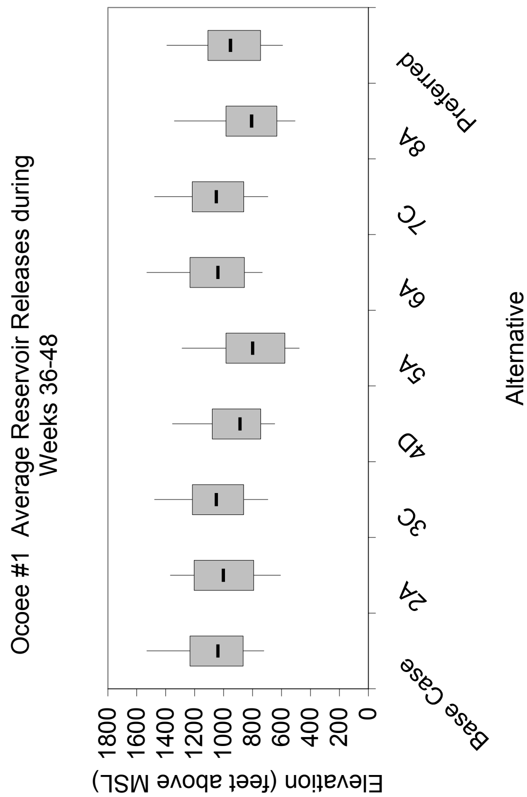

Douglas Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
12000
10000
8000
6000
4000
2000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

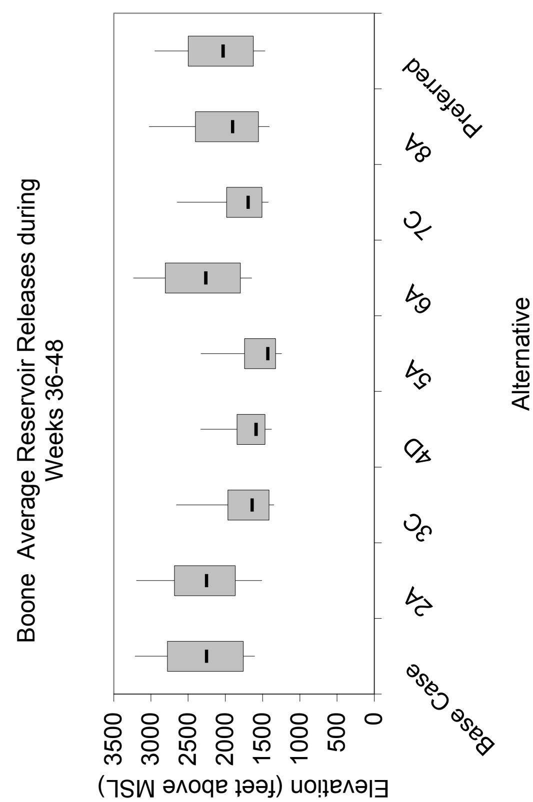

Cherokee Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

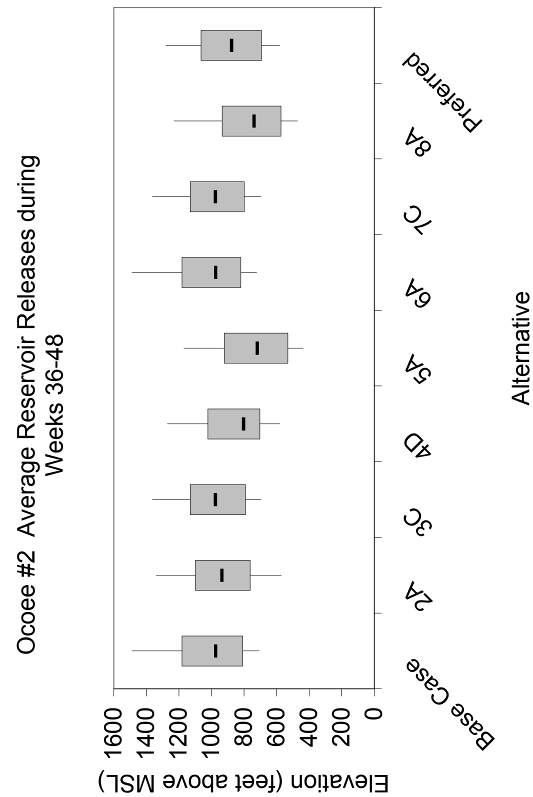

South Holston Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
1600
1400
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

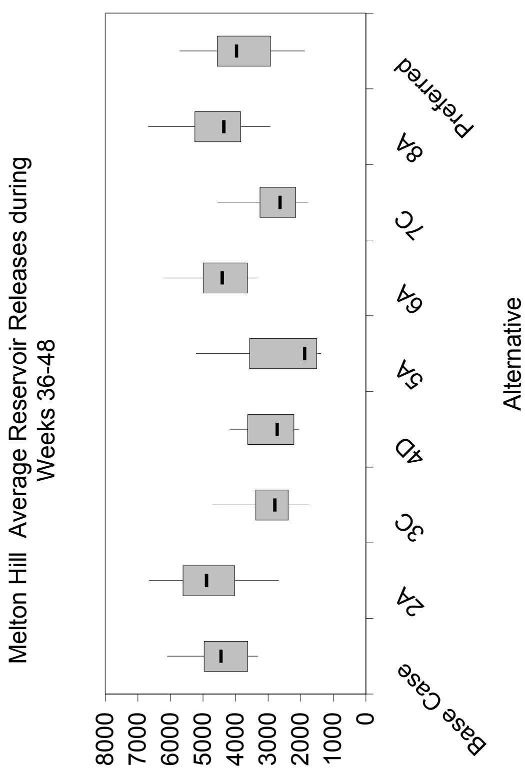

Watauga Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
1000
900
800
700
600
500
400
300
200
100
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

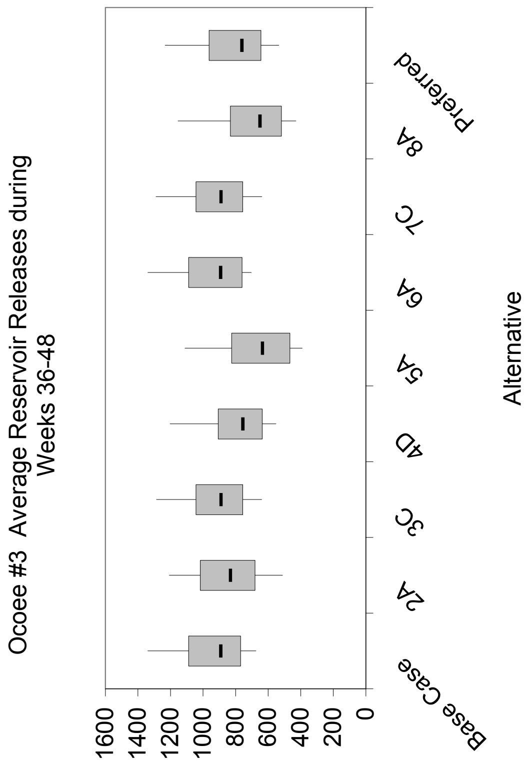

Great Falls Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

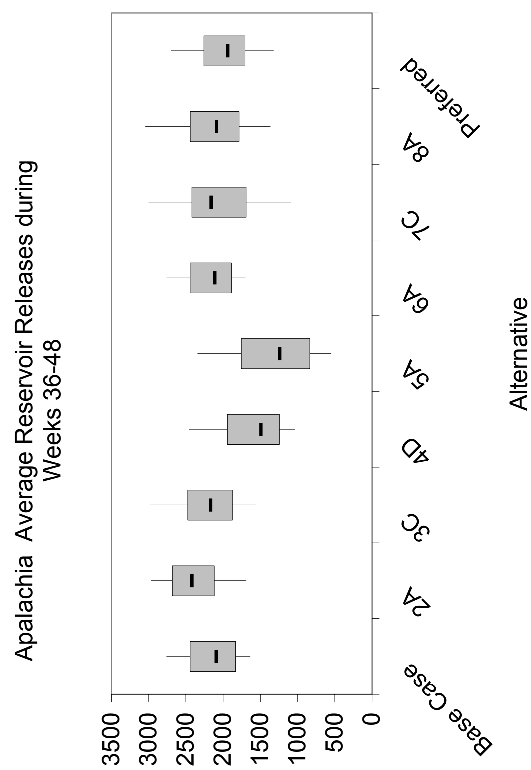

Ocoee #1 Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
1800
1600
1400
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

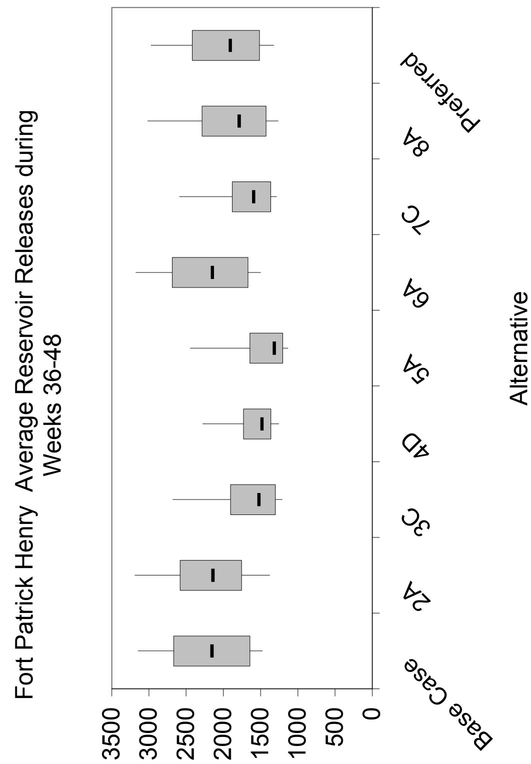

Boone Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
3500
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative


Ocoee #2 Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
1600
1400
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

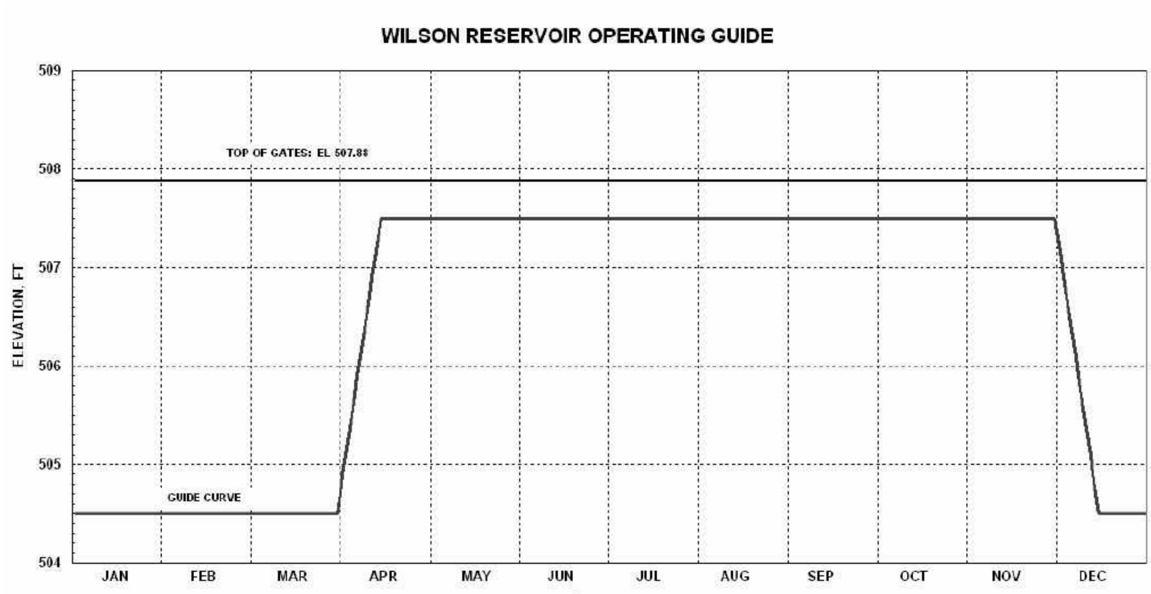

Melton Hill Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
8000
7000
6000
5000
4000
3000
2000
1000
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

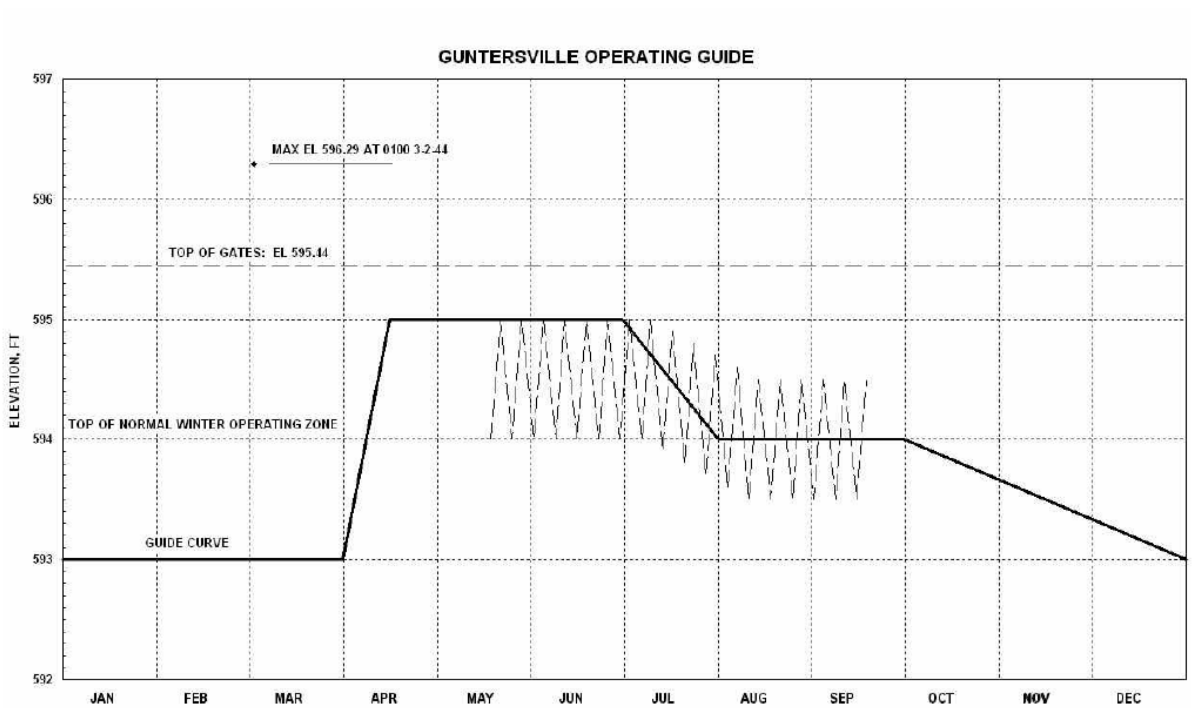

Ocoee #3 Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
1600
1400
1200
1000
800
600
400
200
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative


Apalachia Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
3500
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

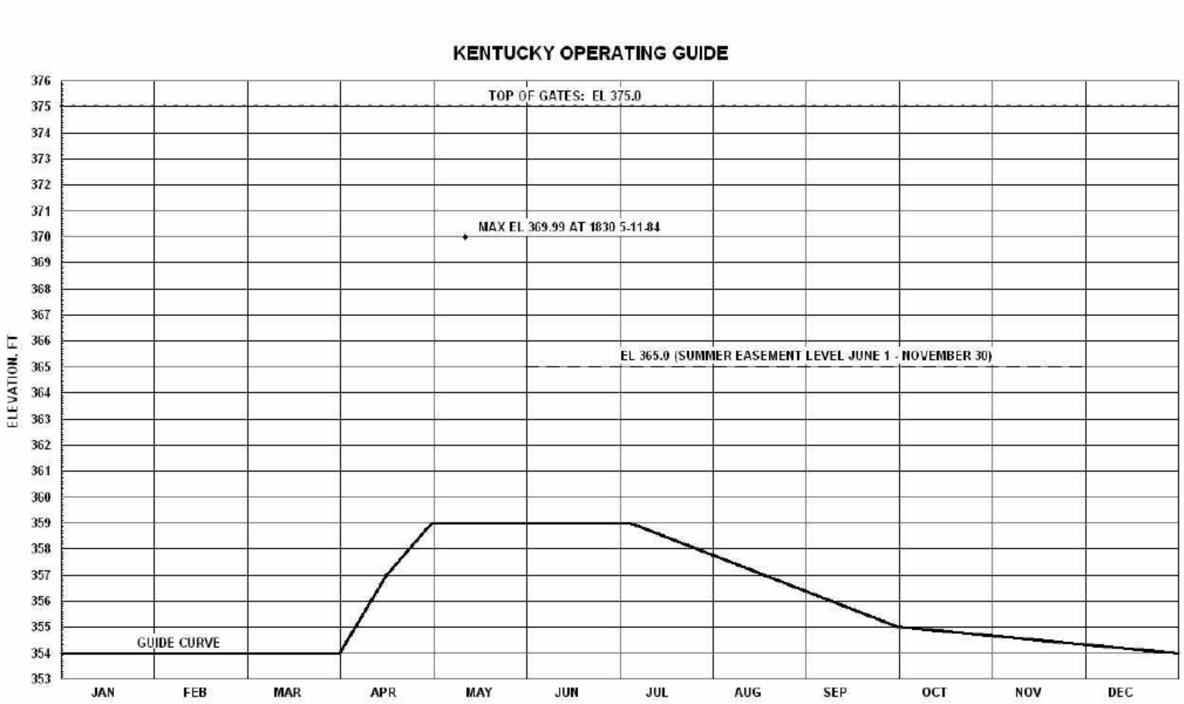

Fort Patrick Henry Average Reservoir Releases during
Weeks 36-48
Elevation (feet above MSL)
3500
3000
2500
2000
1500
1000
500
0
Base Case
2A
3C
4D
5A
6A
7C
8A
Preferred
Alternative

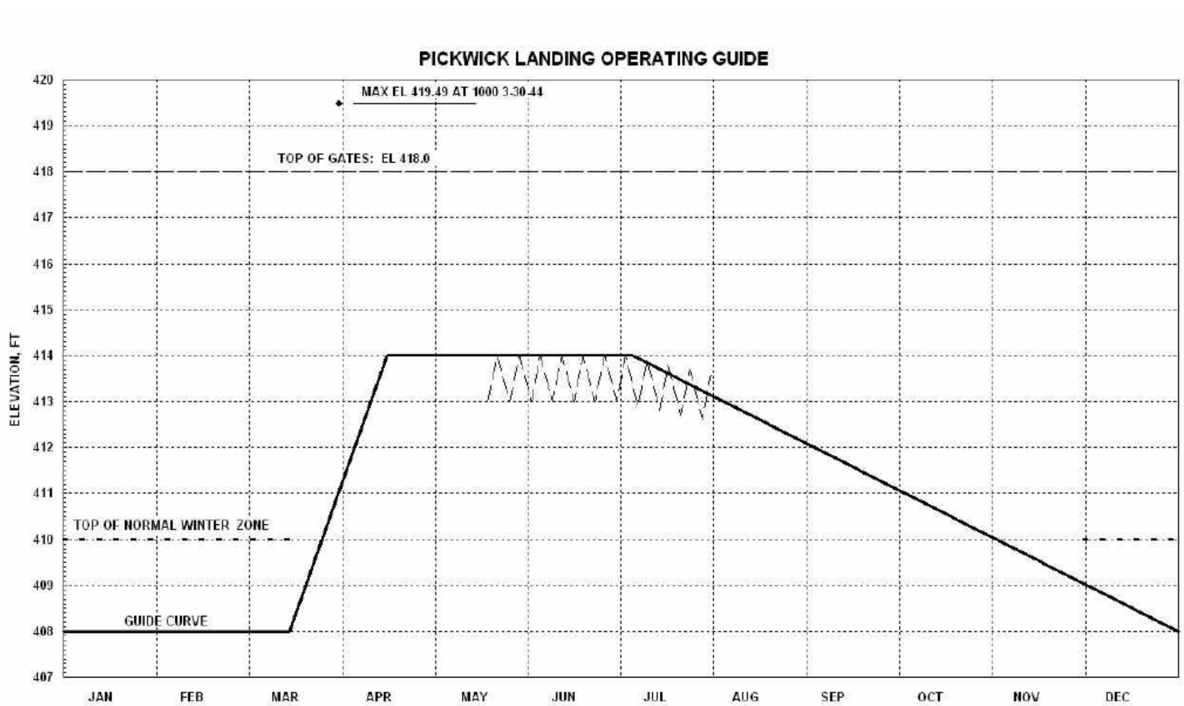
Operating guides for the 9 mainstem projects, Great Falls, and Boone under the Base Case



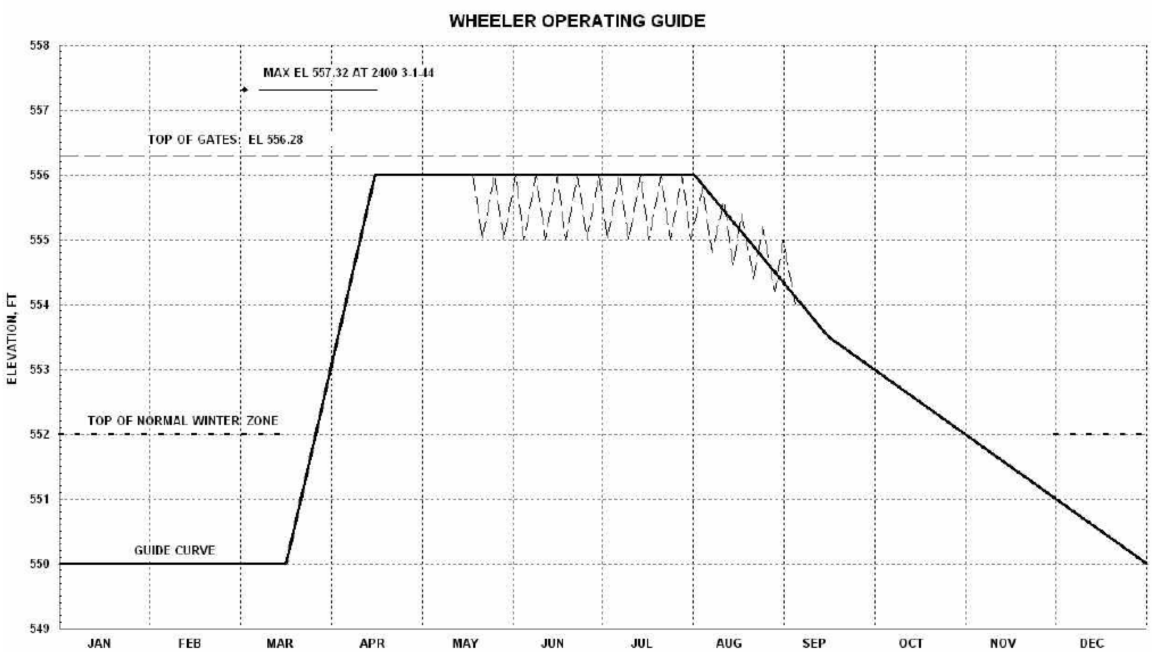


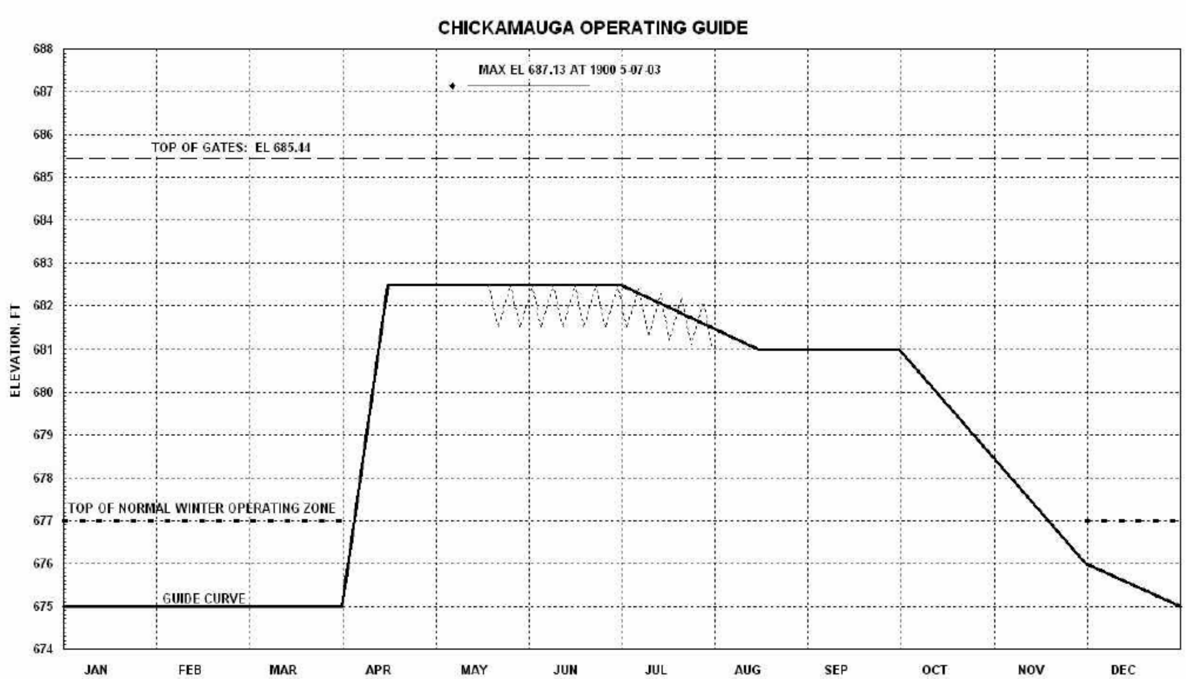
Operating guides for the 9 mainstem projects, Great Falls, and Boone under the Base Case (cont.)



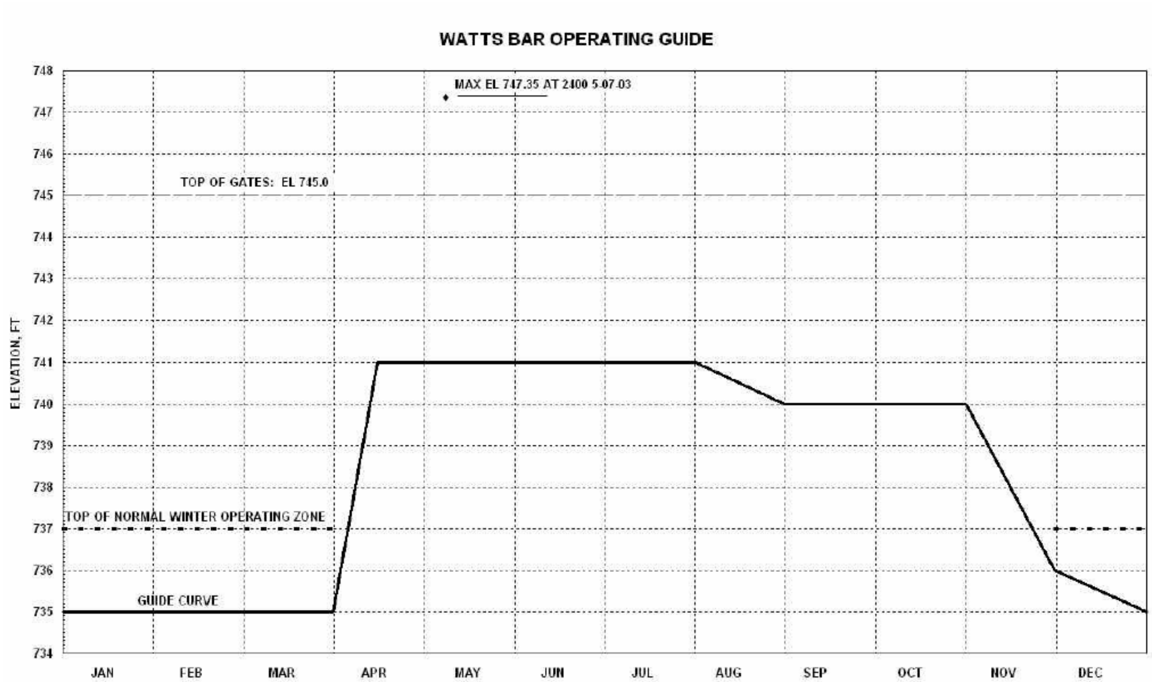


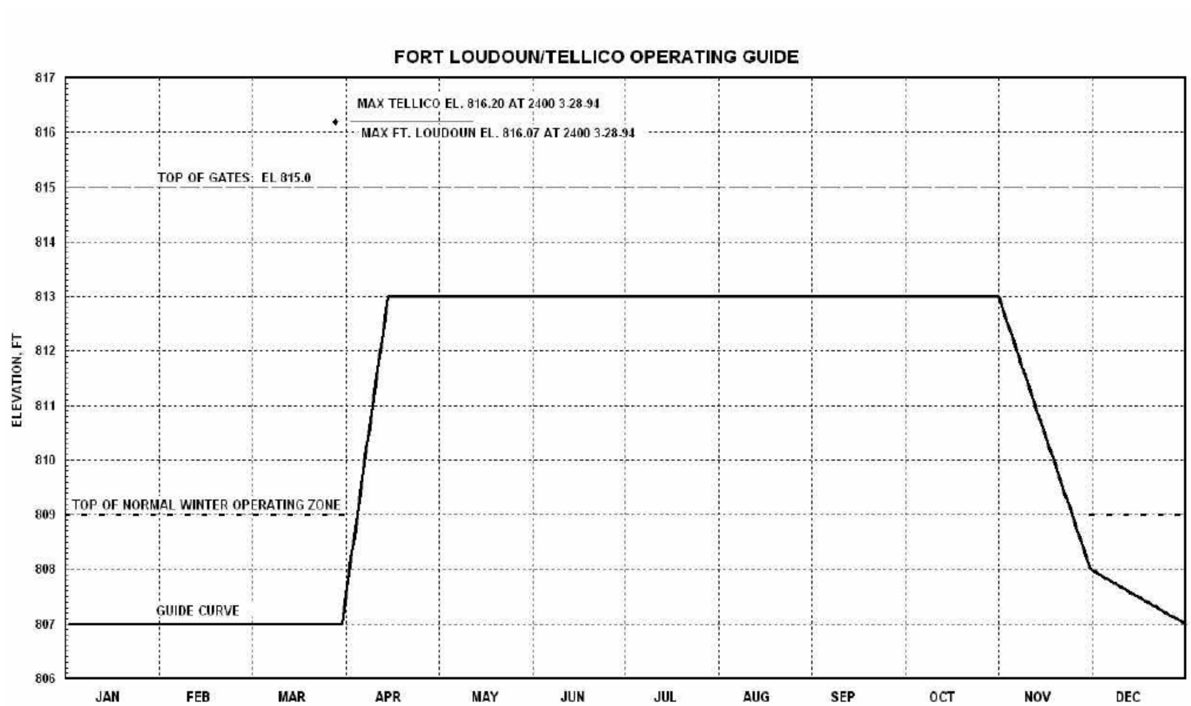
Operating guides for the 9 mainstem projects, Great Falls, and Boone under the Base Case (cont.)



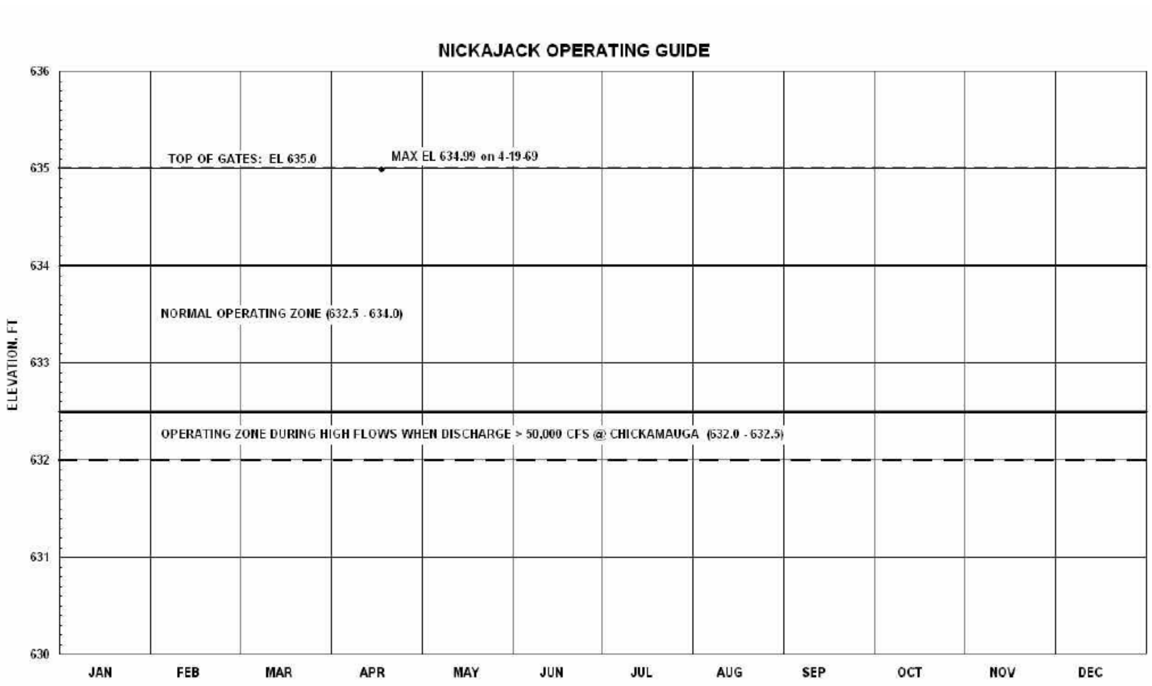


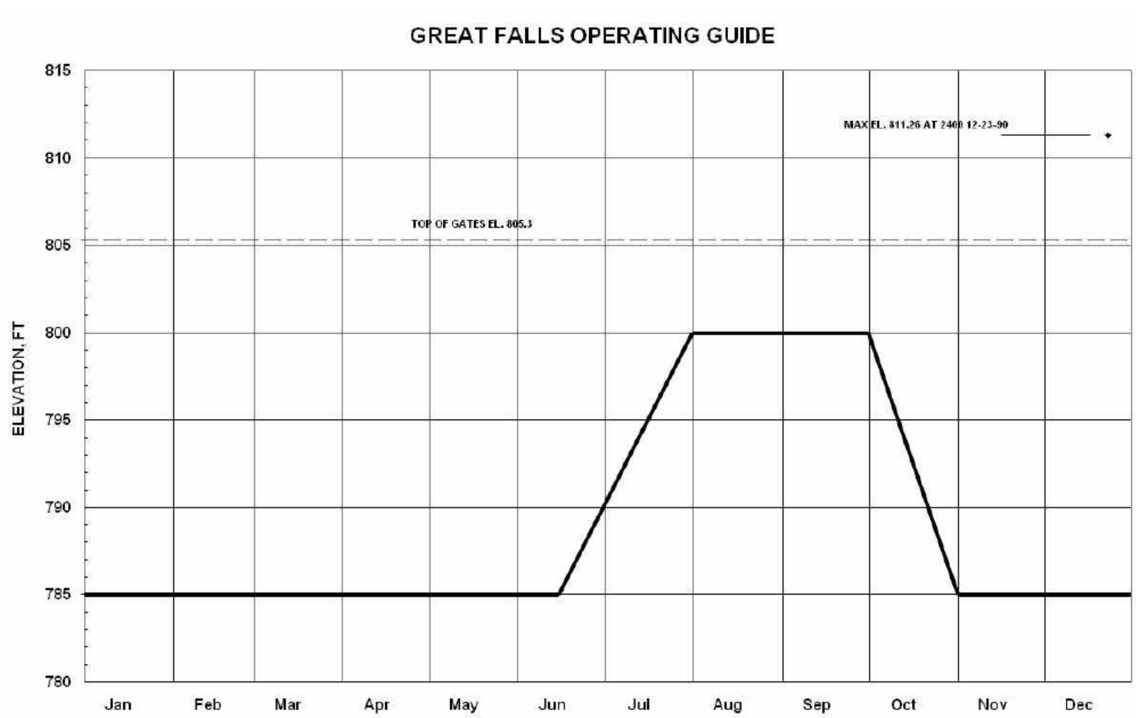
Operating guides for the 9 mainstem projects, Great Falls, and Boone under the Base Case (cont.)



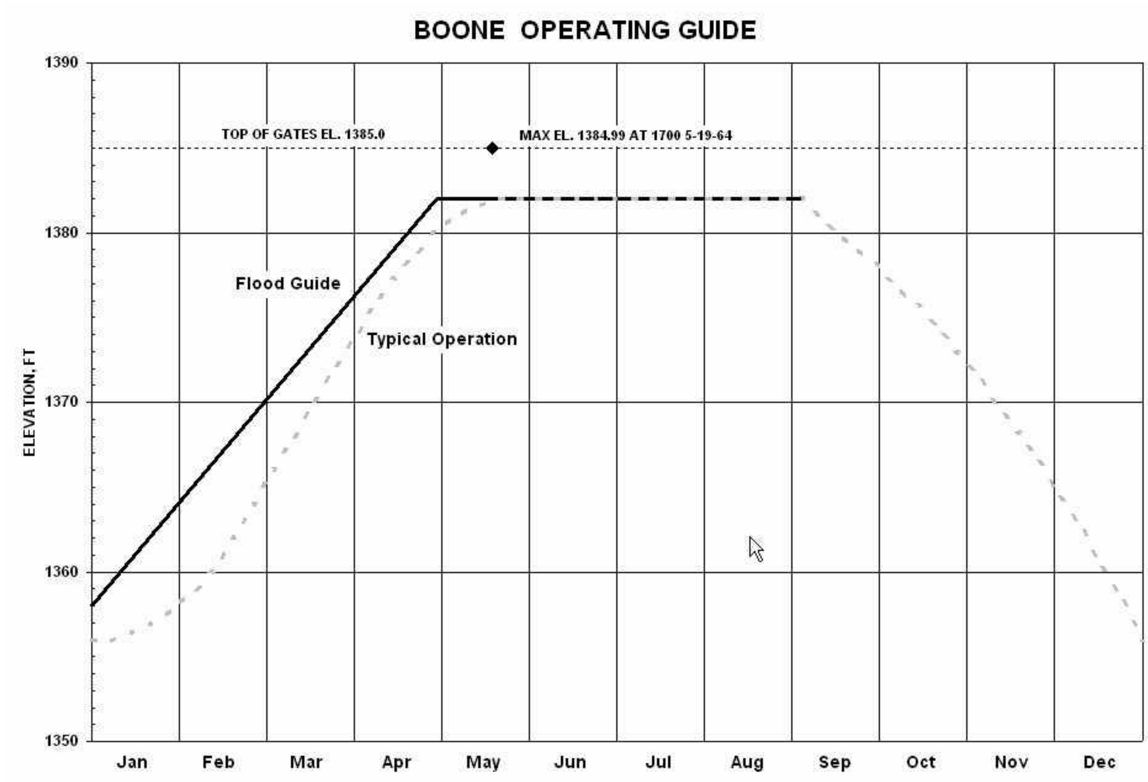


Operating guides for the 9 mainstem projects, Great Falls, and Boone under the Base Case (cont.)

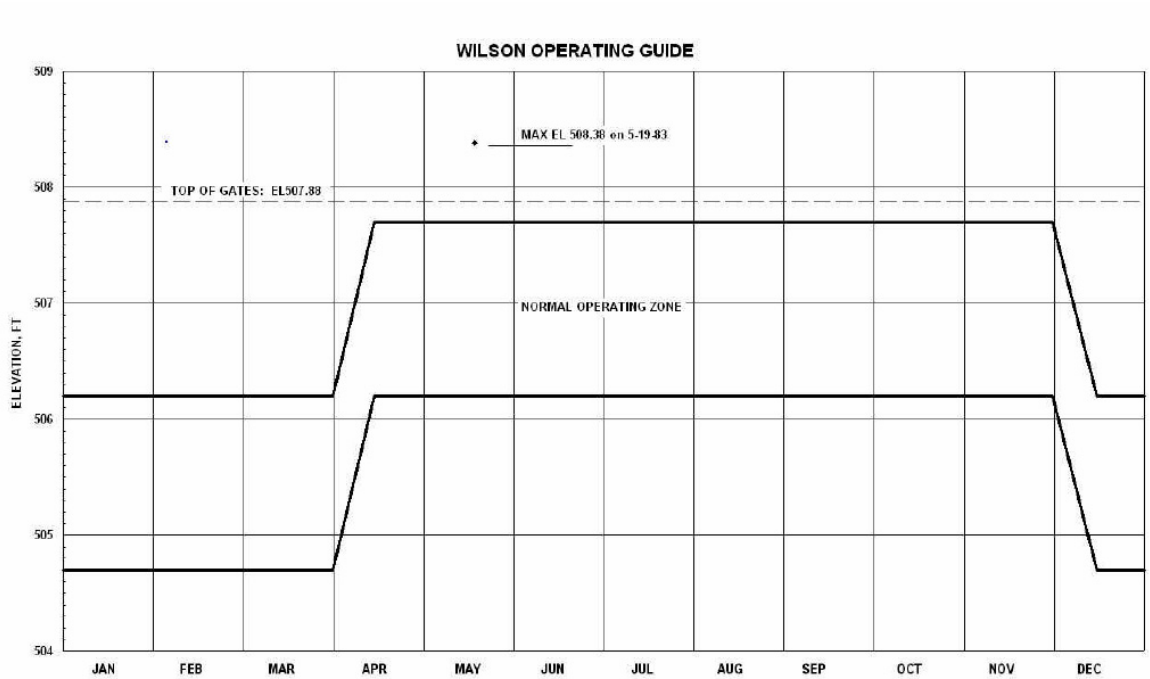


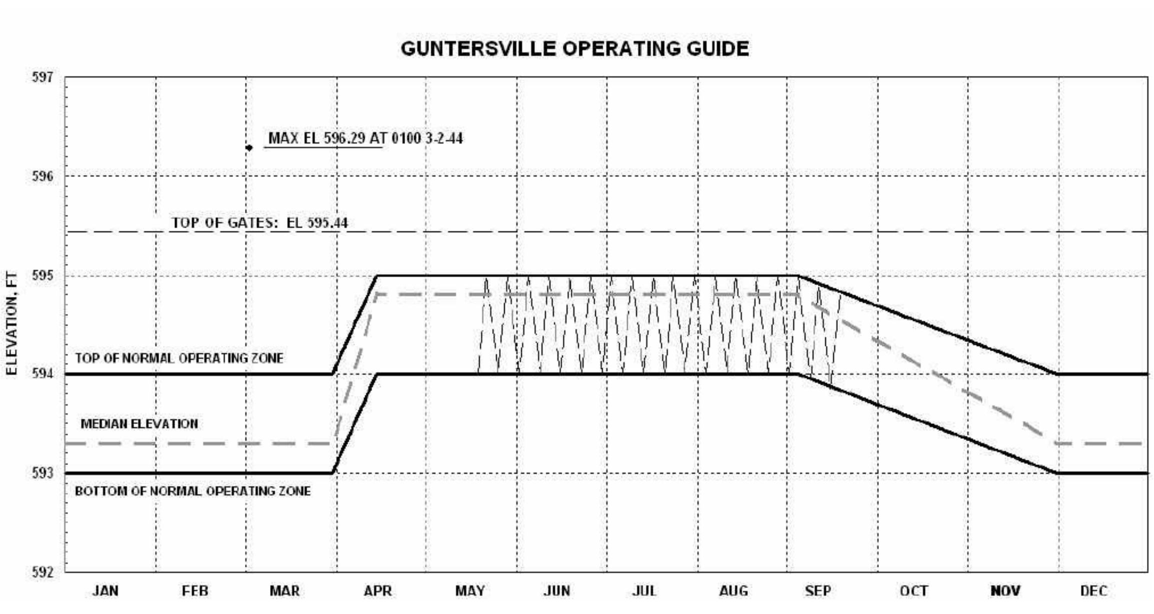


Operating guides for the 9 mainstem projects, Great Falls, and Boone under the Base Case (cont.)

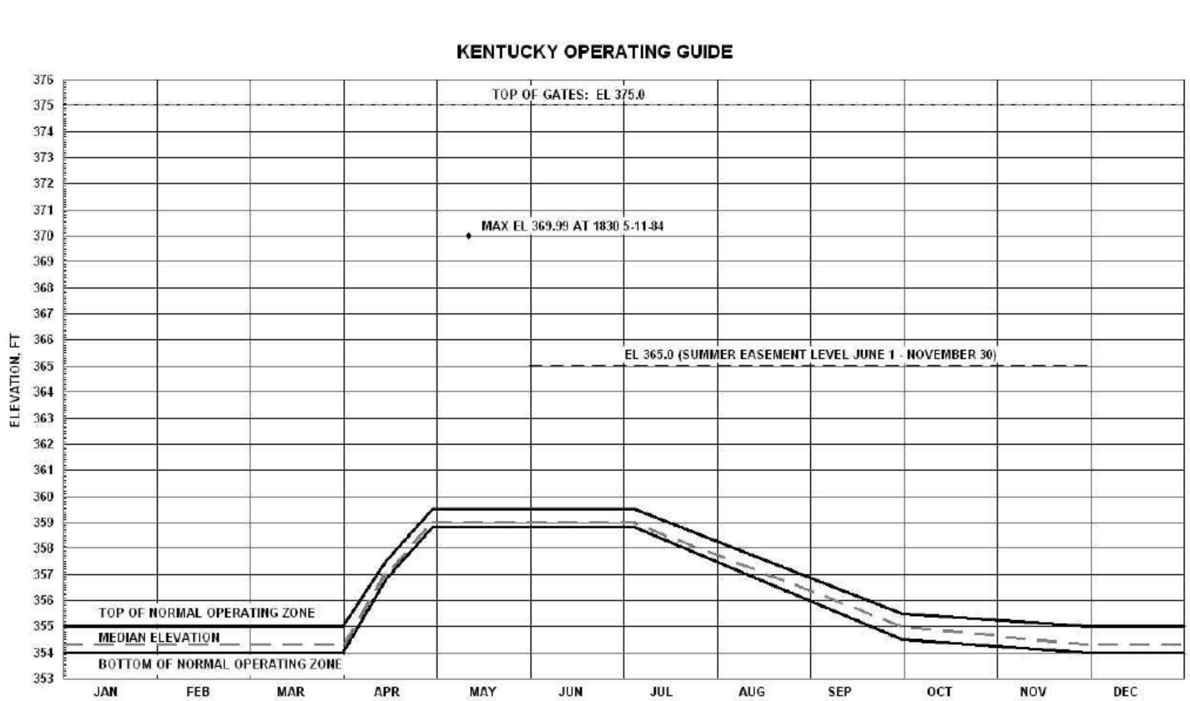


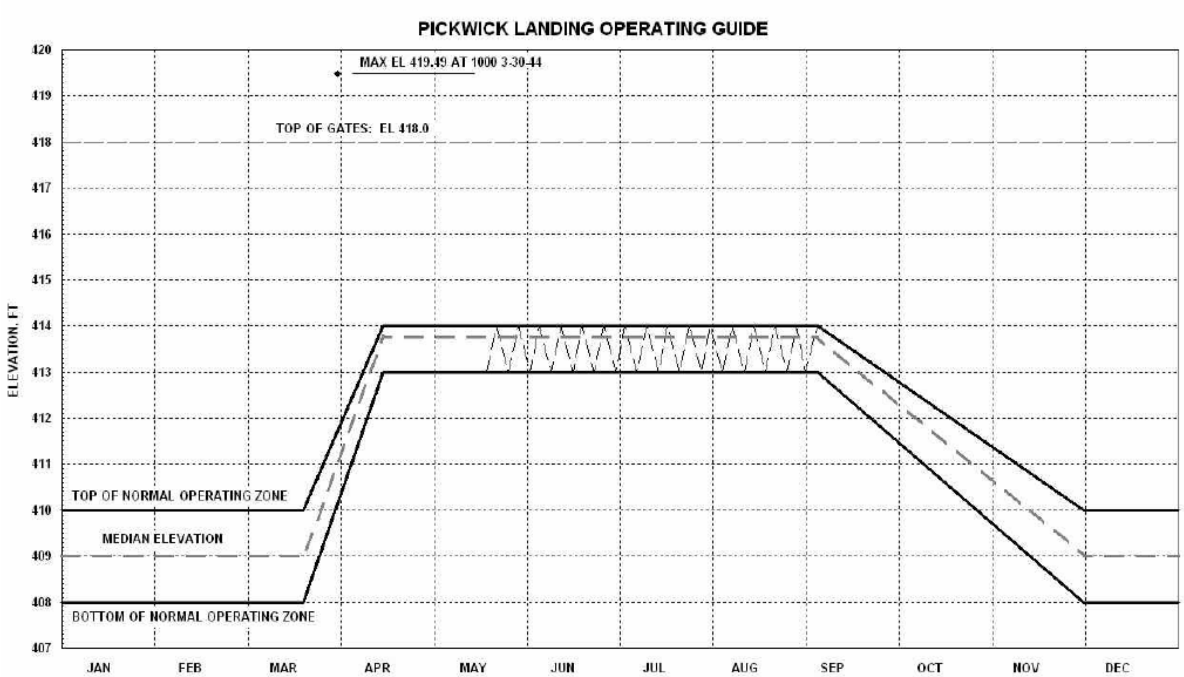
Operating guides for the nine mainstem projects, Great Falls, and Boone under the Preferred Alternative



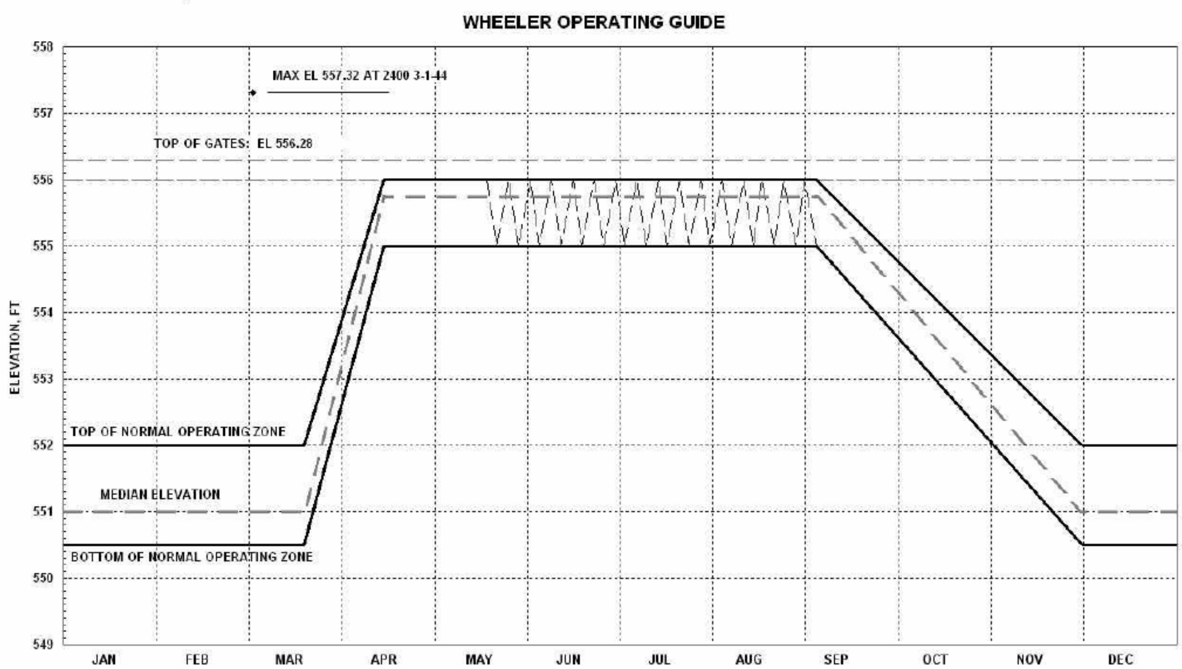


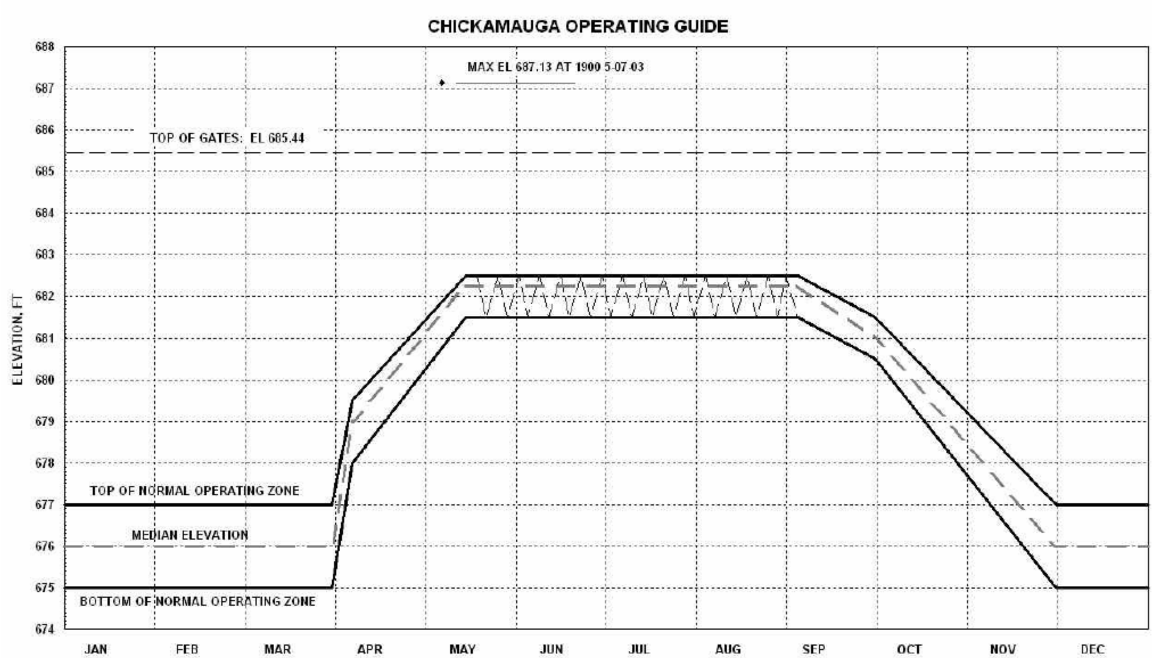
Operating guides for the nine mainstem projects, Great Falls, and Boone under the Preferred Alternative (cont.)



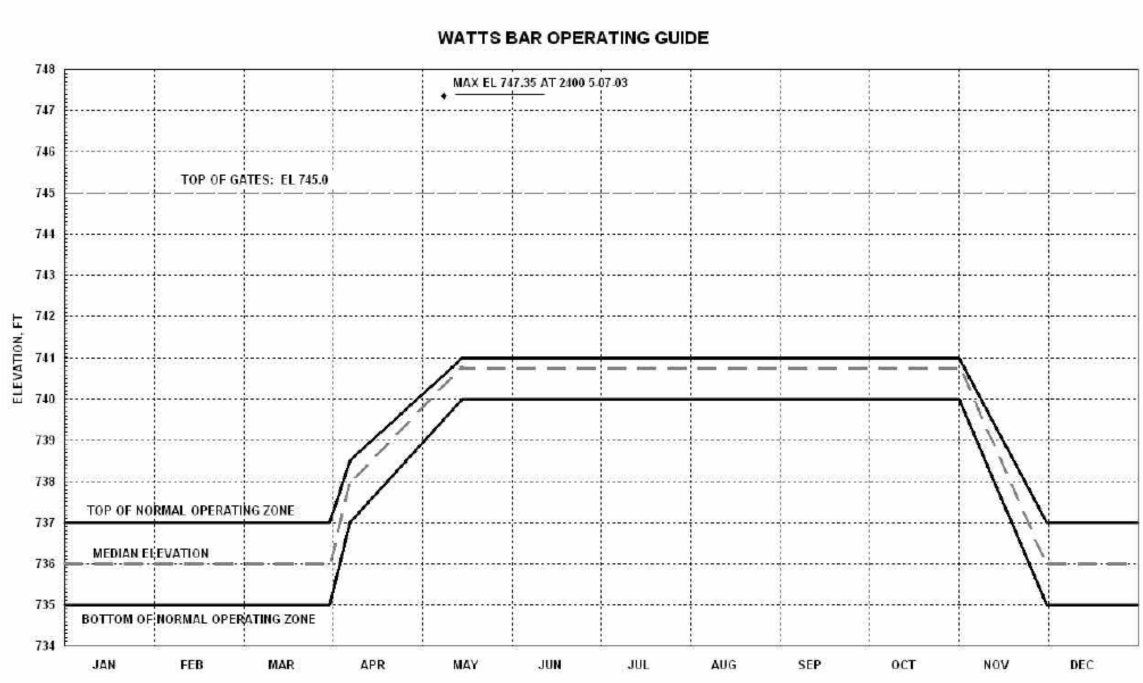


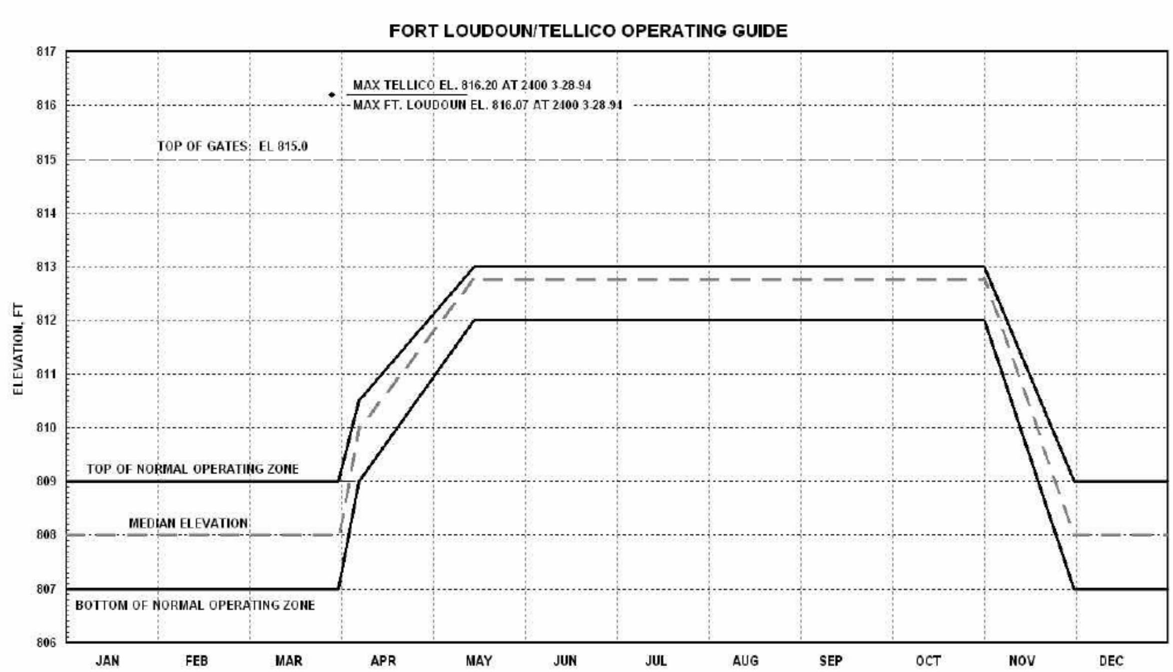
Operating guides for the nine mainstem projects, Great Falls, and Boone under the Preferred Alternative (cont.)



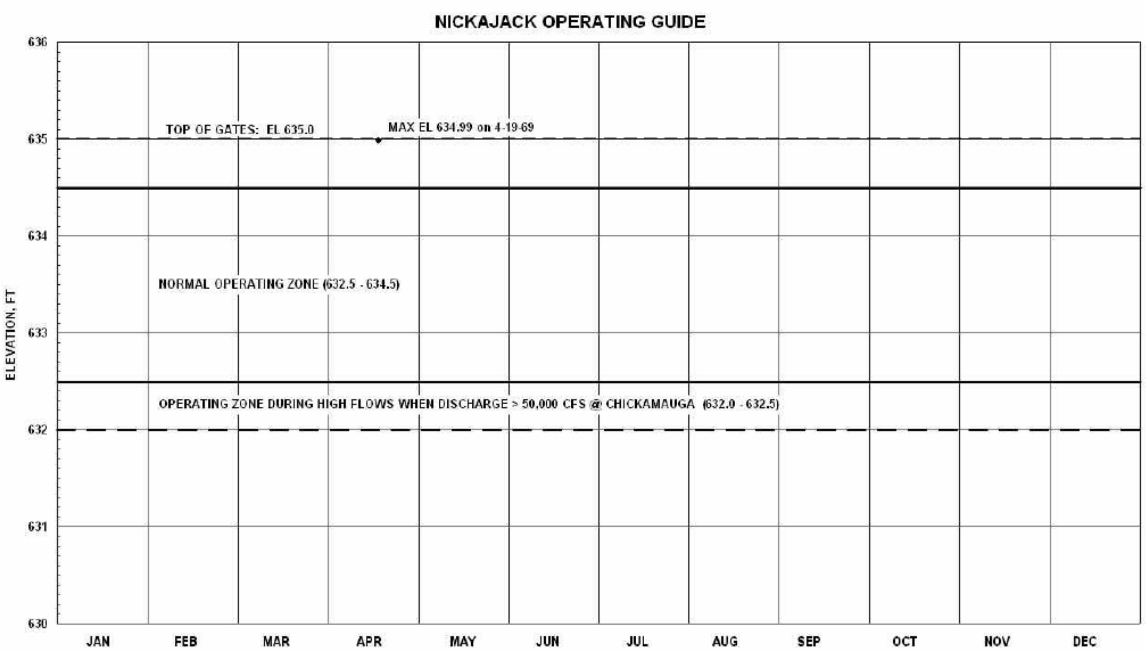


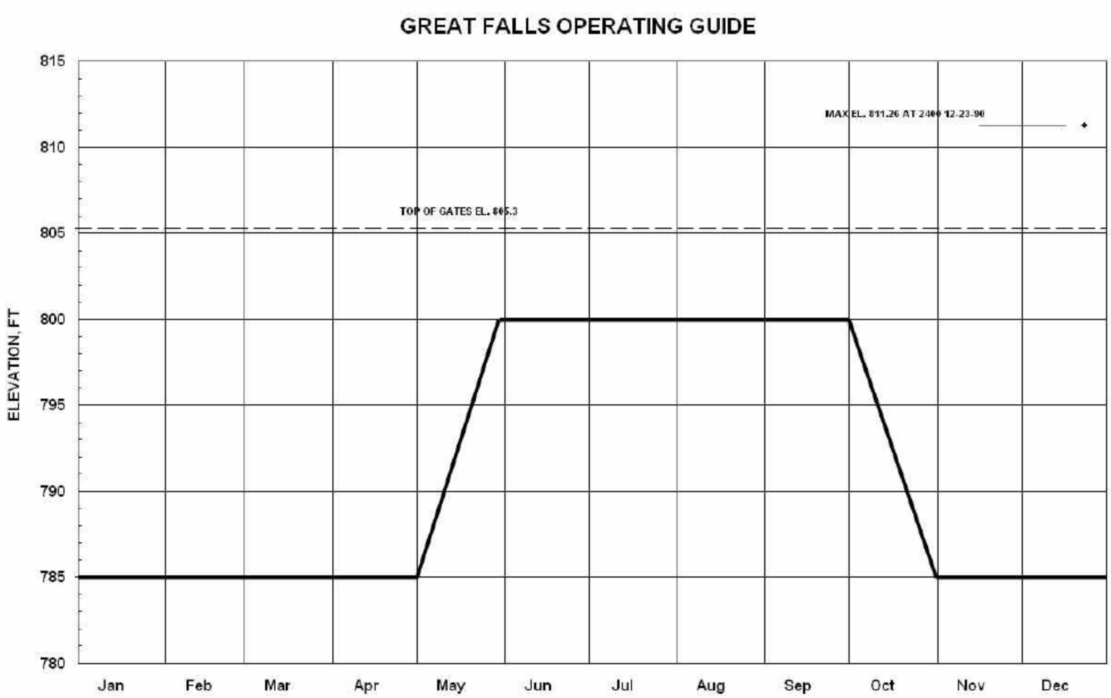
Operating guides for the nine mainstem projects, Great Falls, and Boone under the Preferred Alternative (cont.)



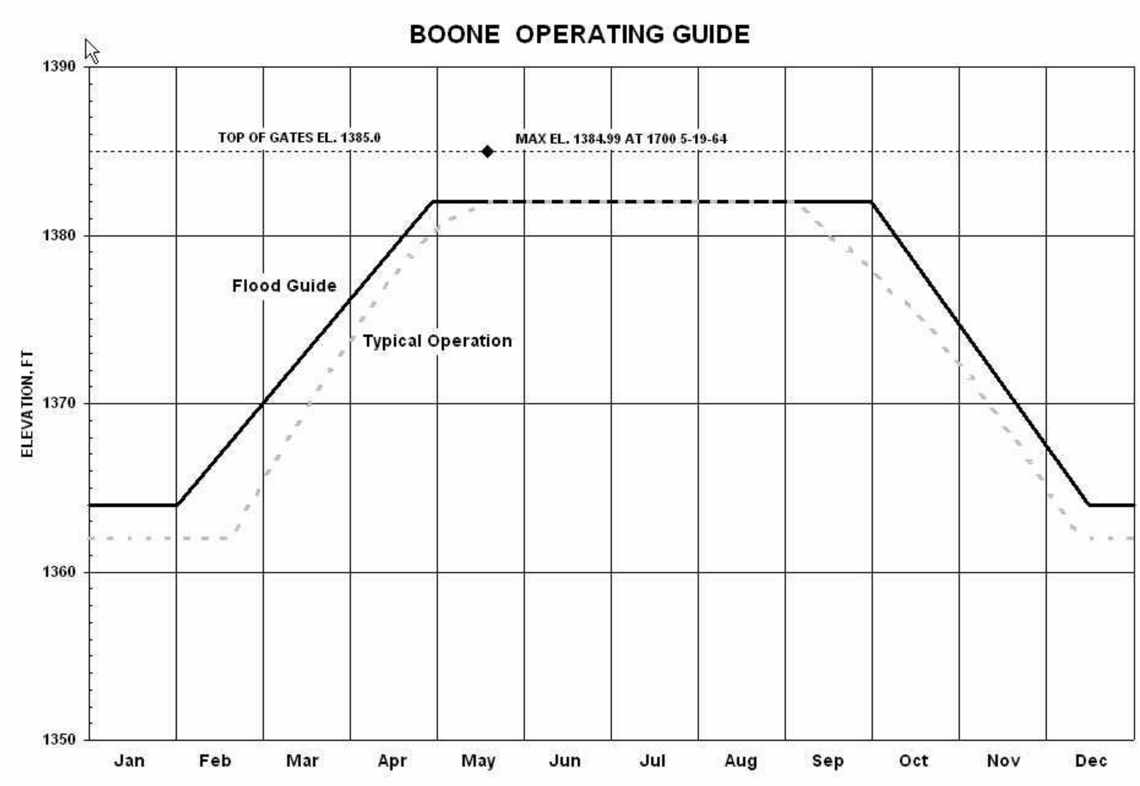


Operating guides for the nine mainstem projects, Great Falls, and Boone under the Preferred Alternative (cont.)

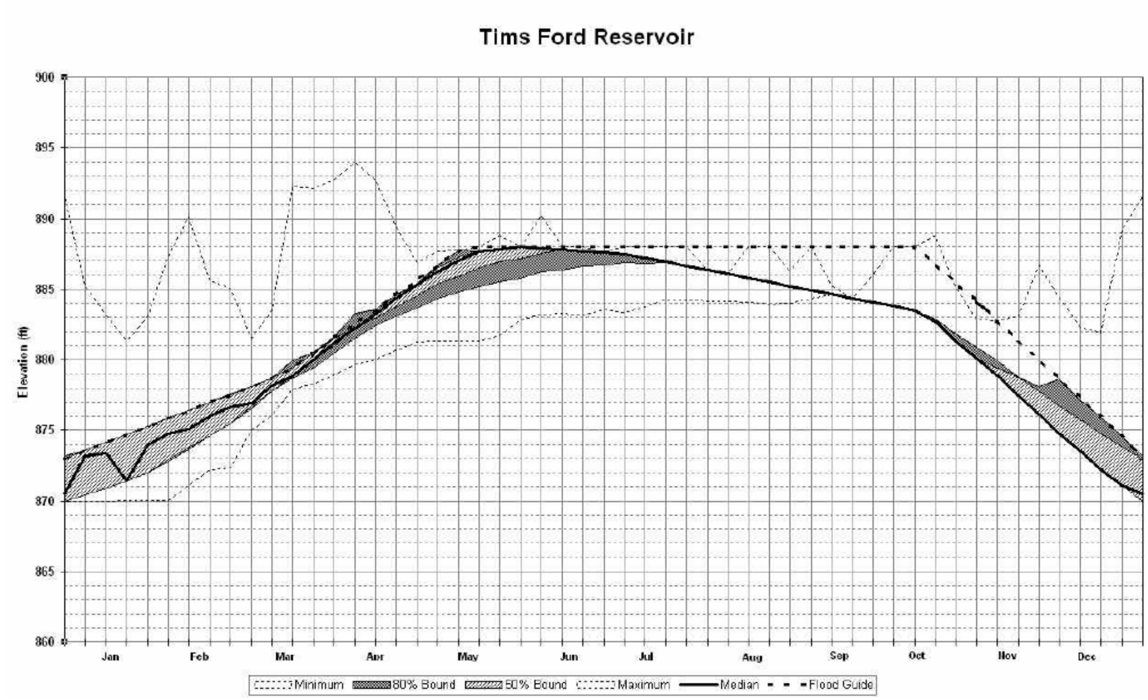


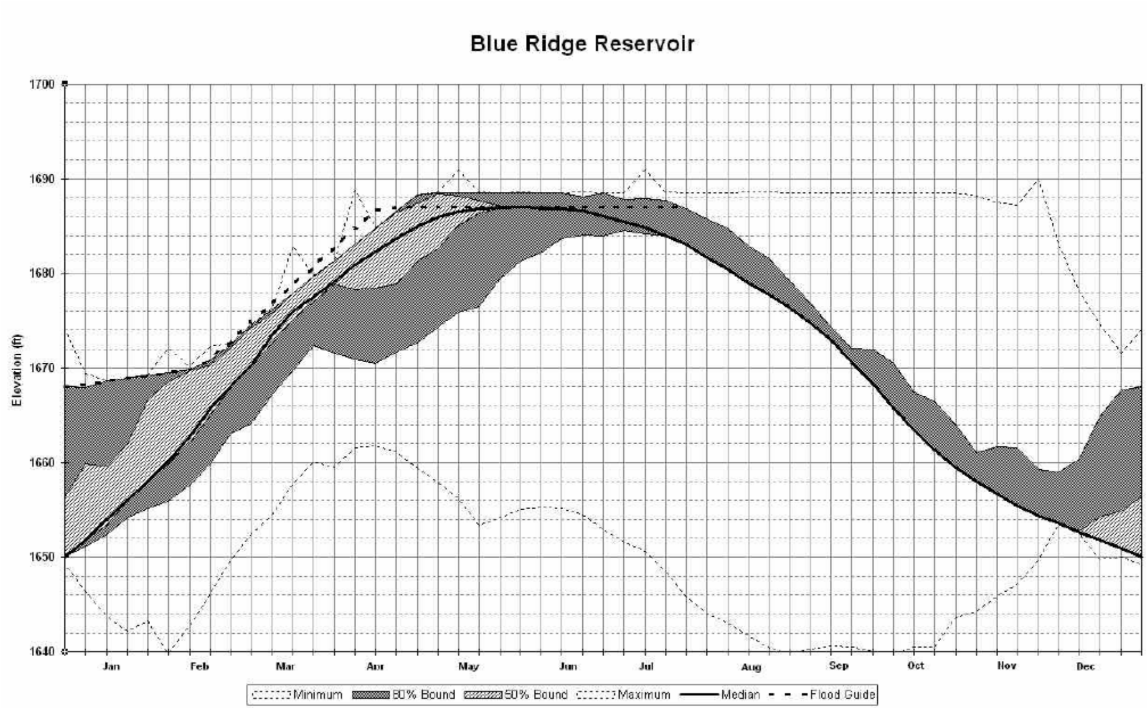


Operating guides for the nine mainstem projects, Great Falls, and Boone under the Preferred Alternative (cont.)

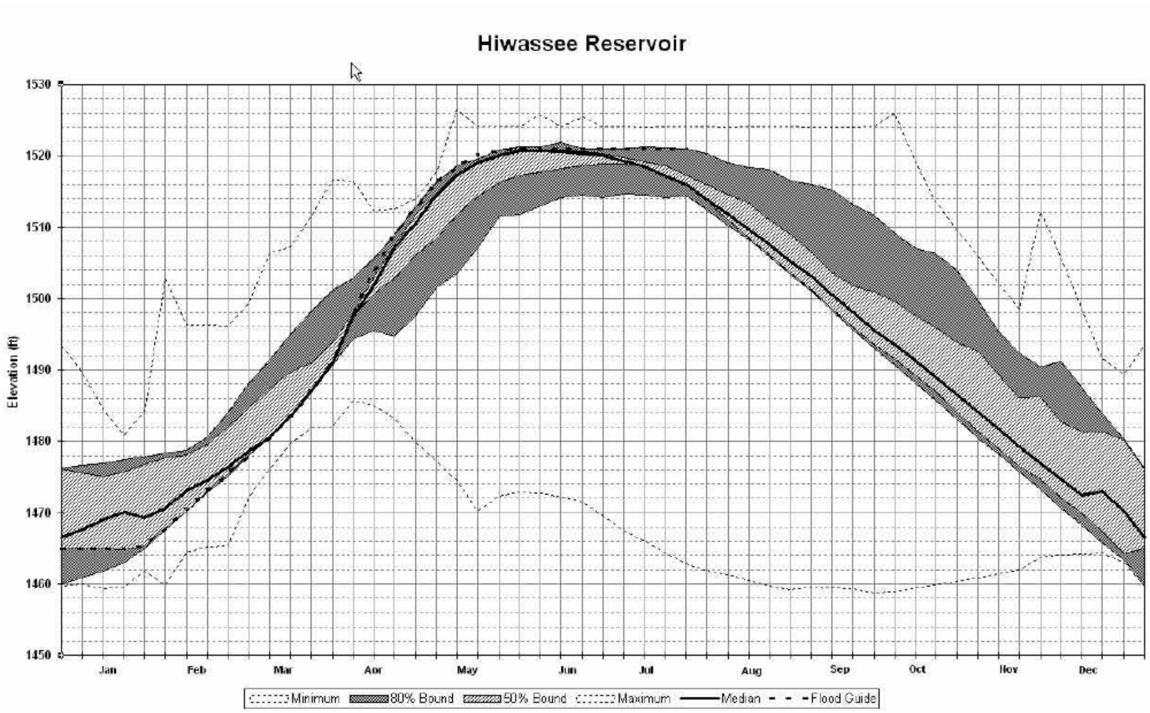


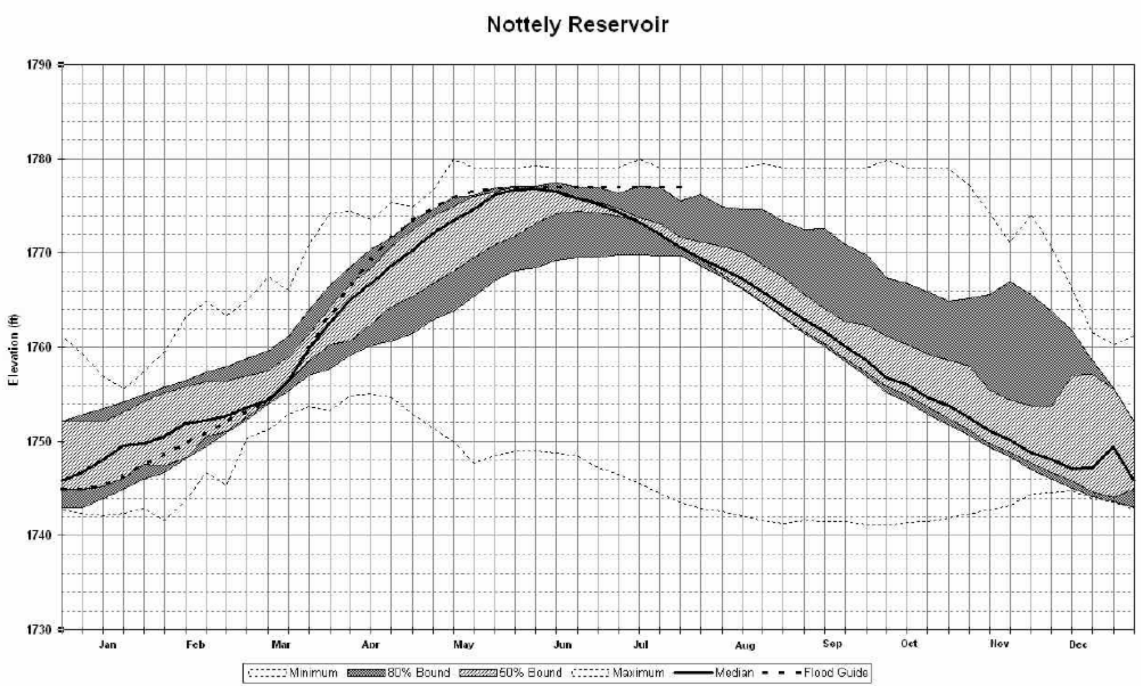
Elevation probability plots along with flood guide curves for tributary reservoirs under the Base Case



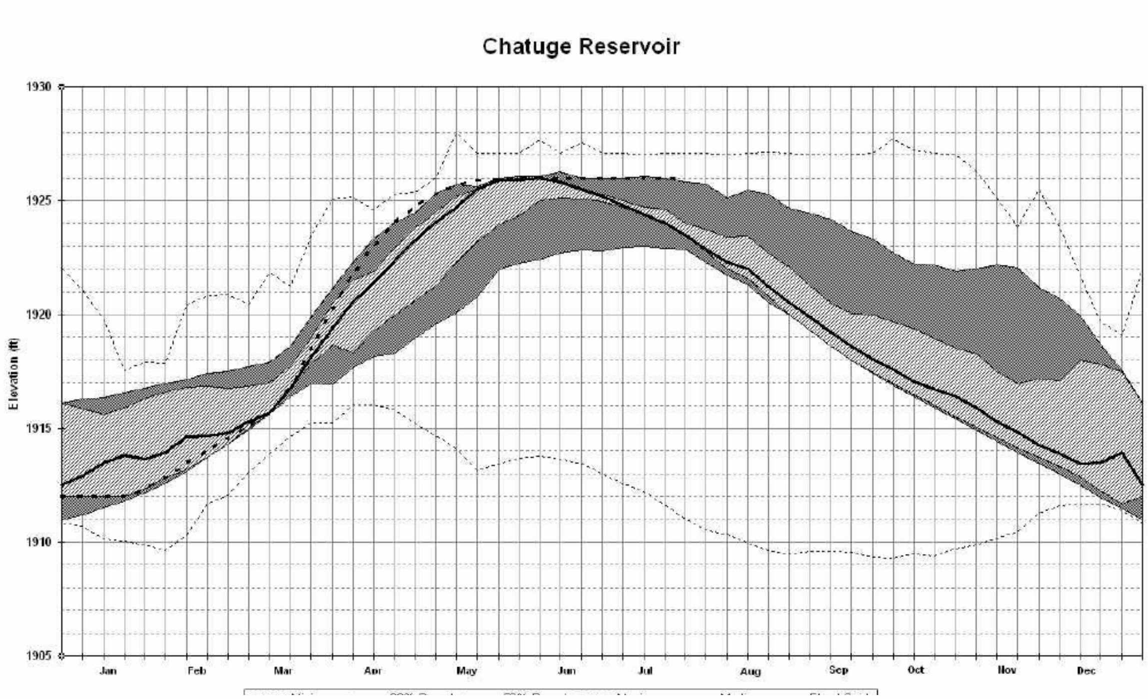


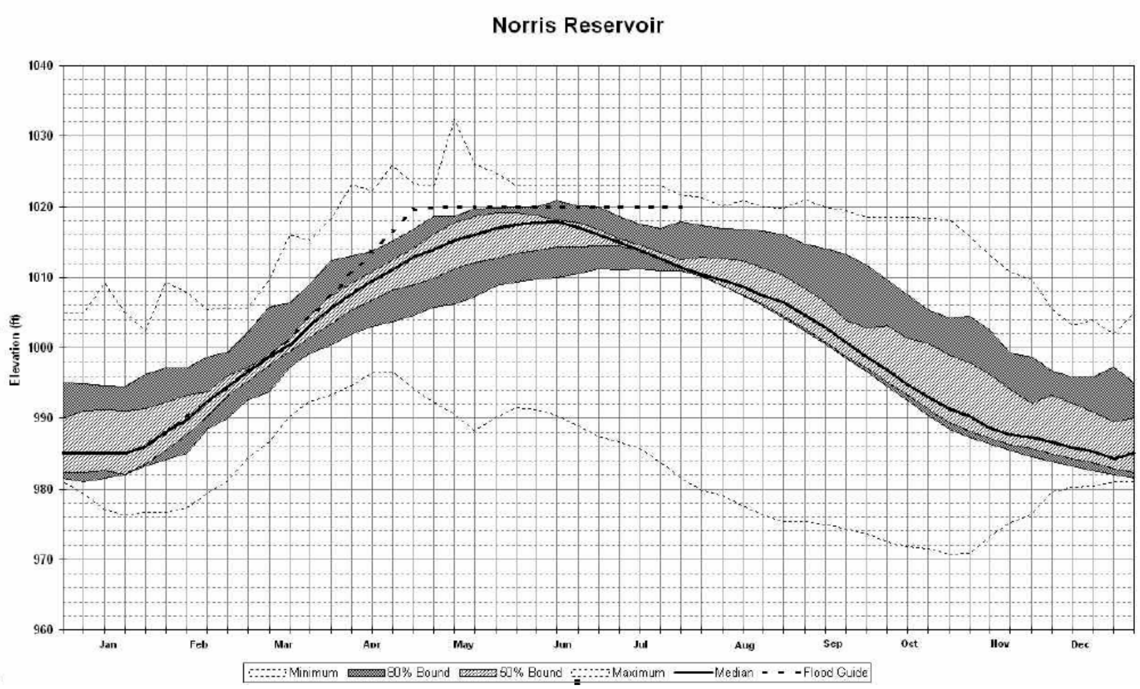
Elevation probability plots along with flood guide curves for tributary reservoirs under the Base Case (cont.)



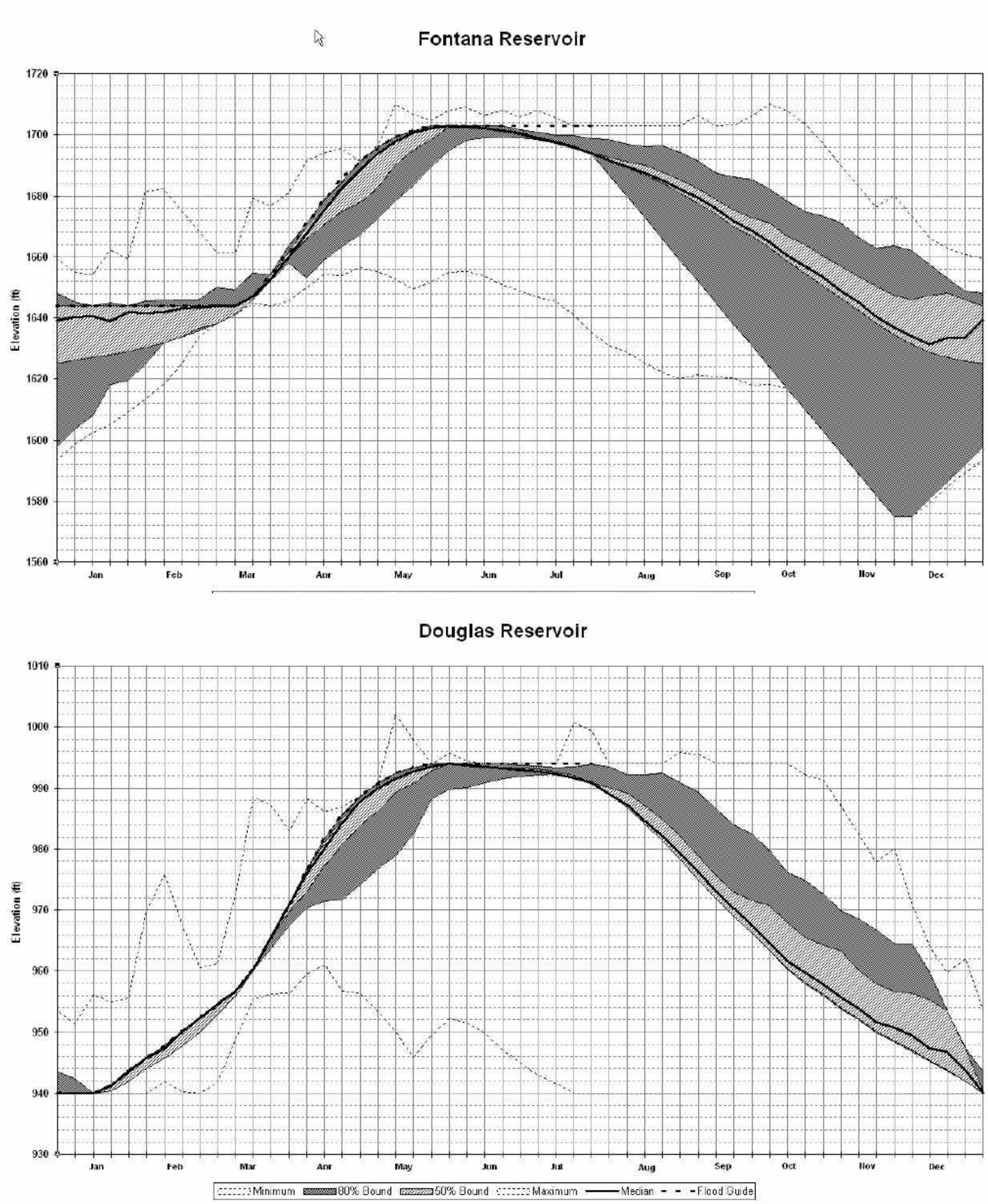


Elevation probability plots along with flood guide curves for tributary reservoirs under the Base Case (cont.)

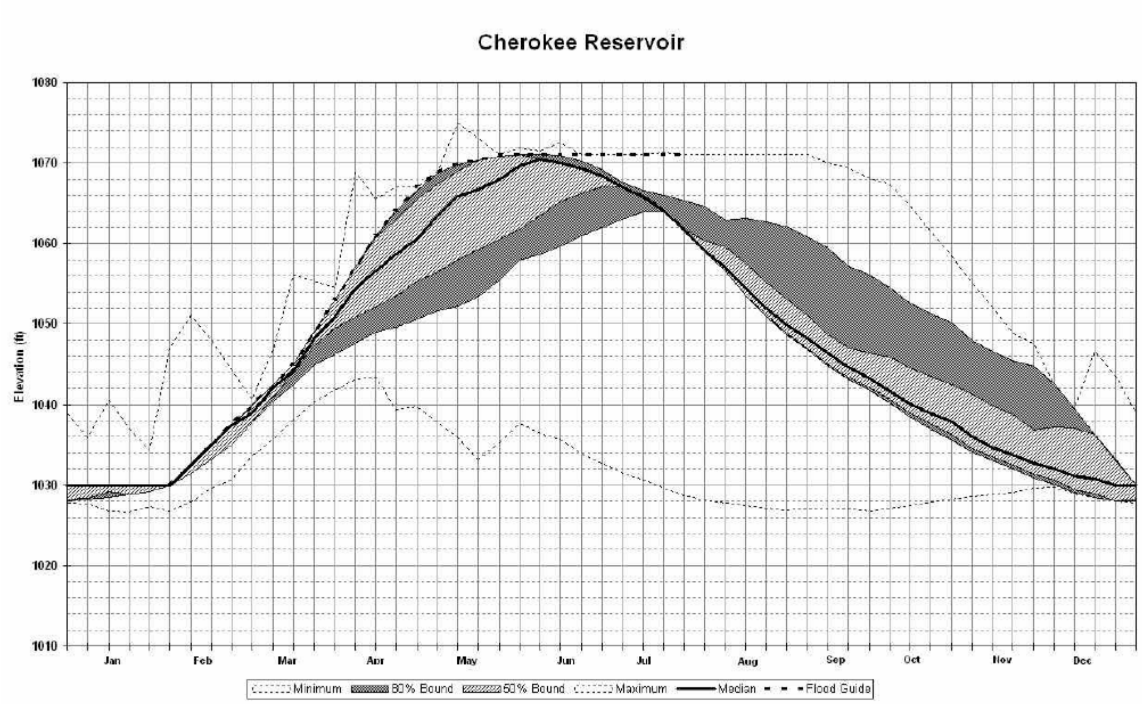


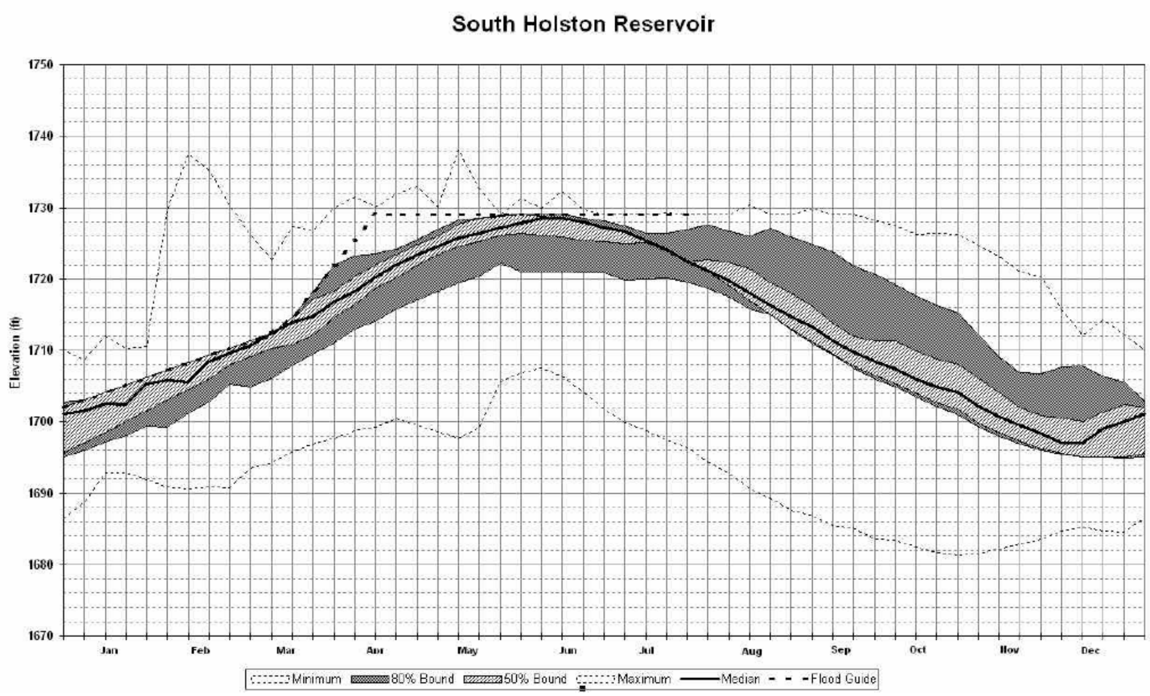


Elevation probability plots along with flood guide curves for tributary reservoirs under the Base Case (cont.)

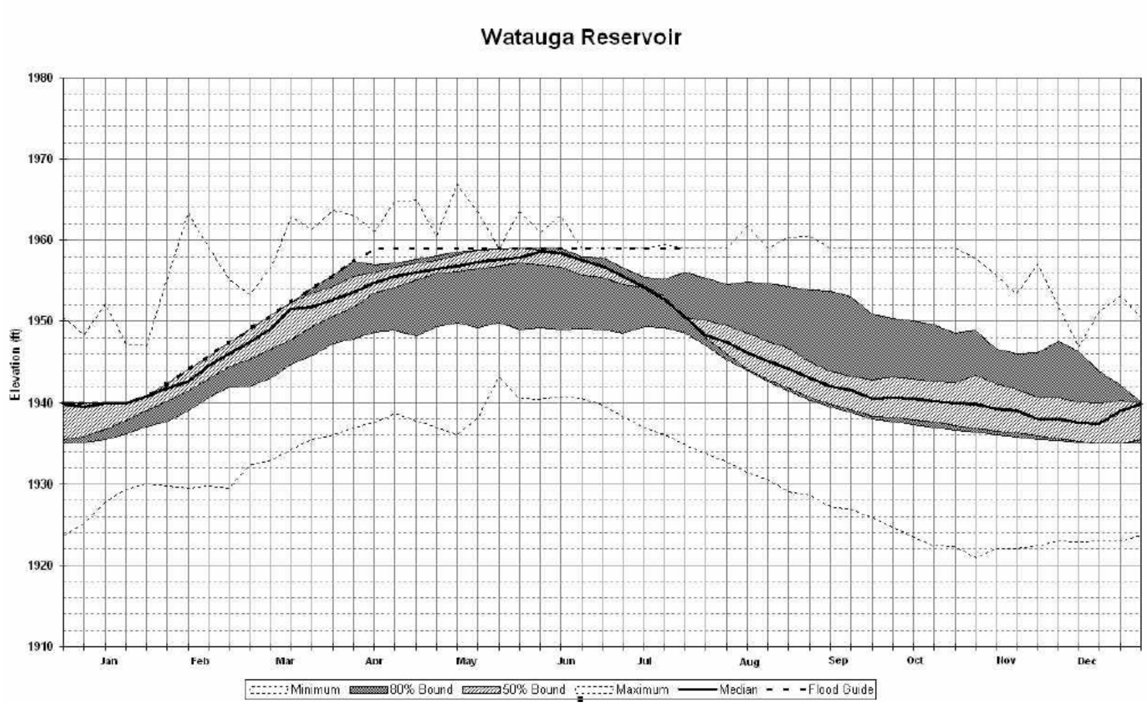


Elevation probability plots along with flood guide curves for tributary reservoirs under the Base Case (cont.)

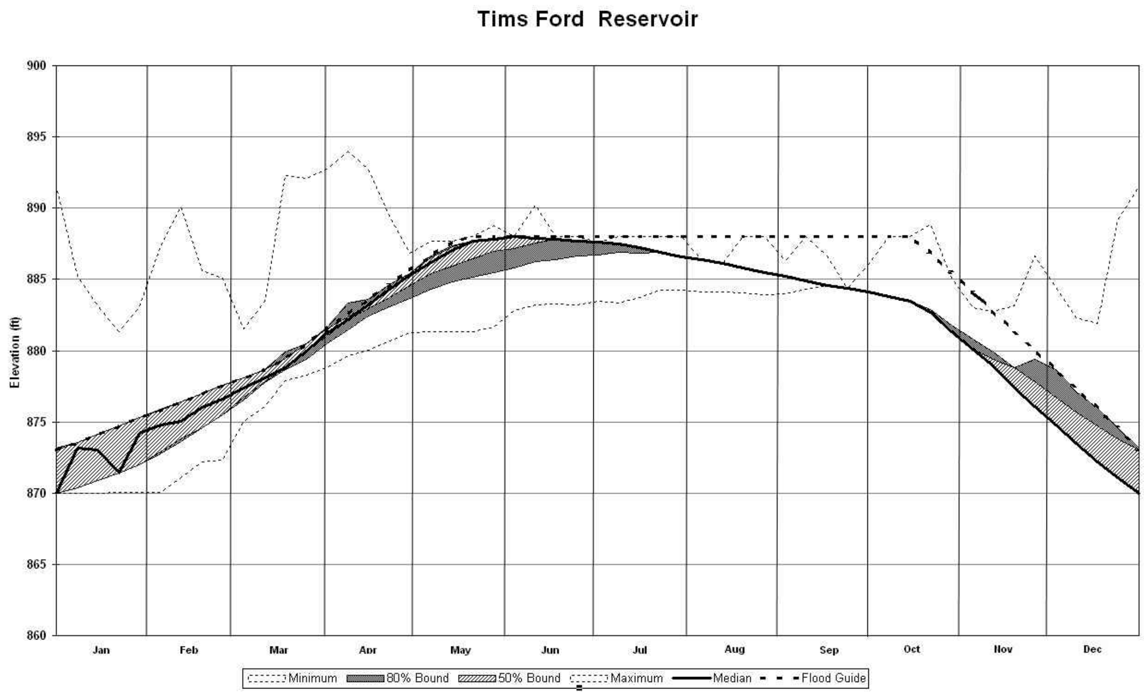


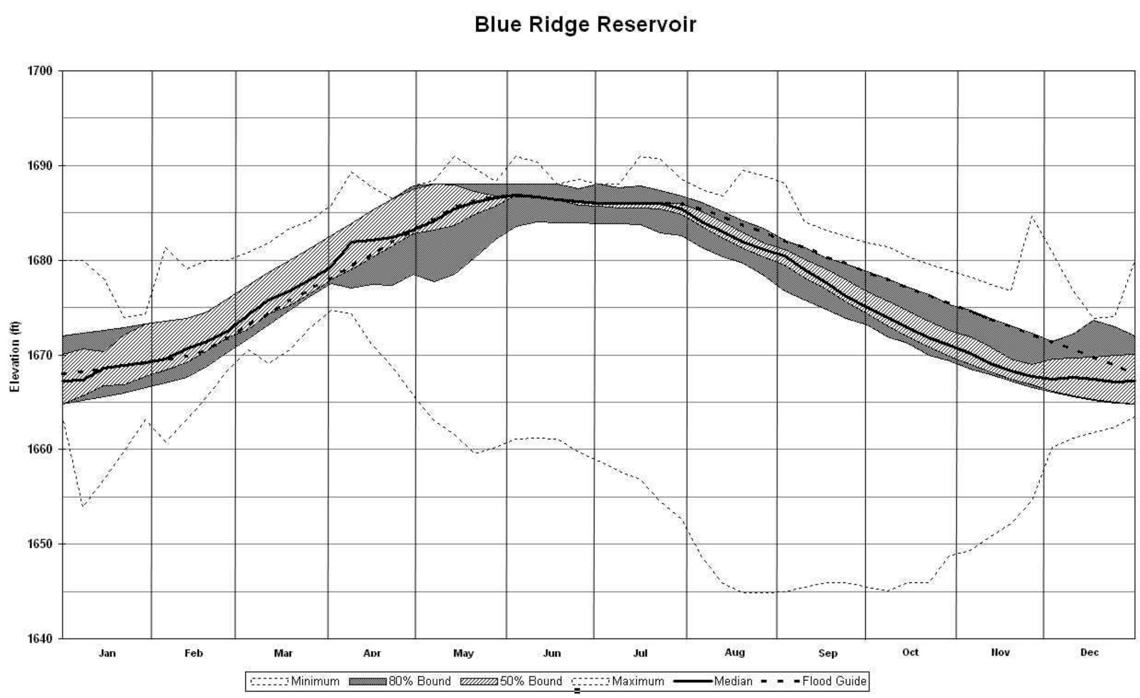


Elevation probability plots along with flood guide curves for tributary reservoirs under the Base Case (cont.)

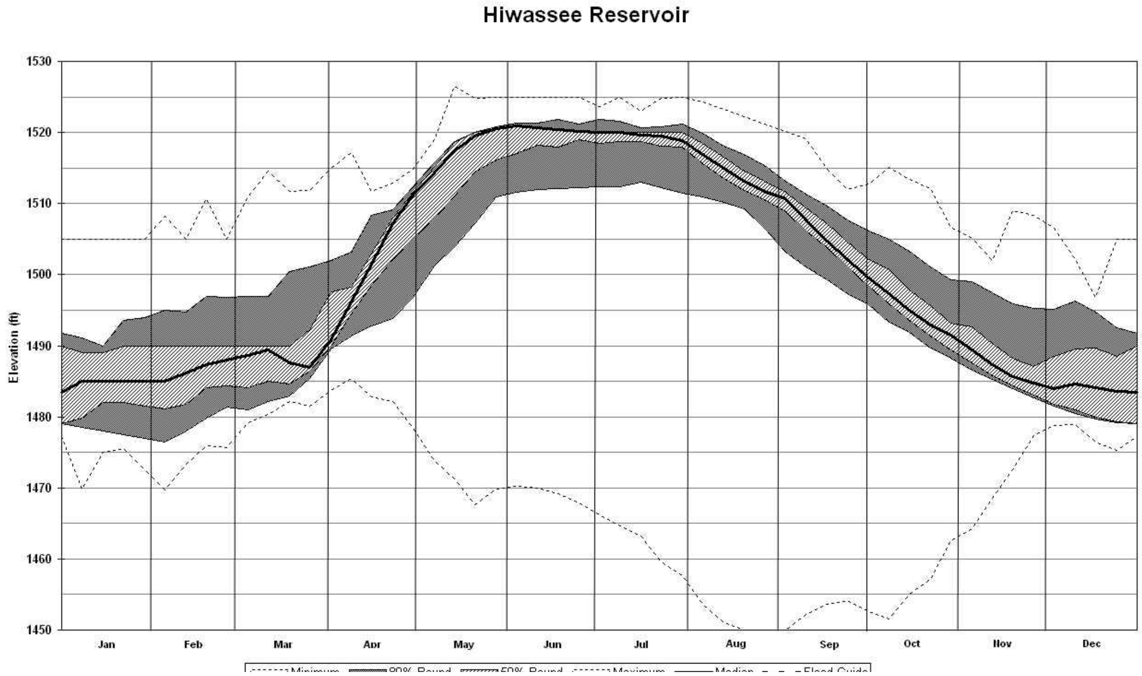


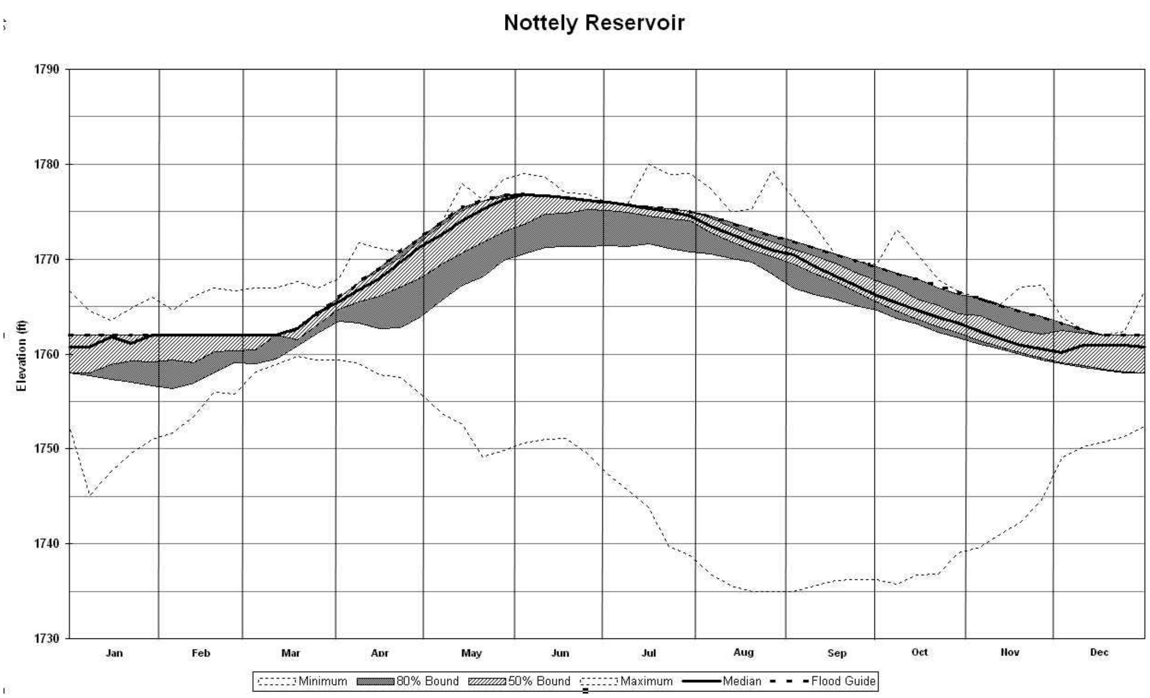
Elevation probability plots along with flood guide curves for tributary reservoirs under the Preferred Alternative



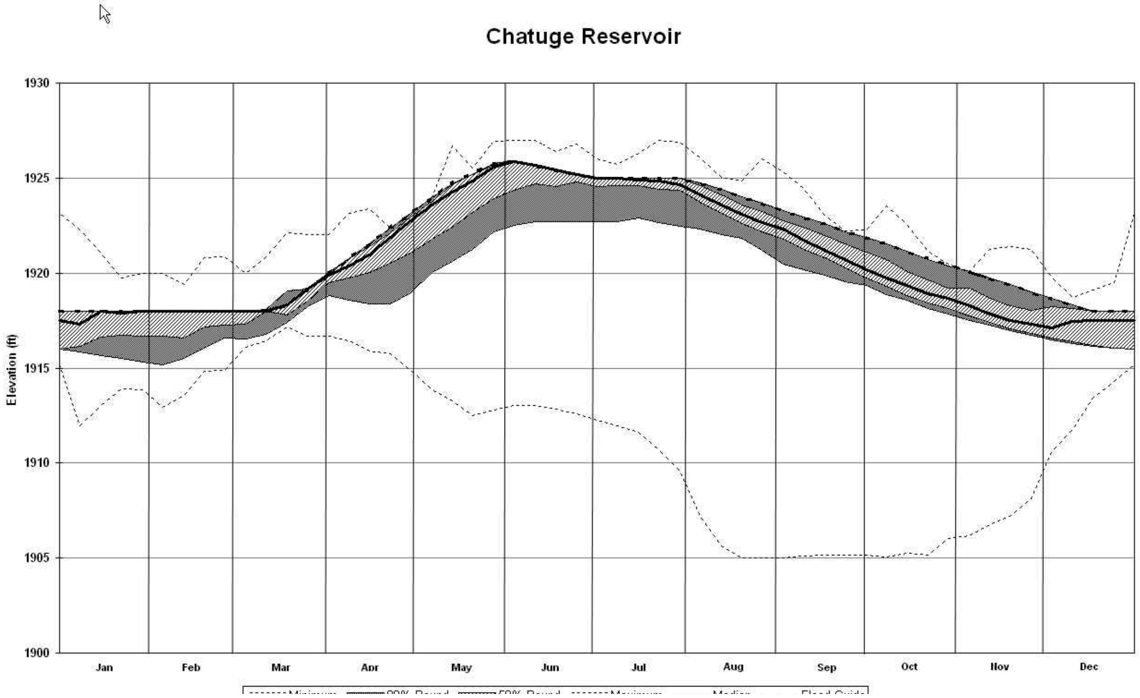


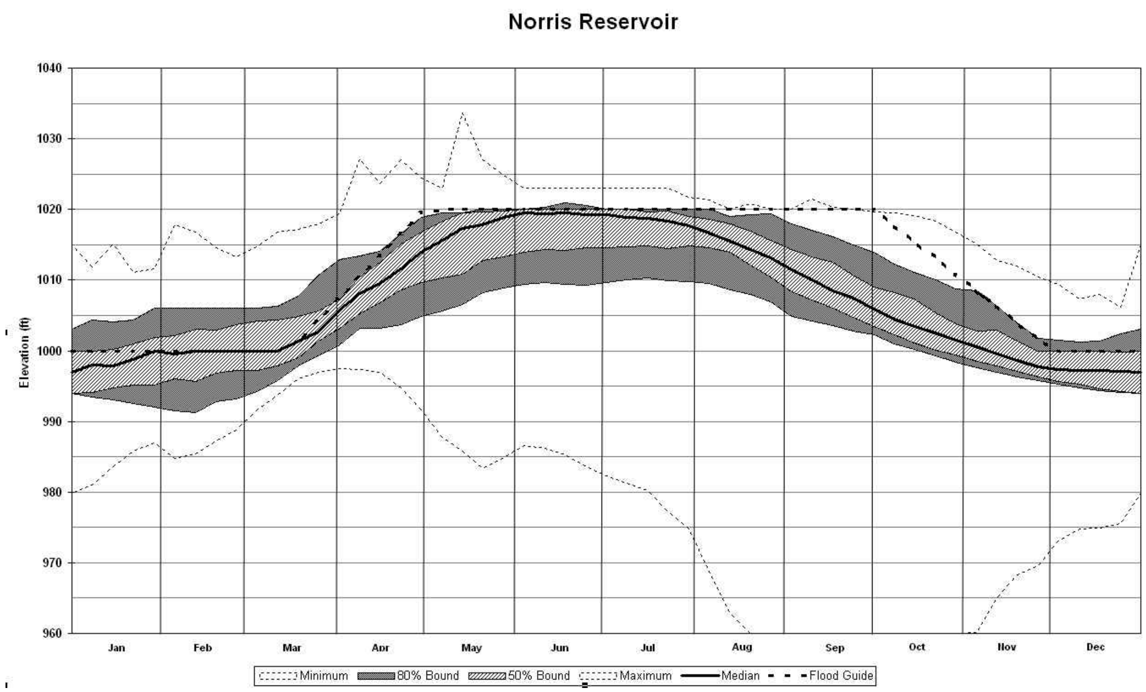
Elevation probability plots along with flood guide curves for tributary reservoirs under the Preferred Alternative (cont.)



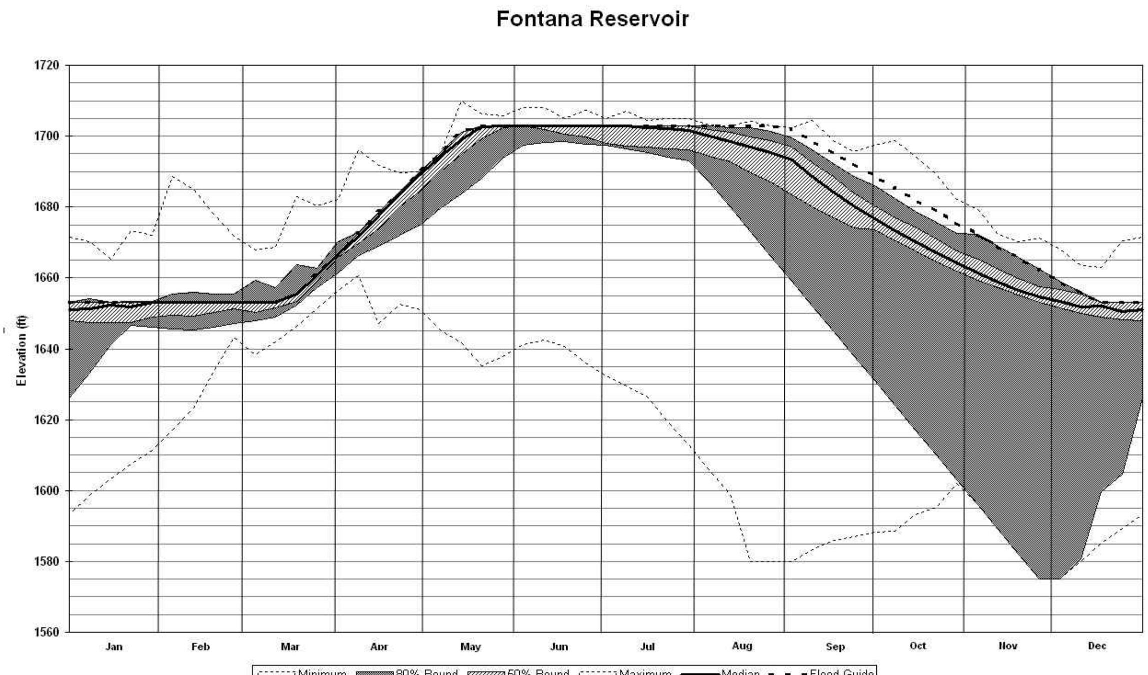


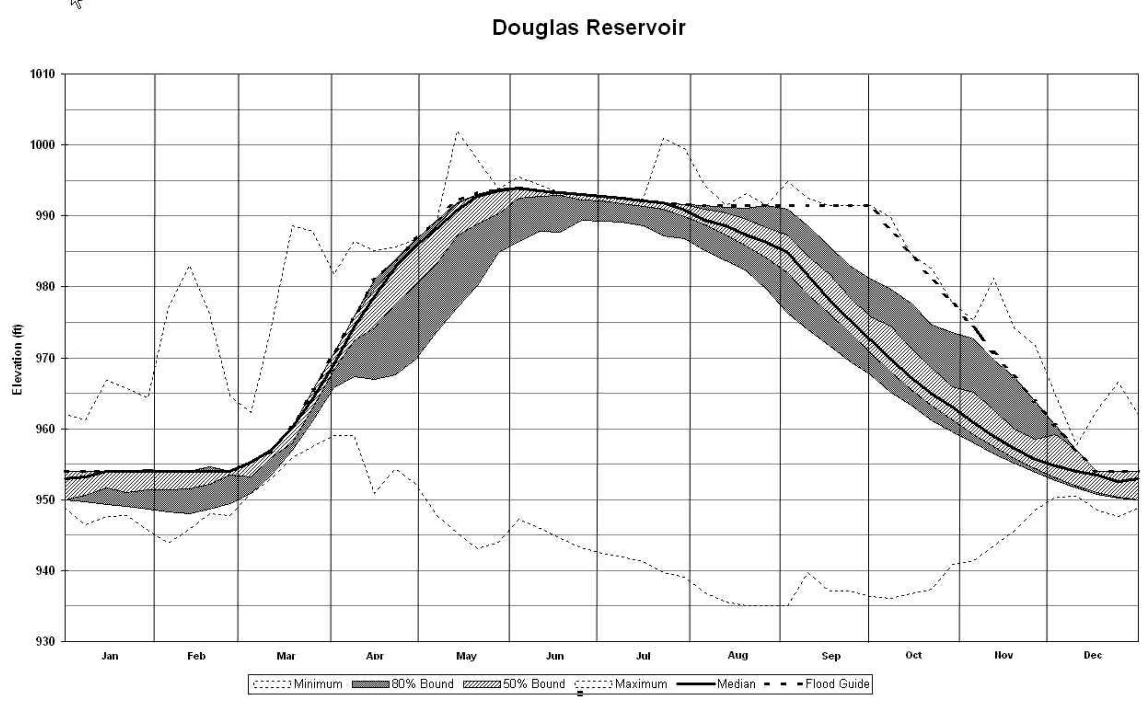
Elevation probability plots along with flood guide curves for tributary reservoirs under the Preferred Alternative (cont.)



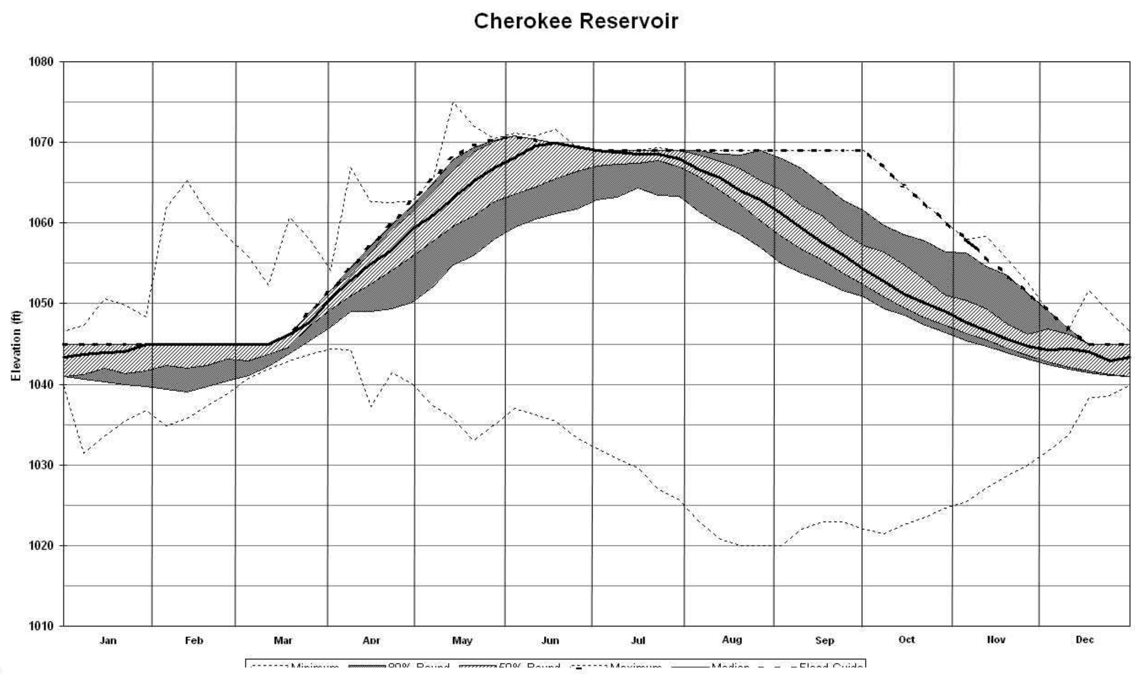


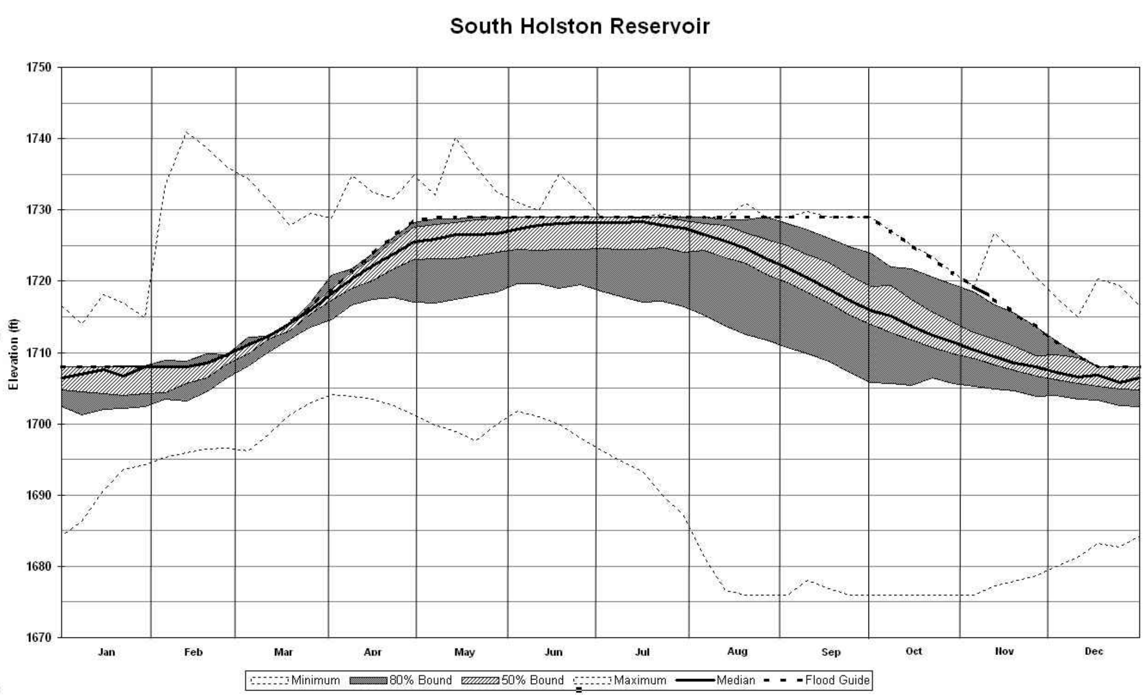
Elevation probability plots along with flood guide curves for tributary reservoirs under the Preferred Alternative (cont.)



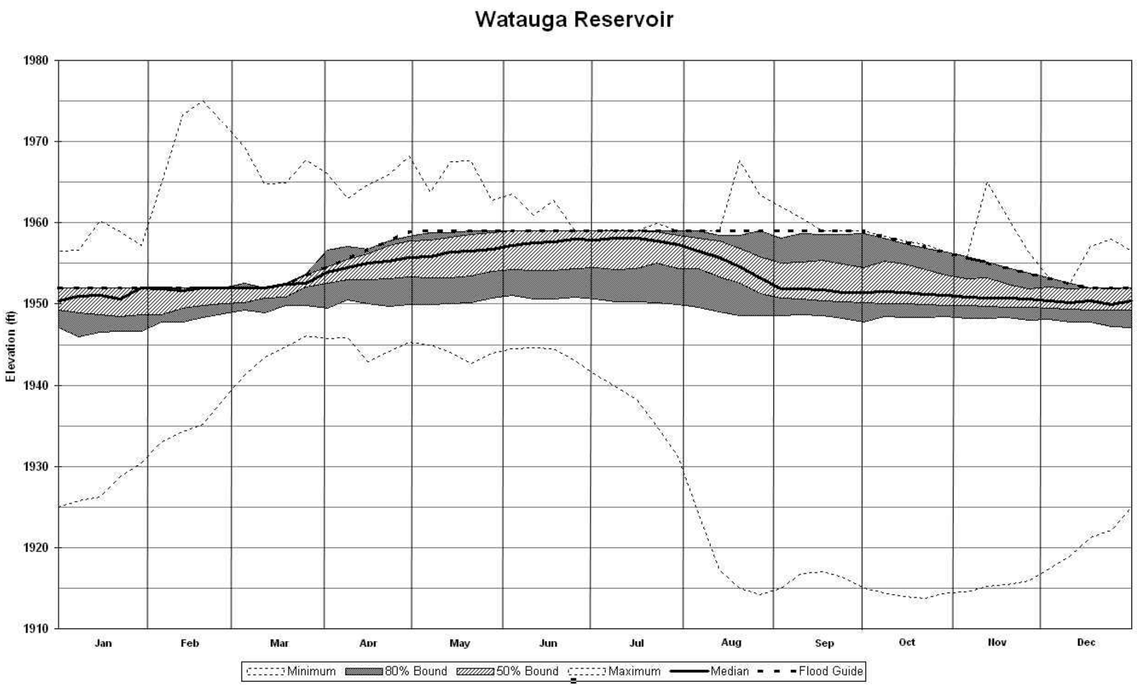


Elevation probability plots along with flood guide curves for tributary reservoirs under the Preferred Alternative (cont.)





Elevation probability plots along with flood guide curves for tributary reservoirs under the Preferred Alternative (cont.)



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Appendix D

Additional Information for Resource Areas

Appendix D

Appendix D1	Water Quality
Appendix D2	Groundwater Resources
Appendix D3	Aquatic Resources
Appendix D4	Wetlands
Appendix D5	Terrestrial Ecology
Appendix D6	Threatened and Endangered Species
Appendix D7	Cultural Resources
Appendix D8	Recreation
Appendix D9	Inter-Basin Transfers—A Sensitivity Analysis
Appendix D10	Social and Economic Resources

Appendix D1

Water Quality

TVA

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Table D1-01 303 (d) List of Impaired Waters along Mainstems and Major Tributaries of the TVA System

Waterbody ID	Affected Waterbody	State	County	Partially Impaired	Impaired	Cause	Pollutant Source
TN06010102 001-1000	South Fork Holston River	TN	Sullivan	5.5		Flow alterations Thermal modifications	Upstream impoundment
TN06010102 001-2000	South Fork Holston River	TN	Sullivan	2.4		Organic enrichment/ low DO Flow alterations Thermal modifications	Upstream impoundment
TN06010102 006-1000	Boone Reservoir	TN	Washington Sullivan	4,400 acres		PCBs Chlordane	Contaminated sediment
TN06010102 014-1000	South Fork Holston River	TN	Sullivan	4.4		Flow alterations Thermal modifications	Upstream impoundment
TN06010104 001-2000	Holston River	TN	Grainger Jefferson	26.9		Low DO Flow alteration	Upstream impoundment
TN06010107 006-2000	French Broad River	TN	Sevier	4.9		Low DO Thermal modifications Flow alteration	Upstream impoundment
TN06010201 1	Watts Bar Reservoir	TN	Rhea		3,900 acres	PCBs Mercury	Contaminated sediment
TN06010201 16	Tennessee River From Sweetwater Creek to Fort Loudoun Dam	TN	Loudon		10.8	Organic enrichment/ Low DO Flow alteration PCBs	Upstream impoundment Contaminated sediment
TN06010201 20	Fort Loudoun Reservoir	TN	Knox Loudoun		14,600 acres	PCBs	Contaminated sediment
TN06010201 026-1000	Little River	TN	Blount		7.1	PCBs	Contaminated sediment
TN06010204 001-1000	Tellico Reservoir	TN	Loudoun Monroe		16,500 acres	PCBs	Contaminated sediment

Table D1-01 303 (d) List of Impaired Waters along Mainstems and Major Tributaries of the TVA System (continued)

Waterbody ID	Affected Waterbody	State	County	Partially Impaired	Impaired	Cause	Pollutant Source
TN06010207 1	Clinch River and Tributaries	TN	Roane		42	PCBs Chlordane Metals	Industrial point source Contaminated sediment
TN06010207 006-1000	Melton Hill Reservoir	TN	Anderson		5,690 acres	PCBs Chlordane	Contaminated sediment
TN06010207 019-2000	Clinch River	TN	Anderson	7.4		Thermal modifications Flow alteration	Upstream impoundment
TN06020001 001-1000	Nickajack Reservoir	TN	Marion Hamilton	10,370.0 acres		PCBs Dioxins	Contaminated sediment
TN06020002 018-3000 & 4000	Hiwassee River	TN	Polk	11.4		Flow alteration	Upstream impoundment
TN06020003 004-1000 & 2000	Parksville-Reservoir Ocoee Dam #1 to Baker Creek is partial From Baker Creek to reservoir headwaters is not supporting	TN	Polk	704 acres	576 acres	Metals Siltation	Contaminated sediment
TN06020003 013-1000	Ocoee River-Parksville-Reservoir to Ocoee #2 Dam is not supporting	TN	Polk		4.7	Metals Flow alteration	Resource extraction Upstream impoundment
TN06020003 013.5-1000	Ocoee #2 Reservoir	TN	Polk		494 acres	Metals Siltation Flow alteration	Contaminated sediment Resource extraction Upstream impoundment
TN06020003 013.55-1000	Ocoee River From Reservoir #2 to Dam #3 is not supporting	TN	Polk		3.9	Metals Siltation Flow alteration	Contaminated sediment Resource extraction Upstream impoundment

Table D1-01 303 (d) List of Impaired Waters along Mainstems and Major Tributaries of the TVA System (continued)

Waterbody ID	Affected Waterbody	State	County	Partially Impaired	Impaired	Cause	Pollutant Source
TN06020003 013.7-1000	Ocoee #3 Reservoir	TN	Polk		480 acres	Metals Siltation	Abandoned mining Contaminated sediment
AL/06030004 060_01	Shoal Creek	AL	Limestone		X	Pathogens	Pasture grazing
AL/06030004 080_01	Big Creek	AL	Limestone	X		OE/DO	Pasture grazing
AL/Wheeler Res_02	Elk River	AL	Limestone	X		pH/OE/DO	Pasture grazing Nonirrigated crop production
AL/06030005 010_01	Big Nance Creek	AL	Lawrence		X	Pesticides, ammonia, siltation, OE/DO, pathogens	Nonirrigated crop production Int. animal feeding operation Landfills, Pasture grazing
AL/06030005 040_01	Town Creek	AL	Lawrence		X	OE/DO	Nonirrigated crop production Pasture grazing
	Nottely River Toccoa River	GA GA	Union Fannin	X X		Fecal coliform DO, fecal coliform	Non-point source Dam release/non-point source

Notes:
DO = Dissolved oxygen.
PCBs = Polychlorinated biphenyls.
OE = Organic enrichment.

Sources:
State of Alabama. 2002. Federal 303(d) List of Impaired Waters for Alabama.
State of Georgia. 2002. Federal 305(b)/303(d) List of Impaired Waters for Georgia.
State of Tennessee. 2002. Federal 303(d) List of Impaired Waters for Tennessee.

Table D1-02 Summary of Modeling Results for Reservoir Dynamics and Water Quality Characteristics on Representative Reservoirs for Alternatives Other Than the Summer Hydropower Alternative (see Table D1-03)

Reservoir	Water Quality Category	Data (Average Condition)	Alternative[1]							
			Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
South Holston	Reservoir hydrodynamics	Summer residence time 6/1 - 9/30 (d)	435	579	634	641	449	677	556	483
		Days forebay surface-bottom temp. ≥4 °C (# d)	220	220	220	219	220	219	220	221
		Maximum forebay surface-bottom temp. diff. (°C)	22	22	22	22	22	22	22	22
		Sum daily total reservoir vol. (million m3-d)	254,604	268,309	279,998	268,037	251,940	281,604	269,932	261,428
	Dissolved oxygen	Sum daily vol. DO ≤5 (million m3-d)	45,300	48,845	49,953	48,527	45,280	50,218	50,023	47,644
		Minimum reservoir vol. DO ≥5 (mil. m3-d) on "worst-case"	174	200	205	181	172	210	198	185
		Sum daily vol. DO ≤2 (million m3-d) 7/1 – 10/31	15,020	14,762	14,500	14,828	15,320	14,417	14,957	15,068
		Sum daily vol. DO ≤2 (million m3-d) 6/1 – 9/30	10,309	10,239	10,089	10,045	10,434	10,076	10,308	10,387
		Sum daily vol. DO ≤1 (million m3-d)	9,563	9,202	8,999	9,239	9,707	8,879	9,287	9,526
	Temperature	Sum daily vol. temp. >26 (million m3-d)	1,568	1,835	1,851	1,526	1,540	1,852	1,764	1,674
		Sum daily vol. temp. ≤10 (million m3-d)	143,722	153,099	162,086	151,514	141,460	162,702	153,766	146,823

Table D1-02 Summary of Modeling Results for Reservoir Dynamics and Water Quality Characteristics on Representative Reservoirs for Alternatives Other Than the Summer Hydropower Alternative (see Table D1-03) (continued)

Reservoir	Water Quality Category	Data (Average Condition)	Alternative[1]							
			Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Boone	Reservoir hydrodynamics	Summer residence time 6/1 - 9/30 (d)	25	31	32	30	25	30	33	29
		Days forebay surface-bottom temp. ≥4 °C (# d)	219	219	212	215	221	216	220	221
		Maximum forebay surface-bottom temp. diff. (°C)	19	19	19	18	19	19	19	19
		Sum daily total reservoir vol. (million m3-d)	37,885	37,849	37,385	37,108	37,931	37,368	37,876	38,416
	Dissolved oxygen	Sum daily vol. DO ≤5 (million m3-d)	5,568	7,088	6,476	6,127	5,820	6,837	6,822	6,177
		Minimum reservoir vol. DO ≥5 (mil. m3-d) on "worst-case"	64	57	59	52	63	59	60	61
		Sum daily vol. DO ≤2 (million m3-d) 7/1 – 10/31	17	579	618	312	122	372	625	183
		Sum daily vol. DO ≤2 (million m3-d) 6/1 – 9/30	38	627	592	285	199	367	621	199
		Sum daily vol. DO ≤1 (million m3-d)	1	93	33	36	50	46	28	17
	Temperature	Sum daily vol. temp. >26 (million m3-d)	1,966	2,357	2,386	1,195	1,976	2,376	2,458	2,306
		Sum daily vol. temp. ≤10 (million m3-d)	10,791	10,937	11,218	11,958	10,790	11,232	10,969	11,285

Table D1-02 Summary of Modeling Results for Reservoir Dynamics and Water Quality Characteristics on Representative Reservoirs for Alternatives Other Than the Summer Hydropower Alternative (see Table D1-03) (continued)

Reservoir	Water Quality Category	Data (Average Condition)	Alternative[1]							
			Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Douglas	Reservoir hydrodynamics	Summer residence time 6/1 - 9/30 (d)	72	83	99	85	74	98	120	75
		Days forebay surface-bottom temp. ≥4 °C (# d)	182	183	186	174	181	186	186	182
		Maximum forebay surface-bottom temp. diff. (°C)	18	18	18	16	17	18	18	18
		Sum daily total reservoir vol. (million m3-d)	242,040	268,404	290,573	194,840	238,533	288,649	297,091	251,913
	Dissolved oxygen	Sum daily vol. DO ≤5 (million m3-d)	69,139	75,454	82,175	46,525	68,803	81,829	88,573	70,137
		Minimum reservoir vol. DO ≥5 (mil. m3-d) on "worst-case"	180	258	268	187	178	262	273	257
		Sum daily vol. DO ≤2 (million m3-d) 7/1 – 10/31	23,836	26,780	30,296	13,426	23,856	30,151	33,127	24,088
		Sum daily vol. DO ≤2 (million m3-d) 6/1 – 9/30	28,419	31,385	34,793	18,220	28,367	34,633	37,024	28,666
		Sum daily vol. DO ≤1 (million m3-d)	22,393	24,869	27,825	14,852	22,337	27,679	30,090	22,835
	Temperature	Sum daily vol. temp. >26 (million m3-d)	15,466	16,675	17,339	14,787	15,321	17,383	17,132	14,273
		Sum daily vol. temp. ≤10 (million m3-d)	41,499	54,958	59,495	44,999	40,816	59,263	55,964	49,140

Table D1-02 Summary of Modeling Results for Reservoir Dynamics and Water Quality Characteristics on Representative Reservoirs for Alternatives Other Than the Summer Hydropower Alternative (see Table D1-03) (continued)

Reservoir	Water Quality Category	Data (Average Condition)	Alternative[1]							
			Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Melton Hill	Reservoir hydrodynamics	Summer residence time 6/1 - 9/30 (d)	16	20	24	26	15	23	23	19
		Days forebay surface-bottom temp. ≥4 °C (# d)	176	179	176	170	174	178	175	179
		Maximum forebay surface-bottom temp. diff. (°C)	17	17	17	17	17	18	17	17
		Sum daily total reservoir vol. (million m3-d)	43,418	43,308	43,103	43,142	43,179	46,531	43,029	45,513
	Dissolved oxygen	Sum daily vol. DO ≤5 (million m3-d)	314	771	987	1,442	291	743	1,196	529
		Minimum reservoir vol. DO ≥5 (mil. m3-d) on "worst-case"	105	101	98	94	106	104	93	110
		Sum daily vol. DO ≤2 (million m3-d) 7/1 – 10/31	11	85	80	117	14	25	179	9
		Sum daily vol. DO ≤2 (million m3-d) 6/1 – 9/30	28	108	98	145	25	26	193	27
		Sum daily vol. DO ≤1 (million m3-d)	8	41	31	54	7	5	81	7
	Temperature	Sum daily vol. temp. >26 (million m3-d)	1,870	2,769	3,131	3,537	1,816	2,806	2,980	2,045
		Sum daily vol. temp. ≤10 (million m3-d)	12,058	12,882	13,374	13,381	11,977	14,793	12,519	13,270

Table D1-02 Summary of Modeling Results for Reservoir Dynamics and Water Quality Characteristics on Representative Reservoirs for Alternatives Other Than the Summer Hydropower Alternative (see Table D1-03) (continued)

Reservoir	Water Quality Category	Data (Average Condition)	Alternative[1]							
			Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Guntersville	Reservoir hydrodynamics	Summer residence time 6/1 - 9/30 (d)	17	19	22	24	17	22	23	19
		Days forebay surface-bottom temp. ≥4 °C (# d)	55	57	58	56	52	56	62	57
		Maximum forebay surface-bottom temp. diff. (°C)	9	9	9	9	8	9	9	9
		Sum daily total reservoir vol. (million m3-d)	400,001	401,851	404,928	402,555	400,053	404,946	401,636	404,875
	Dissolved oxygen	Sum daily vol. DO ≤5 (million m3-d)	11,231	13,076	14,446	12,948	10,639	14,217	15,577	11,541
		Minimum reservoir vol. DO ≥5 (mil. m3-d) on "worst-case"	896	887	875	898	902	892	870	929
		Sum daily vol. DO ≤2 (million m3-d) 7/1 – 10/31	1,290	1,939	2,455	1,652	1,361	2,436	2,750	1,102
		Sum daily vol. DO ≤2 (million m3-d) 6/1 – 9/30	2,279	3,080	3,612	3,041	2,264	3,529	3,806	1,913
		Sum daily vol. DO ≤1 (million m3-d)	1,767	2,329	2,721	2,015	1,441	2,587	2,400	1,342
	Temperature	Sum daily vol. temp. >26 (million m3-d)	105,019	107,543	110,937	111,577	105,043	110,923	107,693	109,153
		Sum daily vol. temp. ≤10 (million m3-d)	87,475	88,429	88,366	88,582	87,579	88,473	88,384	88,150

Table D1-02 Summary of Modeling Results for Reservoir Dynamics and Water Quality Characteristics on Representative Reservoirs for Alternatives Other Than the Summer Hydropower Alternative (see Table D1-03) (continued)

Reservoir	Water Quality Category	Data (Average Condition)	Alternative[1]							
			Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Pickwick	Reservoir hydrodynamics	Summer residence time 6/1 - 9/30 (d)	16	18	21	23	15	21	22	18
		Days forebay surface-bottom temp. ≥4 °C (# d)	72	76	77	77	70	76	78	77
		Maximum forebay surface-bottom temp. diff. (°C)	10	10	10	10	10	10	10	10
		Sum daily total reservoir vol. (million m3-d)	368,754	383,813	386,237	368,547	376,538	386,268	382,471	375,957
	Dissolved oxygen	Sum daily vol. DO ≤5 (million m3-d)	21,309	24,122	25,515	25,042	20,893	25,396	26,298	22,442
		Minimum reservoir vol. DO ≥5 (mil. m3-d) on "worst-case"	717	703	692	723	712	698	670	757
		Sum daily vol. DO ≤2 (million m3-d) 7/1 – 10/31	3,342	4,937	6,069	5,351	3,246	6,018	5,971	4,268
		Sum daily vol. DO ≤2 (million m3-d) 6/1 – 9/30	5,304	7,124	8,285	7,834	5,127	8,187	8,172	6,212
		Sum daily vol. DO ≤1 (million m3-d)	3,447	4,583	5,492	4,965	3,247	5,454	5,107	3,983
	Temperature	Sum daily vol. temp. >26 (million m3-d)	99,407	101,415	102,172	102,402	98,953	102,392	98,233	103,794
		Sum daily vol. temp. ≤10 (million m3-d)	74,937	80,507	80,517	74,900	80,421	80,586	80,726	74,888

Table D1-02 Summary of Modeling Results for Reservoir Dynamics and Water Quality Characteristics on Representative Reservoirs for Alternatives Other Than the Summer Hydropower Alternative (see Table D1-03) (continued)

Reservoir	Water Quality Category	Data (Average Condition)	Alternative[1]							
			Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Kentucky	Reservoir hydrodynamics	Summer residence time 6/1 - 9/30 (d)	39	45	51	48	36	51	50	41
		Days forebay surface-bottom temp. ≥4 °C (# d)	46	48	49	49	40	48	52	49
		Maximum forebay surface-bottom temp. diff. (°C)	8	8	8	8	8	8	9	9
		Sum daily total reservoir vol. (million m3-d)	989,951	1,013,106	1,071,116	993,578	1,037,845	1,071,091	1,014,296	988,419
	Dissolved oxygen	Sum daily vol. DO ≤5 (million m3-d)	34,388	39,615	43,010	41,858	31,333	42,918	53,955	38,445
		Minimum reservoir vol. DO ≥5 (mil. m3-d) on "worst-case"	2,194	2,284	2,324	2,203	2,215	2,335	2,068	2,204
		Sum daily vol. DO ≤2 (million m3-d) 7/1 – 10/31	2,824	3,416	5,205	4,727	1,723	5,252	8,079	3,180
		Sum daily vol. DO ≤2 (million m3-d) 6/1 – 9/30	3,504	4,216	5,974	5,420	1,916	6,027	10,395	4,229
		Sum daily vol. DO ≤1 (million m3-d)	954	918	1,881	1,721	492	1,941	4,753	1,028
	Temperature	Sum daily vol. temp. >26 (million m3-d)	267,947	278,028	281,759	278,123	268,687	282,336	273,752	264,727
		Sum daily vol. temp. ≤10 (million m3-d)	219,849	220,728	243,234	220,197	243,591	243,268	219,779	219,345

Table D1-02 Summary of Modeling Results for Reservoir Dynamics and Water Quality Characteristics on Representative Reservoirs for Alternatives Other Than the Summer Hydropower Alternative (see Table D1-03) (continued)

Reservoir	Water Quality Category	Data (Average Condition)	Alternative[1]							
			Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Hiwassee	Reservoir hydrodynamics	Summer residence time 6/1 - 9/30 (d)	70	80	89	82	74	93	112	79
		Days forebay surface-bottom temp. ≥4 °C (# d)	232	222	221	225	220	221	226	220
		Maximum forebay surface-bottom temp. diff. (°C)	20	19	19	19	19	19	19	19
		Sum daily total reservoir vol. (million m3-d)	93,821	98,452	100,767	88,119	92,850	99,357	101,640	98,340
	Dissolved oxygen	Sum daily vol. DO ≤5 (million m3-d)	10,217	11,200	12,565	9,309	10,242	12,799	14,055	10,669
		Minimum reservoir vol. DO ≥5 (mil. m3-d) on "worst-case"	155	151	143	131	148	138	134	154
		Sum daily vol. DO ≤2 (million m3-d) 7/1 – 10/31	1,533	1,754	2,130	1,551	1,426	2,425	3,014	1,606
		Sum daily vol. DO ≤2 (million m3-d) 6/1 – 9/30	1,387	1,626	1,899	1,421	1,317	2,202	2,383	1,468
		Sum daily vol. DO ≤1 (million m3-d)	790	884	1,045	914	759	1,196	1,521	833
	Temperature	Sum daily vol. temp. >26 (million m3-d)	836	818	830	755	784	865	703	781
		Sum daily vol. temp. ≤10 (million m3-d)	27,005	30,540	30,100	26,403	28,027	29,505	31,419	40,376

Table D1-02 Summary of Modeling Results for Reservoir Dynamics and Water Quality Characteristics on Representative Reservoirs for Alternatives Other Than the Summer Hydropower Alternative (see Table D1-03) (continued)

Reservoir	Water Quality Category	Data (Average Condition)	Alternative[1]							
			Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Watts Bar	Reservoir hydrodynamics	Summer residence time 6/1 - 9/30 (d)	21	24	27	29	21	27	30	23
		Days forebay surface-bottom temp. ≥4 °C (# d)	160	164	169	165	160	169	181	162
		Maximum forebay surface-bottom temp. diff. (°C)	16	16	16	15	15	16	16	16
		Sum daily total reservoir vol. (million m3-d)	340,084	349,162	350,967	330,958	348,132	350,960	348,422	341,731
	Dissolved oxygen	Sum daily vol. DO ≤5 (million m3-d)	67,675	70,125	71,312	68,096	67,647	71,283	64,592	81,841
		Minimum reservoir vol. DO ≥5 (mil. m3-d) on "worst-case"	370	364	362	345	367	365	393	312
		Sum daily vol. DO ≤2 (million m3-d) 7/1 – 10/31	12,590	17,418	21,576	20,969	12,169	21,308	17,002	21,580
		Sum daily vol. DO ≤2 (million m3-d) 6/1 – 9/30	16,816	22,115	25,093	23,928	16,331	25,001	20,069	27,665
		Sum daily vol. DO ≤1 (million m3-d)	6,557	9,953	13,097	12,776	6,174	12,886	9,029	14,604
	Temperature	Sum daily vol. temp. >26 (million m3-d)	40,633	43,911	48,667	51,454	39,894	48,104	57,879	41,602
		Sum daily vol. temp. ≤10 (million m3-d)	77,861	84,572	83,869	78,284	82,559	84,158	83,719	79,053

Note: DO = Dissolved oxygen.

Table D1-03 Summary of Modeling Results for Reservoir Dynamics and Water Quality Characteristics on Representative Reservoirs under the Summer Hydropower Alternative (Based on Rainfall and Flows in 1990–1994, the Only Consecutive Years That Allowed Successful Model Runs)

Sites	Data	Modeled Metric Results for Base Case and Summer Hydropower Alternative	
		Base Case	Summer Hydropower
South Holston	Summer residence time 6/1 - 9/30 (days)	462	394
	Days forebay surface-bottom temp>=4 ºC (d)	227	225
	Max. forebay surface-bottom temp. (ºC)	22	22
	Sum daily res. vol. (million m3-d)	258,936	270,147
	Sum daily vol. DO<=5 (million m3-d)	50,030	51,161
	Min. res. vol. DO>=5 (mil. M3) on "worst-case" d	161	143
	Sum daily vol. DO<=2 (million m3-d) 7/1 - 10/31	17,410	17,459
	Sum daily vol. DO<=2 (million m3-d) 6/1 - 9/30	11,992	11,891
	Sum daily vol. DO<=1 (million m3-d)	9,563	11476
	Sum daily vol. temp. >26 (million m3-d)	1,648	1,644
	Sum daily vol. temp. <=10 (million m3-d)	141,907	147,451
Boone	Summer residence time 6/1 - 9/30 (days)	23	16
	Days forebay surface-bottom temp>=4ºC (d)	223	209
	Max. forebay surface-bottom temp. (ºC)	19	18
	Sum daily res. vol. (million m3-d)	37,907	31,886
	Sum daily vol. DO<=5 (million m3-d)	5,544	3,328
	Min. res. vol. DO>=5 (mil. M3) on "worst-case" d	65	46
	Sum daily vol. DO<=2 (million m3-d) 7/1 - 10/31	14	22
	Sum daily vol. DO<=2 (million m3-d) 6/1 - 9/30	12	22
	Sum daily vol. DO<=1 (million m3-d)	1	4
	Sum daily vol. temp. >26 (million m3-d)	2,088	1,299
	Sum daily vol. temp. <=10 (million m3-d)	10,207	10,416
Douglas	Summer residence time 6/1-9/30 (days)	78	57
	Days forebay surface-bottom temp>=4 ºC (d)	195	192
	Max. forebay surface-bottom temp. (ºC)	18	18
	Sum daily res. vol. (million m3-d)	256,182	253,705
	Sum daily vol. DO<=5 (million m3-d)	82,743	65,985

Table D1-03 Summary of Modeling Results for Reservoir Dynamics and Water Quality Characteristics on Representative Reservoirs under the Summer Hydropower Alternative (Based on Rainfall and Flows in 1990–1994, the Only Consecutive Years That Allowed Successful Model Runs) (continued)

Sites	Data	Modeled Metric Results for Base Case and Summer Hydropower Alternative	
		Base Case	Summer Hydropower
Douglas (continued)	Min. res. vol. DO>=5 (mil. m3) on "worst-case" d	185	245
	Sum daily vol. DO<=2 (million m3-d) 7/1 - 10/31	28,774	19,046
	Sum daily vol. DO<=2 (million m3-d) 6/1 - 9/30	33,956	23,944
	Sum daily vol. DO<=1 (million m3-d)	22,393	18,765
	Sum daily vol. temp. >26 (million m3-d)	17,037	16,465
	Sum daily vol. temp. <=10 (million m3-d)	40,173	55,925
Hiwassee	Summer residence time 6/1-9/30 (days)	65	67
	Days forebay surface-bottom temp>=4 ºC (d)	234	219
	Max. forebay surface-bottom temp. (ºC)	20	18
	Sum daily res. vol. (million m3-d)	97,701	92,640
	Sum daily vol. DO<=5 (million m3-d)	11,410	8,463
	Min. res. vol. DO>=5 (mil. m3) on "worst-case" d	165	144
	Sum daily vol. DO<=2 (million m3-d) 7/1 - 10/31	1,672	1,212
	Sum daily vol. DO<=2 (million m3-d) 6/1 - 9/30	1,530	1,169
	Sum daily vol. DO<=1 (million m3-d)	832	708
	Sum daily vol. temp. >26 (million m3-d)	919	650
	Sum daily vol. temp. <=10 (million m3-d)	25,658	28,140
Melton Hill	Summer residence time 6/1 - 9/30 (days)	16	17
	Days forebay surface-bottom temp>=4 ºC (d)	179	175
	Max. forebay surface-bottom temp. (ºC)	17	17
	Sum daily res. vol. (million m3-d)	43,456	43,239
	Sum daily vol. DO<=5 (million m3-d)	457	420
	Min. res. vol. DO>=5 (mil. m3) on "worst-case" d	100	101
	Sum daily vol. DO<=2 (million m3-d) 7/1 - 10/31	18	26
	Sum daily vol. DO<=2 (million m3-d) 6/1 - 9/30	44	41
	Sum daily vol. DO<=1 (million m3-d)	8	13
	Sum daily vol. temp. >26 (million m3-d)	2,015	1,745
	Sum daily vol. temp. <=10 (million m3-d)	11,199	12,747

Table D1-03 Summary of Modeling Results for Reservoir Dynamics and Water Quality Characteristics on Representative Reservoirs under the Summer Hydropower Alternative (Based on Rainfall and Flows in 1990–1994, the Only Consecutive Years That Allowed Successful Model Runs) (continued)

Sites	Data	Modeled Metric Results for Base Case and Summer Hydropower Alternative	
		Base Case	Summer Hydropower
Watts Bar	Summer residence time 6/1 - 9/30 (days)	19	16
	Days forebay surface-bottom temp>=4 ºC (d)	165	164
	Max. forebay surface-bottom temp. (ºC)	16	15
	Sum daily res. vol. (million m3-d)	340,184	324,583
	Sum daily vol. DO<=5 (million m3-d)	76,332	83,988
	Min. res. vol. DO>=5 (mil. m3) on "worst-case" d	338	238
	Sum daily vol. DO<=2 (million m3-d) 7/1 - 10/31	12,334	9,697
	Sum daily vol. DO<=2 (million m3-d) 6/1 - 9/30	16,706	13,707
	Sum daily vol. DO<=1 (million m3-d)	5,240	3,318
	Sum daily vol. temp. >26 (million m3-d)	42,298	38,316
	Sum daily vol. temp. <=10 (million m3-d)	72,490	75,557
Guntersville	Summer residence time 6/1-9/30 (days)	16	14
	Days forebay surface-bottom temp>=4 ºC (d)	49	43
	Max. forebay surface-bottom temp. (ºC)	8	8
	Sum daily res. vol. (million m3-d)	399,955	395,888
	Sum daily vol. DO<=5 (million m3-d)	8,694	4,933
	Min. res. vol. DO>=5 (mil. m3) on "worst-case" d	918	975
	Sum daily vol. DO<=2 (million m3-d) 7/1 - 10/31	744	83
	Sum daily vol. DO<=2 (million m3-d) 6/1 - 9/30	1,297	224
	Sum daily vol. DO<=1 (million m3-d)	1,767	135
	Sum daily vol. temp. >26 (million m3-d)	110,594	107,461
	Sum daily vol. temp. <=10 (million m3-d)	77,307	77,943
Pickwick	Summer residence time 6/1 - 9/30 (days)	14	12
	Days forebay surface-bottom temp>=4 ºC (d)	61	49
	Max. forebay surface-bottom temp. (ºC)	9	8
	Sum daily res. vol. (million m3-d)	369,048	357,611
	Sum daily vol. DO<=5 (million m3-d)	19,328	11,423
	Min. res. vol. DO>=5 (mil. m3) on "worst-case" d	730	756

Table D1-03 Summary of Modeling Results for Reservoir Dynamics and Water Quality Characteristics on Representative Reservoirs under the Summer Hydropower Alternative (Based on Rainfall and Flows in 1990–1994, the Only Consecutive Years That Allowed Successful Model Runs) (continued)

Sites	Data	Modeled Metric Results for Base Case and Summer Hydropower Alternative	
		Base Case	Summer Hydropower
Pickwick (continued)	Sum daily vol. DO<=2 (million m3-d) 7/1 - 10/31	2,757	609
	Sum daily vol. DO<=2 (million m3-d) 6/1 - 9/30	4,308	1,149
	Sum daily vol. DO<=1 (million m3-d)	3,447	577
	Sum daily vol. temp. >26 (million m3-d)	106,642	100,700
	Sum daily vol. temp. <=10 (million m3-d)	65,992	65,913
Kentucky	Summer residence time 6/1 - 9/30 (days)	36	32
	Days forebay surface-bottom temp>=4 ºC (d)	36	29
	Max. forebay surface-bottom temp. (ºC)	7	7
	Sum daily res. vol. (million m3-d)	989,985	965,189
	Sum daily vol. DO<=5 (million m3-d)	30,132	21,289
	Min. res. vol. DO>=5 (mil. m3) on "worst-case" d	2,239	2,137
	Sum daily vol. DO<=2 (million m3-d) 7/1 - 10/31	1,838	616
	Sum daily vol. DO<=2 (million m3-d) 6/1 - 9/30	2,118	691
	Sum daily vol. DO<=1 (million m3-d)	954	169
	Sum daily vol. temp. >26 (million m3-d)	272,324	260,420
	Sum daily vol. temp. <=10 (million m3-d)	199,719	199,681

Note:
DO = Dissolved oxygen.

Table D1-04 Summary of Modeling Results Providing Water Quality Characteristics in Representative Dam Releases under Alternatives Other Than the Summer Hydropower Alternative (Based on Rainfall and Flows during 1987–1994)

Sites	Data	Alternative							
		Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
South Holston	Annual average minimum (dissolved oxygen (DO) (mg/L)	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target
	Average # days/years DO <5 mg/L	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target
	Average # days/year temp >10 °C	91	70	65	80	95	62	65	82
	Annual average maximum temp	13.6	12.6	12.2	12.8	13.7	12.1	12.3	13.2
Boone	Annual average minimum DO (mg/L)	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target
	Average # days/years DO <5 mg/L	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target
	Average # days/year temp >10 °C	228	228	226	236	228	227	229	229
	Annual average maximum temp	17.4	18.6	19.1	18.3	17.5	18.6	18.7	18.3
Douglas	Annual average minimum DO (mg/L)	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target
	Average # days/years DO <5 mg/L	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target
	Average # days/year temp >10 °C	237	239	244	246	237	244	242	239
	Annual average maximum temp	24.3	24.2	23.6	25.2	24.3	23.6	22.9	24.2
Hiwassee	Annual average minimum DO (mg/L)	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target
	Average # days/years DO <5 mg/L	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target
	Average # days/year temp >10 °C	226	221	221	230	221	226	216	223
	Annual average maximum temp	20.6	20.7	20.3	21.5	21.1	20.4	19.8	20.9

Table D1-04 Summary of Modeling Results Providing Water Quality Characteristics in Representative Dam Releases under Alternatives Other Than the Summer Hydropower Alternative (Based on Rainfall and Flows during 1987–1994) (continued)

Sites	Data	Alternative							
		Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Melton Hill	Annual average minimum DO (mg/L)	5.6	4.9	4.3	4.3	6.0	4.8	3.9	5.6
	Average # days/years DO <5 mg/L	7	18	21	32	7	12	30	12
	Average # days/year temp >10°C	263	255	250	252	263	246	255	255
	Annual average maximum temp	23.9	24.9	25.0	25.7	23.9	23.9	24.7	23.4
Watts Bar	Annual average minimum DO (mg/L)	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target
	Average # days/years DO <5 mg/L	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target	LIP target
	Average # days/year temp >10°C	274	272	272	274	273	272	273	272
	Annual average maximum temp	26.8	27.3	27.3	27.9	26.8	27.2	26.5	26.8
Guntersville	Annual average minimum DO (mg/L)	4.7	4.4	4.3	4.5	4.7	4.4	4.3	5.0
	Average # days/years DO <5 mg/L	19	24	28	23	18	26	31	12
	Average # days/year temp >10°C	282	281	281	281	281	281	281	281
	Annual average maximum temp	30.3	30.4	30.4	30.5	30.4	30.4	30.2	30.4
Pickwick	Annual average minimum DO (mg/L)	4.3	4.1	4.0	4.0	4.3	4.0	3.8	4.3
	Average # days/years DO <5 mg/L	30	39	43	42	29	44	48	36
	Average # days/year temp >10°C	281	281	281	282	281	281	281	281
	Annual average maximum temp	29.9	29.7	29.6	29.7	29.9	29.6	29.5	29.8
Kentucky	Annual average minimum DO (mg/L)	3.4	3.0	2.8	2.9	3.8	2.8	2.5	3.1
	Average # days/years DO <5 mg/L	47	54	57	60	39	57	60	56
	Average # days/year temp >10°C	272	272	272	272	271	272	272	272
	Annual average maximum temp	29.1	28.9	28.6	28.8	29.3	28.6	28.6	29.0

Note: LIP = Lake Improvement Plan.

Table D1-05 Summary of Modeled Water Quality Characteristics in Representative Dams under the Summer Hydropower Alternative (Based on Rainfall and Flows in 1990–1994, the Only Consecutive Years That Allowed Successful Model Runs)

Sites	Data	Alternative	
		Base Case	Summer Hydropower
South Holston	Annual average minimum DO (mg/L)	LIP target	LIP target
	Average # days/years DO <5 mg/L	LIP target	LIP target
	Average # days/year temp >10°C	96	105
	Annual average maximum temp	13.8	13.6
Boone	Annual average minimum DO (mg/L)	LIP target	LIP target
	Average # days/years DO <5 mg/L	LIP target	LIP target
	Average # days/year temp >10 °C	237	234
	Annual average maximum temp	17.5	19.3
Douglas	Annual average minimum DO (mg/L)	LIP target	LIP target
	Average # days/years DO <5 mg/L	LIP target	LIP target
	Average # days/year temp >10 °C	241	239
	Annual average maximum temp	24.0	24.8
Hiwassee	Annual average minimum DO (mg/L)	LIP target	LIP target
	Average # days/years DO <5 mg/L	LIP target	LIP target
	Average # days/year temp >10 °C	235	232
	Annual average maximum temp	20.9	22.0
Melton Hill	Annual average minimum DO (mg/L)	5.2	4.9
	Average # days/years DO <5 mg/L	11.0	10.2
	Average # days/year temp >10 °C	270.2	256.2
	Annual average maximum temp	23.9	23.7
Watts Bar	Annual average minimum DO (mg/L)	2.5	2.7
	Average # days/years DO <5 mg/L	127	134
	Average # days/year temp >10 °C	LIP target	LIP target
	Annual average maximum temp	LIP target	LIP target
Guntersville	Annual average minimum DO (mg/L)	4.9	5.7
	Average # days/years DO <5 mg/L	10	0
	Average # days/year temp >10 °C	292	291
	Annual average maximum temp	30.5	30.3

Table D1-05 Summary of Modeled Water Quality Characteristics in Representative Dams under the Summer Hydropower Alternative (Based on Rainfall and Flows in 1990–1994, the Only Consecutive Years That Allowed Successful Model Runs) (continued)

Sites	Data	Alternative	
		Base Case	Summer Hydropower
Pickwick	Annual average minimum DO (mg/L)	4.4	5.0
	Average # days/years DO <5 mg/L	22	2
	Average # days/year temp >10 °C	291	292
	Annual average maximum temp	30.1	30.4
Kentucky	Annual average minimum DO (mg/L)	3.7	4.3
	Average # days/years DO <5 mg/L	40	26
	Average # days/year temp >10 °C	279	279
	Annual average maximum temp	29.0	29.3

Notes:
DO = Dissolved oxygen.
LIP = Lake Improvement Plan.
mg/L = Milligrams per liter.

Appendix D2

Groundwater Resources

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D2.1 Reservoir Analysis

Assessment of the surface water and groundwater interactions involved two phases: (1) an initial screening-level analysis to determine the maximum zone of surface water influence on groundwater resources, and (2) a reservoir-specific analysis to determine potential effects on groundwater wells situated within the maximum zone of surface water influence identified in the screening-level analysis.

D2.1.1 Screening-Level Analysis

A screening-level analysis was performed to determine the maximum zone of surface water influence on groundwater resources around each TVA reservoir. The furthest distance from the reservoirs where a change in reservoir elevation could be discerned in the groundwater zone was calculated.

The calculation used an analytical solution to the natural situation and assumed a sudden change in reservoir elevation that propagates through groundwater. The calculation took as input the elevation change in the reservoir and calculated the decrease in this elevation change as it propagates into the subsurface groundwater zone. The model depends on the magnitude of the elevation change in the reservoir, aquifer properties (transmissivity and specific yield), and the duration of the changed condition. The distance at which no effect of the reservoir change is discernable in the groundwater zone was calculated for the duration of water increase. “No effect” is considered to be a change in groundwater elevation less than or equal to 0.1 feet.

The screening-level analysis used January 1 (minimum pool) and June 1 (maximum pool) elevations and a duration of 150 days as inputs to the calculation. This range in elevation provided an upper bound for changes in groundwater levels. None of the reservoir operations policy alternatives would produce a greater change in groundwater levels than those predicted by the screening-level analysis.

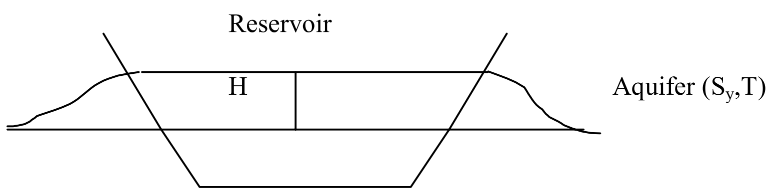
As discussed in Section 4.1, Introduction to Affected Environment, Zurawski (1978) divided the Tennessee River region into six physiographic and hydrologic provinces with distinctive characteristics: the Coastal Plain, Highland Rim, Central Basin, Cumberland Plateau (including the geologically distinct Sequatchie Valley), Valley and Ridge, and Blue Ridge. The approach of this analysis was to treat each province as consisting of a specific range of aquifer properties. This simplification allowed an initial breakdown of the Tennessee River Valley region, but did not lead to a site-specific analysis.

Calculation

The background and derivation of the calculation approach are described in Marsily (1986). The solution is appropriate for sudden variation in water elevation, in a semi-infinite domain. It fits the case of a semi-infinite aquifer initially in equilibrium with an initial elevation that is then subjected to a change in water elevation at the boundary. The aquifer can be confined or unconfined. The solution is taken from consideration of problems of heat and mass transport presented in Carslaw and Jaeger (1959), in Figure D2-01.

Figure D2-01 Calculation of Groundwater Table Elevation Changes

$$h(x, t) = H \operatorname{erfc}\left(x \sqrt{S_y / 4Tt}\right)$$



In the equation $h(x, t) = H \operatorname{erfc}(x \sqrt{S_y / 4Tt})$, h (x,t) is the change in water table elevation resulting from a change H in reservoir pool levels with distance (x) and time (t) from the edge of the reservoir. S_y is the specific yield of the unconfined aquifer, a property of the aquifer. T is the transmissivity of the aquifer, a measure of the resistance to water flow in the aquifer. Values for transmissivity and specific yield used in the calculation are summarized in Table D2-01.

Calculation Assumptions, Limitations, and Sensitivity Analysis

This simple representation of surface water/groundwater interaction made several assumptions. A sensitivity analysis was conducted to test some of the assumptions. In general, the calculation results present the likely maximum extent of groundwater influence. Some of the key assumptions, and associated limitations, are described in the following:

Assumption One: Surface water and groundwater are interconnected. In addition, groundwater gradients were assumed to be away from reservoirs. These assumptions are the basis for this analysis, but in all provinces it is possible that the reservoirs are not connected to groundwater or that there is a connection, but the groundwater gradient is towards the reservoir. For example, in a study of Reelfoot Reservoir in the Coastal Plain physiographic province, McLaughlin (1988) concluded that the reservoir was not in communication with groundwater, despite being in an alluvial setting. In a study of the Highland Rim, Brahana and Bradley (1986a) identify sections of the Highland Rim region west of the Tennessee River where groundwater movement is primarily toward the Tennessee River. By assuming that all reservoirs are in communication with groundwater and that the groundwater moves in a direction toward the reservoirs, this analysis predicted a greater zone of groundwater influence than may be the case.

Table D2-01 Summary of Aquifer Properties for the Physiographic Provinces in the Tennessee River Region

Physiographic Province	Transmissivity (ft^2/day)		Specific Yield	
	Mean	Range	Representative Value	Range
Coastal Plain	500	10 to 10,000	0.2	0.1 to 0.3
Highland Rim	320	1 to 100	0.2	0.1 to 0.3
Central Basin	79	1 to 500	0.2	0.1 to 0.3
Cumberland Plateau	480	10 to 5,000	0.2	0.1 to 0.3
Sequatchie Valley	79	1 to 100	0.2	0.1 to 0.3
Valley and Ridge	140	10 to 5,000	0.2	0.1 to 0.3
Blue Ridge	120	10 to 500	0.2	0.1 to 0.3

Note:

Values for transmissivity, a measure of resistance to groundwater flow, are taken from the following Tennessee-specific literature sources: Brahana and Broshears (2001), Broshears and Bradley (1992), Hoos (1990), Wolfe et al. (1997), and Zurawski (1978). In addition, wider-ranging data compilations were consulted to broaden the range of properties, including the following: Lohman (1979), Freeze and Cherry (1979), De Marsily (1986) and Kruseman and de Ridder (1990). Values for specific yield, a measure of aquifer water storage volume, were obtained from Lohman (1979), Freeze and Cherry (1979), and Spitz and Moreno (1996).

Assumption Two: A single set of aquifer properties (transmissivity and specific yield) applies to an entire physiographic province. This assumption was variably true throughout the Tennessee River Valley. A sensitivity analysis was performed using high transmissivity/low specific yield and low transmissivity/high specific yield values for six reservoirs in the TVA system, Appalachia, Bear Creek, Blue Ridge, Boone, Normandy, and Wilson reservoirs. These reservoirs were chosen as they span the major types of aquifers in the Tennessee River Valley region including fractured bedrock, limestone, and unconsolidated aquifers.

In fractured bedrock of the Blue Ridge, the assumptions may be fairly good, except in heavily fractured areas. The sensitivity analysis indicated variation by a factor of 10 between the high transmissivity/low specific yield case and the low transmissivity/high specific yield case. Although a high degree of variation, it is relatively low for a general analysis of this sort.

In the limestone areas of the Central Basin Highland Rim, and Valley and Ridge provinces, the assumption may also be fairly good except in areas of karst. The sensitivity analysis gave a comparable range in variation to the fractured bedrock case. In karst terrains within these provinces, however, porosity and permeability can be very large, approaching open, interconnected cavities. In the karst subareas of these provinces the assumption could be very far off, and cannot be adequately modeled with this approach. The area of groundwater influence calculated for these provinces is reasonably accurate in non-karst zones; influence in karst zones are better addressed by identifying areas of seepage. Seeps and springs are the surface outlet for some karst areas.   The discharge rate may be affected by project operations, but the range of change will be much smaller than other influences on seeps and springs, including precipitation, recharge, and existing reservoir operations.

In the alluvium of the Coastal Plain and regolith areas of the Highland Rim, Blue Ridge, and Valley and Ridge, the aquifer properties can vary by three or more orders of magnitude. A high degree of variation in groundwater influences is expected in these areas. The sensitivity analysis indicated a correspondingly high degree of variation: a factor of approximately 50 separated the results for the high transmissivity/low specific yield case from the low transmissivity/high specific yield case.

Owing to this variability, the "base case" analysis took a reasonable set of aquifer properties based on the literature. The values were chosen based on field observations of some of the surrounding materials of the reservoirs, and mid-range values from the literature.

Assumption Three: The boundary condition for the calculation is a constant head boundary at the edge of the reservoir. This condition is independent of the conditions in the reservoir, and assumes no change in elevation. This assumption gave a larger zone of groundwater influence than may actually be the case.

Assumption Four: The calculation only considers changes to water table elevation resulting from changes in reservoir level for cases of the water table being initially equal to the starting reservoir level. It does not consider the actual groundwater level, which could be less than the initial reservoir level. In this case, the model predicted greater zone of influences and greater groundwater elevation changes than are actually the case.

Assumption Five: The calculation assumes an immediate change in reservoir elevation. The change in elevation at the edge of the reservoir is also assumed to dissipate in the groundwater system according to a diffusion-like model. This model is appropriate for a one-dimensional analysis, but cannot reproduce effects in three dimensions, or effects due to changes in aquifer properties. No boundary condition was used for elevations in the surrounding aquifer, since this was the objective of the analysis.

Potentially Affected Groundwater Resources

Table D2-02 summarizes the results of the maximum groundwater influence calculations for the screening-level analysis. For the following reservoirs, at least one public water supply well was located within the calculated maximum zone of influence and was identified for further analysis: Cherokee, Douglas, Fort Loudoun, Kentucky, Norris, Ocoee #3, Tims Ford, and Watts Bar.

Table D2-02 Public Groundwater Wells within Maximum Zones of Influence of TVA Reservoirs

TVA Reservoir	Calculated Maximum Zone of Influence (feet)	Public Wells within Maximum Zone of Influence of Reservoir
Apalachia	1,050	0
Bear Creek	2,200	0
Blue Ridge	1,150	0
Boone	1,300	0
Cedar Creek	1,850	0
Chatuge	1,150	0
Cherokee	1,350	3
Chickamauga	1,140	0
Douglas	1,400	2
Fontana	1,325	0
Fort Loudoun	1,075	2
Fort Patrick Henry	1,050	0
Great Falls	1,870	0
Guntersville	1,600	0
Hiwassee	1,325	0
Kentucky	1,600	1
Little Bear Creek	1,820	0
Melton Hill	1,100	0
Nickajack	1,820	0
Normandy	1,800	0
Norris	1,350	1
Nottely	1,250	0
Ocoee #1	1,050	0
Ocoee #2	0	0
Ocoee #3	1,040	1
Pickwick	2,050	0
South Holston	1,330	0
Tellico	1,100	0
Tims Ford	1,875	1
Upper Bear Creek	2,090	0
Watauga	1,150	0
Watts Bar	1,100	2
Wheeler	1,650	0
Wilbur	1,150	0
Wilson	1,125	0

Notes:

The “maximum zone of influence” is the maximum zone of surface water influence on groundwater resources. No influence (0) is defined as changes in groundwater levels of less than 0.1 feet.

D2.1.2 Reservoir-Specific Analysis

Reservoirs identified in the screening-level analysis as containing public wells within the maximum zone of surface water influence were further analyzed with respect to specific policy alternatives. For each of the reservoir areas chosen for further analysis, the closest public well to the reservoir was designated as the most sensitive groundwater resource. The distances from these wells to the reservoirs were determined. In addition, median monthly changes in reservoir water levels were determined for all the alternatives. For all alternatives, the potential monthly change in groundwater levels at the wells closest to the reservoirs was calculated with respect to the Base Case.

The same solution to the differential equation and assumptions discussed in Section D2.1.1 was used to calculate the potential monthly change in groundwater levels at the closest wells to TVA reservoirs for each alternative. As inputs into the equation, values for transmissivity and specific yield appropriate to the reservoir area remained the same as the screening-level analysis. The distance from the reservoir to the closest groundwater well was used for distance (x) in the equation.

The analysis assumed that initial groundwater elevation at the wells was equal to reservoir water level elevations. Reservoir water level elevations in January were used as a starting point for the calculation as reservoir levels are usually lowest in this month. For each consecutive month (February to December), the change in median reservoir elevations from the previous month to the current month was used for H in the equation (H= median elevation for current month – median elevation for previous month). Time (t) was assumed to be 30 days for all months. For each alternative, the analysis was iterated for each month of the year. Changes in groundwater elevations at the closest groundwater wells for each month were added or subtracted from initial groundwater elevations (assumed to equal January reservoir water elevations) to project the cumulative change in groundwater elevations over the year. This result gives an estimation as to how groundwater elevations at the closest wells to the reservoirs would change for each alternative each month of the year, assuming that January groundwater elevations are equal to January reservoir elevations.

The Base Case would continue existing conditions to the year 2030. Since this alternative does not include a physical change and groundwater usage was assumed to remain fairly constant, there would be no adverse consequence to groundwater resources. All other alternatives were, therefore, analyzed with respect to the Base Case. The projected monthly changes in groundwater elevations at the wells for each alternative were then compared to the projected monthly changes in groundwater elevations at the wells for the Base Case. Any increase in groundwater levels was considered a beneficial effect on groundwater resources. A decrease in groundwater levels of more than 3 feet was considered an adverse effect on groundwater resources if the change occurred at or near reservoir minimum pool. This 3-foot threshold was based on the typical seasonal and annual changes in groundwater elevations attributable to non-reservoir influences and variation in groundwater use patterns. Due to the conservative nature of the calculations used in this analysis, any adverse effects on groundwater resources at any of the reservoirs were further analyzed to determine, to the extent possible, consistency with the assumptions outlined in the above calculations.

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Appendix D3

Aquatic Resources

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D3.1 Fish Index of Biotic Integrity (Used in Tailwaters)

An Index of Biotic Integrity (IBI) is used to assess environmental quality by applying ecologically based metrics to resident aquatic communities. TVA uses a 12-metric fish IBI to assess tailwater quality. Each metric rates the condition of one aspect of the community. Metrics are scored against the expected condition of regional un-impacted stream communities. Potential scores are 1-poor, 3-intermediate, or 5-best condition.

The 12 metrics used in the fish IBI are as follows:

1. Number of native species
2. Number of native darter species
3. Number of sunfish species
4. Number of native sucker species
5. Number of intolerant species
6. Percentage of fish as tolerant species
7. Percentage of fish as omnivores and stoneroller species
8. Percentage of fish as specialized insectivores
9. Percentage of fish as piscivores
10. Catch rate (average number per standardized sampling effort)
11. Percentage of fish as hybrids
12. Percentage of fish with disease, tumors, body damage, or other anomalies

To produce a site rating, scores for the 12 metrics are summed. Sites attain 1 of 6 possible ratings: (1) no fish, (2) very poor (12-22), (3) poor (28-34), (4) fair (40-44), (5) good (48-52), or (6) excellent (58-60) (Karr et al. 1986).

The worst rating, no fish, indicates that repetitive sampling fails to turn up any fish. Sites rating very poor have few fish present, fish tend to be introduced or tolerant species, hybrids are common, and disease and anomalies occur regularly on fish. Poor sites are dominated by omnivores (fish that eat plants, animals, and sometimes detritus), fish are tolerant of pollution and are habitat generalists, few top piscivores are present, and hybrids and disease are present. Sites attaining a fair rating have lowered species diversity, few intolerant forms, skewed trophic structure (increasing number of omnivores), and older age classes of top predators may be rare. Good ratings are attained when species richness is only slightly below regional expectations, mostly due to loss of most sensitive species, abundances or size distribution is not quite optimal, and trophic structure shows some signs of stress (more omnivores than usual and fewer piscivores than natural conditions). The highest rating, excellent, is attained by sites that are comparable to the best natural situations without influence of humans. Excellent sites have all regionally expected species for the habitat and stream size, including tolerant forms, a normal age-size distribution, all sex classes, and a balanced trophic structure.

D3.2 Benthic Index of Biotic Integrity (Used in Tailwaters)

TVA uses a Benthic Index of Biotic Integrity (BIBI) to monitor the benthic invertebrate community in tailwaters. The BIBI follows the standard methodology of an IBI as described for the fish IBI (Karr et al. 1986), except that it uses 10 metrics to assess benthic invertebrates.

TVA uses the following benthic metrics to monitor resident benthic communities:

1. Taxa richness
2. Number of intolerant snail and mussel species
3. Number of mayfly taxa
4. Number of caddisfly taxa
5. Number of stonefly taxa
6. Percent of individuals as oligochaetes
7. Percent of individual taxa that feed as collector-filterers
8. Percent of individuals that are predators (excluding chironomids and flatworms)
9. Percent of individuals in the top two dominant taxa
10. Total abundance

Sites can attain a BIBI score of 10 to 60, with higher scores representing higher quality communities and environmental conditions.

D3.3 Reservoir Fish Assemblage Index

The Reservoir Fish Assemblage Index (RFAI) is one component of the Vital Signs monitoring program (see Section 4.4, Water Quality). This index evaluates the status of resident fish populations in reservoirs. The method is similar to the Reservoir Benthic Index.

For classification purposes, reservoirs were divided into upper and lower mainstem or tributary reservoirs, with tributary reservoirs further classified by physiographic region. Within reservoirs, sites were classified into three zones: inflow, transition, and forebay. In cases where sample information was gathered with different types of gear, scoring criteria were adjusted to account for the difference.

There are 12 fish community metrics represented by four categories (species richness and composition, trophic composition, abundance, and fish health). There are eight species richness metrics, including:

1. Total number of species
2. Number top carnivores
3. Number of sunfish (excluding *Micropterus*)
4. Number of benthic invertivores
5. Number of intolerant species
6. Percentage of tolerant individuals
7. Percentage of dominance by one species
8. Number of non-native species

The two trophic composition metrics are:

1. Percentage of individuals as omnivores
2. Percentage of individuals as top carnivores

Abundance is evaluated using total catch per effort (number of individuals captured per electrofishing or gill net sample). Fish health is evaluated using the percentage of individuals with anomalies (disease, lesions, tumors, external parasites, deformities, and natural hybrids).

Sample results were compared to reference criteria and assigned a corresponding value: most degraded-1, moderate-3, or least degraded-5. A fish community was rated by summing the scores for all metrics. Conditions of the fish community at a sample location were rated as follows:

RFAI Score	12-21	22-31	32-40	41-50	51-60
Community Rating	Very Poor	Poor	Fair	Good	Excellent

D3.4 Reservoir Benthic Index

TVA monitors resident benthic invertebrate communities in 31 reservoirs as part of the Vital Signs monitoring program described in Section 4.4, Water Quality. Benthic communities are rated using seven metrics. The seven metrics used to classify reservoirs vary depending between reservoir type, either mainstem or tributary reservoir. Within tributary reservoirs, the scoring system varies by physiographic region (Blue Ridge, Ridge and Valley, or Interior Plateau). Further, in each reservoir, the benthic community varies with the amount of flow. Communities at the inflow of the reservoir pool are different than those in the mid-reservoir (transition area) or in the forebay.

The seven metrics used to assess mainstem reservoirs include the following:

1. Number of taxa (species or varieties)
2. Diversity of a sensitive taxa group (EPT)
3. Presence or absence of long-lived species
4. Percent of oligochaetes (tolerant organisms)
5. Percentage of dominant taxa (presence of diversity or not)
6. Density excluding chironomids and oligochaetes
7. Zero samples (proportion of samples with no organisms)

For tributary reservoirs, metrics number 2 and 3 are not used. Instead, they are replaced by two different metrics, the number of non-chironomid and oligochaete taxa (more is better), and chironomid density (again, more is better).

Each metric is worth a maximum of 5 points. Points are given in increments of most degraded-1, moderate-3, or least degraded-5. Sample results were compared to reference conditions which varied based upon, in tributary reservoirs, physiographic provinces and within reservoir zones discussed in Section D3.3. Similarly, mainstem reservoirs support different communities than tributary reservoirs and they have their own scoring criteria. Only inflow areas were evaluated for mainstem reservoirs. All metrics scores for a particular site are summed to obtain the Reservoir Benthic Index score. Benthic communities were rated as very poor (7-12), poor (13-18), fair (19-23), good (24-29), and excellent (30-35).

D3.5 Sport Fishing Index

The Sport Fishing Index (SFI) measures quantity and quality of angler success and fish population characteristics using four metrics (Hickman 2000). Two metrics measure quantity, and two indicate quality.

Metrics used to evaluate quantity of the fish population include:

1. Angler success
2. Catch-per-effort of sampling by biologists

Population quality metrics include:

1. Angler pressure
2. A group of five population quality indicators used by fishery biologists, including such aspects as the proportion of preferred, memorable, and trophy individuals, and fish weight relative to length (plump or thin)

For each fish sample, an individual species was scored on all four metrics. Metric scores were rated as a 5-low, 10-moderate, or 15-high with higher scores meaning a higher quality sport fishery. For a metric comprised of more than one part, the value of a scoring category was divided by the total number of parts to give its score. If one part of a five-part metric scored in the low category (5), it received 1 point (5 points/five parts); if scored in the moderate category, it was worth 2 points (10 points/five parts); and so on. Overall, each of the four metric groups was worth a total of 20 points. Consequently, SFI scores range from 20 (minimum) to 80 (maximum). Sometimes information was available from both TVA and state agency fish samples. In that case, state data were used for catch rate statistics and both data sets were used for population quality aspects. When data were not available for a particular aspect (e.g., angler catch statistics) or the value of one part of a multi-part metric was unknown, the scores of known parts were given more weight so that the total for each metric still equaled 20 points.

To determine the SFI for a particular reservoir, multiple samples are taken in that reservoir. TVA has monitored fish populations with the SFI method since 1996.

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Appendix D4

Wetlands

D4a. Methods for Identifying and Categorizing Potentially Affected Wetlands

D4b. Methods to Compare the Potential Effects of Alternatives on Wetlands

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D4a.1 Creation of a Groundwater Area of Influence Layer

A geographic information system (GIS) coverage of the 35 reservoirs and the connecting waters (Barkley Reservoir and Tombigbee Waterway) included in the Reservoir Operations Study (ROS) was developed by TVA. This coverage was used as a base for both the threatened and endangered species analysis and the wetlands study. Reach identification (ID) codes assigned by TVA were used to distinguish between the reservoirs and tailwaters. The coverage was annotated to include the reservoir and tailwater names and reach ID codes. Individual polygon coverages were created for each reservoir and tailwater. For each reservoir, a groundwater influence buffer was created based on the "distance of no effect from elevation change" calculated for the Groundwater Resources analysis (Sections 4.6 and 5.6). Table D4a-01 provides a list of the physiographic regions and buffer distances used in the wetland analysis.

For each tailwater, a groundwater area of influence polygon was created by: (1) buffering the tailwater with the same "distance of no effect from elevation change" used for the upstream reservoir (see Table D4a-01), (2) converting this buffer polygon to a grid, (3) using the grid as a mask while selecting out those areas of the digital elevation model (DEM) that were less than or equal to the (tailwater headwater elevation + 20 feet) and setting them equal to 1, (4) converting the 0/1 grid to a polygon coverage, and (5) reselecting only those polygons with a value of 1 directly connected to the tailwater. The headwater elevations used in the DEM comparison are shown in Table D4a-02.

The State Soil Geographic Database (STATSGO) provided supplemental information on hydric soils for the seven states included in the Tennessee River Valley: Tennessee, Georgia, Alabama, Virginia, North Carolina, Mississippi, and Kentucky. After creating coverage of mapping unit ID (MUID) polygons for the Tennessee Valley, attributes from the "comp" tables associated with each state's spatial layer were joined in. Each MUID, or soil mapping unit, consists of between 1 and 21 soil components (generally equivalent to a soil series). Each of these components is flagged Y/N for hydric properties, and the percentage of the MUID area that contains that particular component was calculated. For each MUID within the Tennessee Valley, the percentages of those components designated as being hydric were summed. This yielded a range from 0 to 81 percent hydric.

A cutoff value of 50 percent was used for hydric versus non-hydric MUIDs (this cutoff value also approximated the natural break in the data). Those MUIDs with hydric soil composing 50 percent or more of the area were selected to append to the groundwater influence buffers of the applicable reservoirs and tailwaters (Kentucky Reservoir and tailwater, Barkley Reservoir and tailwater, Pickwick tailwater, Guntersville Reservoir, and Nickajack tailwater).

Table D4a-01 Buffer Distances Used to Determine Reservoir Zones of Groundwater Influence

Reservoir	Reach ID	Physiographic Region	Buffer Distance (ft)
Apalachia	38	Blue Ridge	1,050
Barkley	78	Highland Rim	1,600
Bear Creek	24	Cumberland Plateau	2,200
Blue Ridge	48	Blue Ridge	1,150
Boone	67	Valley and Ridge	1,300
Cedar Creek	29	Highland Rim	1,850
Chatuge	42	Blue Ridge	1,150
Cherokee	63	Valley and Ridge	1,350
Chickamauga	13	Valley and Ridge	1,140
Douglas	74	Valley and Ridge	1,400
Fontana	60	Blue Ridge	1,325
Fort Loudoun	17	Valley and Ridge	1,075
Fort Patrick Henry	66	Valley and Ridge	1,050
Great Falls	76	Highland Rim	1,870
Guntersville	9	Cumberland Plateau	1,600
Hiwassee	39	Blue Ridge	1,325
Kentucky	2	Highland Rim	1,600
Little Bear Creek	31	Highland Rim	1,820
Melton Hill	52	Blue Ridge	1,020
Nickajack	11	Cumberland Plateau	1,850
Normandy	22	Highland Rim	1,800
Norris	54	Valley and Ridge	1,350
Nottely	50	Blue Ridge	1,250
Ocoee #1	44	Blue Ridge	1,050
Ocoee #2	45	Blue Ridge	0
Ocoee #3	46	Blue Ridge	1,040
Pickwick	4	Coastal Plain	2,050
South Holston	69	Valley and Ridge	1,330
Tellico	55	Valley and Ridge	1,100
Tims Ford	34	Highland Rim	1,875
Upper Bear Creek	26	Cumberland Plateau	2,100
Watauga	72	Blue Ridge	1,150
Watts Bar	15	Valley and Ridge	1,100
Wheeler	7	Highland Rim	1,650
Wilbur	71	Blue Ridge	1,150
Wilson	6	Highland Rim	1,125

Table D4a-02 Headwater Elevations Used in the Determination of the Tailwater Areas of Groundwater Influence

Tailwater	Reach ID	Headwater Elevation (ft)
Apalachia	37	1,204
Barkley	77	351
Bear Creek	23	571
Blue Ridge	47	1,555
Cedar Creek	28	581
Chatuge	41	1,883
Cherokee	62	935
Chickamauga	12	633
Douglas	73	876
Fontana	59	1,276
Fort Loudoun	16	741
Fort Patrick Henry	65	1,204
Great Falls	80	722
Guntersville	8	558
Kentucky	1	302
Little Bear Creek	30	620
Melton Hill	51	741
Nickajack	10	597
Normandy	21	800
Norris	53	817
Nottely	49	1,624
Ocoee	43	738
Pickwick	3	364
South Holston Dam	68	1,479
Tims Ford	33	754
Tombigbee Waterway	79	413
Upper Bear Creek	25	784
Watts Bar	14	682
Wilbur	70	1,643
Wilson	5	413

D4a.2 Creation of Wetland Layers and Selection of Potentially Affected Wetlands

National Wetland Inventory (NWI) data for the ROS study area were obtained from the U.S. Fish and Wildlife Service. The NWI wetlands were originally mapped at a scale of 1:24,000. Electronic NWI data were prepared and projected to the TN State Plane Coordinate System (NAD 82) by TVA. The data included polygon and linear features in separate coverages. All palustrine system polygons were selected. To pick up connected features that might lie outside the groundwater influence boundary, these polygonal features were merged if they were within 40 feet of this boundary. The merged polygons (clumps) of wetlands that lay wholly within or intersected the groundwater influence boundary were identified for each reservoir and tailwater. Individual palustrine polygons that lay within the selected merged/clumped features were selected. Polygons representing wetlands within the riverine and lacustrine systems (Cowardin classes Emergent [EM], Flat [FL], Aquatic Bed [AB], Unconsolidated Shore [US], and Unconsolidated Bottom Temporarily to Semi-Permanently Flooded [UBA, UBC, UBF, UBG, UBW, UBY, or UBZ]) were selected where they were wholly or partially within each groundwater influence boundary. All linear palustrine system features were selected and clipped to the groundwater influence boundary of each reservoir and tailwater. The lengths of the palustrine linear features within the groundwater influence area were multiplied by a maximum width of 60 feet to provide area estimates. Counts and areas of the selected polygons and linear features were summarized by Cowardin classification. The results for each reservoir and tailwater were summed to provide a summary of all potentially affected wetlands surrounding each reservoir/tailwater.

D4a.3 Categorization of Fringe Wetlands

All lacustrine and riverine polygons were selected. All lacustrine and riverine linear features were selected and buffered by a maximum width of 60 feet. The lacustrine and riverine polygons and buffered linear features were merged to provide a coverage of reservoirs and rivers. Palustrine polygons that intersected the reservoirs and rivers contained within each groundwater influence area were categorized as shoreline fringe wetlands.

D4a.4 Categorization of Island Wetlands

Palustrine polygons that lay completely within the reservoirs and rivers contained within each groundwater influence area were categorized as island wetlands.

D4a.5 Categorization of Surface-Water Isolated Wetlands

The National Hydrologic Dataset (NHD) (USGS 2003) coverages for the seven states of interest were compiled as a base. All NHD rivers/streams were selected, buffered by 1 foot, and appended to the NWI reservoirs and rivers coverage developed for the fringe and island wetland categorization. The affected linear palustrine features were buffered by 60 feet and appended to the merged/clumped palustrine polygon coverage.

All grouped palustrine features touching water were reselected and then the inverse of this set was used to determine which individual palustrine polygons and linear features to categorize as surface-water isolated.

D4a.6 Determination of Undeveloped Upland Area within the Groundwater Area of Influence

An estimate of the remaining undeveloped upland acreage (UU) around each reservoir was calculated by using grids with a cell size of 98.4 feet on each side and the following formula:

UU = groundwater area of influence – reservoir area – NWI polygons – NWI linear features buffered by 60 feet – urban/developed land

The urban/developed land layer used in this calculation was created by selecting low-intensity residential, high-intensity residential, and high-intensity commercial/industrial/transportation from the National Land Cover Dataset (NLCD).

D4a.7 System-Wide Totals

Because some of the same wetlands may be affected by adjacent reservoirs and tailwaters (thereby causing an overlap effect when the numbers for each reservoir and tailwater are added together), a series of system-wide calculations was performed. The groundwater influence areas for the 35 reservoirs, connecting waters, and 30 tailwaters were merged together into a single system-wide groundwater area of influence coverage. This system-wide groundwater influence area was then used in the processes described above to calculate system-wide counts and areas for potentially affected wetlands, fringe, island, and isolated wetlands, as well as to estimate the area of remaining undeveloped upland within the groundwater influence zone.

D4a.8 Reference

U.S. Geological Survey (USGS). 2003. National Hydrography Database. http://nhd.usgs.gov/.

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D4b.1 Introduction

For purposes of impact assessment, the ROS Weekly Scheduling Model (WSM) weekly guide curve model was used to compare changes in the duration of summer pool, summer pool fill dates, and maximum summer and winter pool elevations for system reservoirs under all nine alternatives. This assessment evaluated changes on 22 reservoirs where proposed changes would deviate from existing operations. The median year feature of the ROS model was selected for comparative purposes.

D4b.2 Parameter Selection

Four parameters (summer pool duration, maximum summer pool elevation, summer pool fill dates, and maximum extended winter pool elevation) were selected for analysis with the WSM weekly guide curve model to provide these data for each reservoir. These four parameters were selected because they have profound influences on wetland ecology and hydrology. The three summer pool parameters control the availability of water to wetlands during the growing season or the time of year that plants are actively growing. Water is a key element in wetlands; the amount of water in a wetland controls how large the wetland is, the type of wetland it is, and the kinds of plants and animals that live there. Winter pool conditions affect the exposure and development of flats.

Duration of summer pool was selected because the length of time that summer pool conditions are maintained controls the length of time that water is available in reservoir-influenced wetlands during the growing season. Maximum summer pool elevation was selected because the summer pool elevation controls the area that water can reach in reservoir-influenced wetlands. Summer fill date was selected because it influences when water is available in reservoir-influenced wetlands. Winter pool elevation was selected because it influences the extent to which flats are exposed for seed germination (seeds of most wetland and lacustrine plants cannot germinate under water), and it controls the exposure of flats for shorebird foraging habitat.

Changes in summer pool (duration and elevation) and winter pool (maximum elevation) conditions for all policy alternatives were compared with the Base Case to determine the effect (positive or negative) of each alternative on wetland habitats, wetland water regimes, and wetland functions and to determine an approximate magnitude of those effects. For the purpose of comparison, changes in wetlands on mainstem reservoirs, tributary reservoirs, and tailwaters were compared separately. Since the ROS model does not deal directly with tailwaters, evaluation of tailwater wetlands used data generated by water quality modeling conducted for the threatened and endangered species environmental impact analysis. Relevant data from this analysis included minimum surface water elevations that are expected to occur during 90 percent of the year in tailwaters below dams. Mainstem and tributary tailwaters were evaluated separately because this modeling indicated that proposed changes in tailwaters would vary considerably between the two groups.

D4b.3 Summer Pool Duration

Changes in summer pool duration are summarized in Tables D4b-01 through D4b-03. Table D4b-01 shows duration of summer pool measured in weeks for the Base Case and the policy alternatives. Table D4b-02 shows the change in duration of summer pool measured in weeks for the policy alternatives compared to the Base Case. Table D4b-03 shows the ratio of change in duration of summer pool measured for the policy alternatives compared to the Base Case. The ratios in Table D4b-03 were used to derive the coefficients that were used to describe the direction (positive or negative) and magnitude of effect for each reservoir under each alternative.

D4b.4 Summer Pool Elevation

Changes in summer pool elevation are summarized in Tables D4b-04 through D4b-06. Table D4b-04 shows elevation of summer pool measured in feet for the Base Case and the policy alternatives. Table D4b-05 shows the change in elevation of summer pool measured in feet for the policy alternatives compared to the Base Case. Table D4b-06 shows the ratio of change in elevation of summer pool measured for the policy alternatives compared to the Base Case. The ratios in Table D4b-06 were used to derive the coefficients that were used to describe the direction (positive or negative) and magnitude of effect for each reservoir under each alternative.

D4b.5 Summer Fill Dates

Under the Equalized Summer/Winter Flood Risk Alternative, the date that affected mainstem reservoirs would reach summer pool would be delayed several weeks when compared to existing operations. Table D4b-07 shows the change in summer fill date in weeks for the policy alternatives relative to the Base Case. Most of the mainstem reservoirs would be affected by this delay. Summer pool fill dates would not be delayed on tributary reservoirs.

D4b.6 Winter Pool Elevation

Maximum extended winter pool elevations would vary from reservoir to reservoir under the various alternatives. Winter pool elevations affect the exposure of flats in reservoirs. Exposed flats provide a mineral soil bed needed by seeds of various wetland and lacustrine plants for germination. Exposed flats also provide foraging habitat needed by many shorebirds for winter habitat or during spring and fall migrations. Table D4b-08 shows maximum extended winter pool elevations, and Table D4b-09 shows relative change in winter pool elevation relative to the Base Case.

Table D4b-01 Duration of Summer Pool (weeks)

Reservoir	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs									
Barkley	10	13	18	5	13	10	18	13	10
Kentucky	10	13	18	5	13	10	18	13	10
Pickwick	12	16	21	8	18	12	21	16	20
Wilson	32	32	32	7	32	32	32	32	32
Wheeler	15	15	20	7	18	15	20	15	20
Guntersville	11	15	20	7	18	11	20	15	20
Chickamauga	10	14	19	6	18	10	19	14	16
Watts Bar	23	23	27	6	18	24	27	23	23
Fort Loudoun	27	27	27	6	17	27	27	27	23
Tributary Reservoirs									
Great Falls	9	16	16	3	3	9	13	13	18
Tims Ford	7	7	13	2	4	6	13	6	7
Blue Ridge	4	10	15	2	6	4	14	28	9
Hiwassee	3	8	14	2	11	7	7	18	8
Chatuge	2	9	14	1	4	2	7	21	1
Nottely	2	8	14	1	2	4	6	20	2
Norris	4	8	12	2	8	4	13	13	8
Fontana	2	8	13	1	4	3	14	18	10
Douglas	2	8	13	1	2	5	13	21	2
Boone	13	13	15	1	2	13	15	13	15
South Holston	3	9	8	1	3	3	9	6	6
Cherokee	2	8	13	1	3	2	13	15	6
Watauga	2	7	8	1	7	6	3	10	4

Table D4b-02 Changes in Summer Pool Duration (weeks) Relative to the Base Case

Reservoir	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs									
Barkley	0	3	8	-5	3	0	8	3	0
Kentucky	0	3	8	-5	3	0	8	3	0
Pickwick	0	4	9	-4	6	0	9	4	8
Wilson	0	0	0	-25	0	0	0	0	0
Wheeler	0	0	5	-8	3	0	5	0	5
Guntersville	0	4	9	-4	7	0	9	4	9
Chickamauga	0	4	9	-4	8	0	9	4	6
Watts Bar	0	0	4	-17	-5	1	4	0	-4
Fort Loudoun	0	0	0	-21	-10	0	0	0	-4
Tributary Reservoirs									
Great Falls	0	7	7	-6	-6	0	4	4	9
Tims Ford	0	0	6	-5	-3	-1	6	-1	0
Blue Ridge	0	6	11	-2	2	0	10	24	5
Hiwassee	0	5	11	-1	8	4	4	15	5
Chatuge	0	7	12	-1	2	0	5	19	-1
Nottely	0	6	12	-1	0	2	4	18	0
Norris	0	4	8	-2	4	0	9	9	4
Fontana	0	6	11	-1	2	1	12	16	8
Douglas	0	6	11	-1	0	3	11	19	0
Boone	0	0	2	-12	-11	0	2	0	2
South Holston	0	6	5	-2	0	0	6	3	3
Cherokee	0	6	11	-1	1	0	11	13	4
Watauga	0	5	6	-1	5	4	1	8	2

Table D4b-03 Ratio of Changes in Duration of Summer Pool Compared to the Base Case

Reservoirs	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs									
Barkley	10	0.30	0.80	-0.50	0.30	0.00	0.80	0.30	0.00
Kentucky	10	0.30	0.80	-0.50	0.30	0.00	0.80	0.30	0.00
Pickwick	12	0.33	0.75	-0.33	0.50	0.00	0.75	0.33	0.67
Wilson	32	0.00	0.00	-0.78	0.00	0.00	0.00	0.00	0.00
Wheeler	15	0.00	0.33	-0.53	0.20	0.00	0.33	0.00	0.33
Guntersville	11	0.36	0.82	-0.36	0.64	0.00	0.82	0.36	0.82
Chickamauga	10	0.40	0.90	-0.40	0.80	0.00	0.90	0.40	0.60
Watts Bar	23	0.00	0.17	-0.74	-0.22	0.04	0.17	0.00	-0.15
Fort Loudoun	27	0.00	0.00	-0.78	-0.37	0.00	0.00	0.00	-0.15
Tributary Reservoirs									
Great Falls	9	0.78	0.78	-0.67	-0.67	0.00	0.44	0.44	1.00
Tims Ford	7	0.00	0.86	-0.71	-0.43	-0.14	0.86	-0.14	0.00
Blue Ridge	4	1.50	2.75	-0.50	0.50	0.00	2.50	6.00	1.25
Hiwassee	3	1.67	3.67	-0.33	2.67	1.33	1.33	5.00	1.67
Chatuge	2	3.50	6.00	-0.50	1.00	0.00	2.50	9.50	-0.50
Nottely	2	3.00	6.00	-0.50	0.00	1.00	2.00	9.00	0.00
Norris	4	1.00	2.00	-0.50	1.00	0.00	2.25	2.25	1.00
Fontana	2	3.00	5.50	-0.50	1.00	0.50	6.00	8.00	4.00
Douglas	2	3.00	5.50	-0.50	0.00	1.50	5.50	9.50	0.00
Boone	13	0.00	0.15	-0.92	-0.85	0.00	0.15	0.00	0.15
South Holston	3	2.00	1.67	-0.67	0.00	0.00	2.00	1.00	1.00
Cherokee	2	3.00	5.50	-0.50	0.50	0.00	5.50	6.50	2.00
Watauga	2	2.50	3.00	-0.50	2.50	2.00	0.50	4.00	1.00

Table D4b-04 Maximum Extended Summer Pool Elevation (feet)

Reservoir	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs									
Barkley	359	359	359	359	359	359	359	359	359
Kentucky	359	359	359	359	359	359	359	359	359
Pickwick	414	414	414	414	414	414	414	414	414
Wilson	507	507	507	507	507	507	507	507	507
Wheeler	556	556	556	556	556	556	556	556	556
Guntersville	595	595	595	595	595	595	595	595	595
Chickamauga	682	682	682	682	682	682	682	682	682
Watts Bar	741	741	741	741	741	741	741	741	741
Fort Loudoun	813	813	813	813	813	813	813	813	813
Tributary Reservoirs									
Great Falls	800	800	800	800	800	800	800	800	800
Tims Ford	888	888	888	888	884	888	888	888	888
Blue Ridge	1,686	1,686	1,686	1,686	1,680	1,687	1,687	1,688	1,688
Hiwassee	1,520	1,520	1,520	1,520	1,508	1,521	1,520	1,521	1,521
Chatuge	1,926	1,926	1,926	1,926	1,923	1,926	1,926	1,926	1,926
Nottely	1,777	1,777	1,777	1,777	1,774	1,777	1,777	1,777	1,777
Norris	1,018	1,019	1,019	1,018	1,012	1,018	1,018	1,020	1,019
Fontana	1,703	1,703	1,703	1,703	1,682	1,703	1,703	1,703	1,703
Douglas	994	994	994	994	986	994	994	994	994
Boone	1,382	1,382	1,382	1,382	1,382	1,382	1,382	1,382	1,382
South Holston	1,729	1,729	1,729	1,729	1,727	1,728	1,729	1,728	1,728
Cherokee	1,070	1,071	1,071	1,071	1,067	1,070	1,071	1,071	1,069
Watauga	1,959	1,959	1,959	1,959	1,962	1,958	1,957	1,958	1,958

Table D4b-05 Changes in Summer Pool Elevation (feet) Relative to the Base Case

Reservoir	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs									
Barkley	0	0	0	0	0	0	0	0	0
Kentucky	0	0	0	0	0	0	0	0	0
Pickwick	0	0	0	0	0	0	0	0	0
Wilson	0	0	0	0	0	0	0	0	0
Wheeler	0	0	0	0	0	0	0	0	0
Guntersville	0	0	0	0	0	0	0	0	0
Chickamauga	0	0	0	0	0	0	0	0	0
Watts Bar	0	0	0	0	0	0	0	0	0
Fort Loudoun	0	0	0	0	0	0	0	0	0
Tributary Reservoirs									
Great Falls	0	0	0	0	0	0	0	0	0
Tims Ford	0	0	0	0	-4	0	0	0	0
Blue Ridge	0	0	0	0	-6	1	1	2	2
Hiwassee	0	0	0	0	-12	1	0	1	1
Chatuge	0	0	0	0	-3	0	0	0	0
Nottely	0	0	0	0	-3	0	0	0	0
Norris	0	1	1	0	-6	0	0	2	1
Fontana	0	0	0	0	-21	0	0	0	0
Douglas	0	0	0	0	-8	0	0	0	0
Boone	0	0	0	0	0	0	0	0	0
South Holston	0	0	0	0	-2	-1	0	-1	-1
Cherokee	0	1	1	1	-3	0	1	1	-1
Watauga	0	0	0	0	3	-1	-2	-1	-1

Table D4b-06 Ratio of Change in Summer Pool Elevation Relative to the Base Case

Reservoir	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs									
Barkley	0	0	0	0	0	0	0	0	0
Kentucky	0	0	0	0	0	0	0	0	0
Pickwick	0	0	0	0	0	0	0	0	0
Wilson	0	0	0	0	0	0	0	0	0
Wheeler	0	0	0	0	0	0	0	0	0
Guntersville	0	0	0	0	0	0	0	0	0
Chickamauga	0	0	0	0	0	0	0	0	0
Watts Bar	0	0	0	0	0	0	0	0	0
Fort Loudoun	0	0	0	0	0	0	0	0	0
Tributary Reservoirs									
Great Falls	0	0	0	0	0	0	0	0	0
Tims Ford	0	0	0	0	-0.00450	0	0	0	0
Blue Ridge	0	0	0	0	-0.00356	0.00059	0.00059	0.00119	0.001186
Hiwassee	0	0	0	0	-0.00789	0.00066	0	0.00066	0.000658
Chatuge	0	0	0	0	-0.00156	0	0	0	0
Nottely	0	0	0	0	-0.00169	0	0	0	0.000563
Norris	0	0.00098	0.00098	0	-0.00589	0	0	0.00196	0.000982
Fontana	0	0	0	0	-0.01235	0	0	0	0
Douglas	0	0	0	0	-0.00805	0	0	0	0
Boone	0	0	0	0	0	0	0	0	0
South Holston	0	0	0	0	-0.00116	-0.00058	0	-0.00058	-0.00058
Cherokee	0	0.00093	0.00093	0.00093	-0.00280	0	0.00093	0.00093	-0.00093
Watauga	0	0	0	0	0.00153	-0.00051	-0.00102	-0.00051	-0.00051

Table D4b-07 Changes in Summer Filling Date (weeks) Relative to the Base Case

Reservoir	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs									
Barkley	0	0	0	0	-4	0	0	0	0
Kentucky	0	0	0	0	-4	0	0	0	0
Pickwick	0	0	0	0	-7	0	0	0	-1
Wilson	0	0	0	0	0	0	0	0	0
Wheeler	0	0	0	0	-6	0	0	0	0
Guntersville	0	0	0	0	-6	0	0	0	0
Chickamauga	0	0	0	0	-5	0	0	0	-4
Watts Bar	0	0	0	0	-5	0	0	0	-4
Fort Loudoun	0	0	0	0	0	0	0	0	-4
Tributary Reservoirs									
Great Falls	0	0	0	0	0	0	0	0	-2
Tims Ford	0	0	0	0	-14	0	0	0	0
Blue Ridge	0	0	0	0	-2	0	0	0	-4
Hiwassee	0	0	0	0	2	0	0	0	0
Chatuge	0	0	0	0	4	0	0	0	-1
Nottely	0	0	0	0	-2	0	0	0	0
Norris	0	0	0	0	-11	0	0	0	0
Fontana	0	0	0	0	-2	0	0	0	1
Douglas	0	0	0	0	-2	0	0	0	0
Boone	0	0	0	0	-13	0	0	0	0
South Holston	0	0	0	0	-7	0	0	0	-4
Cherokee	0	0	0	0	-8	0	0	0	-2
Watauga	0	0	0	0	4	0	0	0	-4

Note: Negative numbers indicate a delay from normal filling dates.

Table D4b-08 Maximum Extended Winter Pool Elevation (feet msl)

Reservoir	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs									
Barkley	354.3	354.3	356	354.3	354.3	356	356	354.3	354.3
Kentucky	354.3	354.3	356	354.3	354.3	356	356	354.3	354.3
Pickwick	409	410.5	410.5	409	409	410.5	410.5	410.5	409
Wilson	505.5	505.5	505.5	505.5	505.5	505.5	505.5	505.5	505.5
Wheeler	551	552.5	552.5	551	552.5	552.5	552.5	552.5	551.5
Guntersville	593.3	593.3	593.3	593.3	593.3	593.3	593.3	593.3	593.3
Chickamauga	676	677.5	677.5	676	675	677.5	677.5	677.5	676
Watts Bar	736	737.5	737.5	736	735	737.5	737.5	737.5	736
Fort Loudoun	808	809.5	809.5	808	807	809.5	809.5	809.5	808
Tributary Reservoirs									
Great Falls	785	785	785	785	785	785	785	785	785
Tims Ford	873	877	871.8	871	865	872.5	871.5	877	873
Blue Ridge	1,650	1,670	1,660	1,660	1,669	1,650	1,660	1,678	1,667
Hiwassee	1,468	1,482	1,480	1,480	1,470	1,468	1,480	1,485	1,482
Chatuge	1,913	1,916	1,918	1,916	1,916	1,913	1,918.5	1,917	1,917.5
Nottely	1,747	1,757	1,763	1,755	1,761.5	1,747	1,763	1,762	1,761
Norris	985	999	1,005	1,005	996	985	1,005	1,000	998
Fontana	1,642	1,628	1,658	1,658	1,654	1,636	1,658	1,644	1,650
Douglas	940	958	958	958	946	940	956	958	953
Boone	1,356	1,356	1,356	1,356	1,364	1,356	1,356	1,356	1,362
South Holston	1,698	1,712	1,723	1,707	1,719	1,697	1,723	1,713	1,706
Cherokee	1,030	1,045	1,052	1,050	1,050	1,030	1,053	1,046	1,044
Watauga	1,937	1,946	1,955	1,944	1,954	1,938	1,948	1,952	1,950

Table D4b-09 Change in Winter Pool Elevation (feet) Relative to the Base Case

Reservoir	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs									
Barkley	0	0	1.7	0	0	1.7	1.7	0	0
Kentucky	0	0	1.7	0	0	1.7	1.7	0	0
Pickwick	0	1.5	1.5	0	0	1.5	1.5	1.5	0
Wilson	0	0	0	0	0	0	0	0	0
Wheeler	0	1.5	1.5	0	1.5	1.5	1.5	1.5	0.5
Guntersville	0	0	0	0	0	0	0	0	0
Chickamauga	0	1.5	1.5	0	-1	1.5	1.5	1.5	0
Watts Bar	0	1.5	1.5	0	-1	1.5	1.5	1.5	0
Fort Loudoun	0	1.5	1.5	0	-1	1.5	1.5	1.5	0
Tributary Reservoirs									
Great Falls	0	0	0	0	0	0	0	0	0
Tims Ford	0	4	-1.2	-2	-8	-0.5	-1.5	4	0
Blue Ridge	0	20	10	10	19	0	10	28	17
Hiwassee	0	14	12	12	2	0	12	17	14
Chatuge	0	3	5	3	3	0	5.5	4	4.5
Nottely	0	10	16	8	14.5	0	16	15	14
Norris	0	14	20	20	11	0	20	15	13
Fontana	0	-14	16	16	12	-6	16	2	8
Douglas	0	18	18	18	6	0	16	18	13
Boone	0	0	0	0	8	0	0	0	6
South Holston	0	14	25	9	21	-1	25	15	8
Cherokee	0	15	22	20	20	0	23	16	14
Watauga	0	9	18	7	17	1	11	15	13

D4b.7 Tailwaters

Each alternative would result in different effects on flow in tailwaters. Changes in flow would in turn affect the elevation of the water surface in tailwaters, and these changes would affect mainstem reservoirs differently. A summary of anticipated changes in minimum elevations on mainstem and tributary tailwaters is shown in Table D4b-10. (See detailed descriptions of changes in Appendix D6b.)

In general, water elevations on tailwaters of mainstem reservoirs would increase from 1 to 2 feet over Base Case conditions for Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative; decrease up to 1 foot for the Equalized Summer/Winter Flood Risk Alternative minimum elevation; and increase up to 1 foot for the Commercial Navigation Alternative. On tailwater reservoirs, projected surface water elevations are expected to be essentially equal for the Base Case and Reservoir Recreation Alternative A, Reservoir Recreation Alternative A, the Equalized Summer/Winter Flood Risk Alternative, Commercial Navigation Alternative, and the Tailwater Recreation Alternative. Water levels on tributary tailwaters could increase up to 0.5 foot under the Tailwater Habitat Alternative. Because the water quality model was not able to provide any data for the Summer Hydropower Alternative, an inverse relationship was assumed between pool conditions on reservoirs and releases from dams to tailwaters. For example, as the duration of summer pool increases; the water released to tailwaters decreases.

D4b.8 Integration of Changes in Reservoir Conditions

Since summer pool conditions control wetland hydrology in reservoir and tailwater wetlands, summer pool data were used to determine the magnitude of effects for wetlands each reservoir and tailwater. Winter pool ratios were not used since they primarily affect exposure of flats during the dormant season for most plants. The ratio of changes in duration and elevation of summer pool and elevation compared to the Base Case (see Tables D4b-03 and D4b-06) were combined to create a unique set of coefficients for each reservoir. These two ratios were added for each reservoir and each alternative. Because this sum was greater than 1 (Table D4b-11), this sum was multiplied by 0.1 to produce a set of coefficients between 0 and 1 (Table D4b-12).

These coefficients were then multiplied by wetland acreages on each affected reservoir obtained from National Wetland Inventory data in order to derive a number that described the magnitude of potential impacts on each reservoir's and tailwaters' wetlands. This was done reservoir by reservoir for each wetland vegetation type, wetland water regime, and other selected wetland functional categories discussed in Section 4.8 . The derived values were summed for each reservoir affected by each alternative and sums were compared to evaluate the effect of each alternative on wetlands.

Table D4b-10 Potential Changes in Minimum Surface Water Elevations in Mainstem and Tributary Tailwaters

Reservoir	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem tailwaters	0	1–2 ft	1–2 ft	>2 ft	-1 ft	0–1 ft	1–2 ft	1–2 ft	1–2 ft
Tributary reservoirs	0	0	0	>2 ft	0	0	0	0–0.5 ft	0

Table D4b-11 Derivation of Reservoir-Specific Coefficients, Step 1: Sum Ratios of Changes in Summer Pool Duration and Elevation Relative to the Base Case

Reservoir	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs									
Barkley	0	0.300	0.800	-0.500	0.300	0.000	0.800	0.300	0.00000
Kentucky	0	0.300	0.800	-0.500	0.300	0.000	0.800	0.300	0.00000
Pickwick	0	0.333	0.750	-0.333	0.500	0.000	0.750	0.333	0.66667
Wilson	0	0.000	0.000	-0.781	0.000	0.000	0.000	0.000	0.00000
Wheeler	0	0.000	0.333	-0.533	0.200	0.000	0.333	0.000	0.33333
Guntersville	0	0.364	0.818	-0.364	0.636	0.000	0.818	0.364	0.81818
Chickamauga	0	0.400	0.900	-0.400	0.800	0.000	0.900	0.400	0.60000
Watts Bar	0	0.000	0.174	-0.739	-0.217	0.043	0.174	0.000	-0.14815
Fort Loudoun	0	0.000	0.000	-0.778	-0.370	0.000	0.000	0.000	-0.14815
Tributary Reservoirs									
Great Falls	0	0.778	0.778	-0.667	-0.667	0.000	0.444	0.444	1.00000
Tims Ford	0	0.000	0.857	-0.714	-0.433	-0.143	0.857	-0.143	0.00000
Blue Ridge	0	1.500	2.750	-0.500	0.496	0.001	2.501	6.001	1.25119
Hiwassee	0	1.667	3.667	-0.333	2.659	1.334	1.333	5.001	1.66732
Chatuge	0	3.500	6.000	-0.500	0.998	0.000	2.500	9.500	-0.50000
Nottely	0	3.000	6.000	-0.500	-0.002	1.000	2.000	9.000	0.00056
Norris	0	1.001	2.001	-0.500	0.994	0.000	2.250	2.252	1.00098
Fontana	0	3.000	5.500	-0.500	0.988	0.500	6.000	8.000	4.00000
Douglas	0	3.000	5.500	-0.500	-0.008	1.500	5.500	9.500	0.00000
Boone	0	0.000	0.154	-0.923	-0.846	0.000	0.154	0.000	0.15385
South Holston	0	2.000	1.667	-0.667	-0.001	-0.001	2.000	0.999	0.99942
Cherokee	0	3.001	5.501	-0.499	0.497	0.000	5.501	6.501	1.99907
Watauga	0	2.500	3.000	-0.500	2.502	1.999	0.499	3.999	0.99949

Table D4b-12 Derivation of Reservoir-Specific Coefficients, Step 2: Multiply Sum of Ratio of Changes in Summer Pool Duration and Elevation Relative to the Base Case by 0.1

Reservoir	Alternative								
	Base Case	Reservoir Recreation A	Reservoir Recreation B	Summer Hydropower	Equalized Summer/Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
Mainstem Reservoirs									
Barkley	0	0.030	0.080	-0.050	0.030	0.000	0.080	0.030	0
Kentucky	0	0.030	0.080	-0.050	0.030	0.000	0.080	0.030	0
Pickwick	0	0.033	0.075	-0.033	0.050	0.000	0.075	0.033	0.066667
Wilson	0	0.000	0.000	-0.078	0.000	0.000	0.000	0.000	0
Wheeler	0	0.000	0.033	-0.053	0.020	0.000	0.033	0.000	0.033333
Guntersville	0	0.036	0.082	-0.036	0.064	0.000	0.082	0.036	0.081818
Chickamauga	0	0.040	0.090	-0.040	0.080	0.000	0.090	0.040	0.06
Watts Bar	0	0.000	0.017	-0.074	-0.022	0.004	0.017	0.000	-0.01481
Fort Loudoun	0	0.000	0.000	-0.078	-0.037	0.000	0.000	0.000	-0.01481
Tributary Reservoirs									
Great Falls	0	0.078	0.078	-0.067	-0.067	0.000	0.044	0.044	0.1
Tims Ford	0	0.000	0.086	-0.071	-0.043	-0.014	0.086	-0.014	0
Blue Ridge	0	0.150	0.275	-0.050	0.050	0.000	0.250	0.600	0.125119
Hiwassee	0	0.167	0.367	-0.033	0.266	0.133	0.133	0.500	0.166732
Chatuge	0	0.350	0.600	-0.050	0.100	0.000	0.250	0.950	-0.05
Nottely	0	0.300	0.600	-0.050	0.000	0.100	0.200	0.900	5.63E-05
Norris	0	0.100	0.200	-0.050	0.099	0.000	0.225	0.225	0.100098
Fontana	0	0.300	0.550	-0.050	0.099	0.050	0.600	0.800	0.4
Douglas	0	0.300	0.550	-0.050	-0.001	0.150	0.550	0.950	0
Boone	0	0.000	0.015	-0.092	-0.085	0.000	0.015	0.000	0.015385
South Holston	0	0.200	0.167	-0.067	0.000	0.000	0.200	0.100	0.099942
Cherokee	0	0.300	0.550	-0.050	0.050	0.000	0.550	0.650	0.199907
Watauga	0	0.250	0.300	-0.050	0.250	0.200	0.050	0.400	0.099949

The direction (positive or negative) of the coefficients in Tables D4b-10 and D4b-11 only mirror the direction of change in wetland conditions compared to the Base Case. The actual direction of effect depends on the relationship of the increase or decrease of hydroperiod (summer pool duration and elevation) on each parameter of interest. For example, an increase in hydroperiod might be beneficial for persistent emergent communities but the same increase may adversely affect scrub/shrub and forest wetlands by interfering with seed germination and survival. In these two situations the positive effect on hydroperiod would positively affect emergents and negatively affect woody plants.

Although the derived rating numbers were obtained by multiplying these coefficients with total NWI wetland acreage for each affected reservoir or tailwater, these numbers are not intended to predict the actual effects of each alternative in terms of wetland acres. Rather the products serve to illustrate the net direction (positive or negative) and potential net effect of each alternative on wetland functions in each reservoir or tailwater. Therefore, the ratings were ranked from 1 to 8, and the direction and rankings form the basis for the discussion in Section 4.8 (see Tables 4.8-01 through 4.8-06). These products were developed to compare the effects of the proposed alternatives in terms of their potential to enhance or diminish the functioning of affected wetlands.

Appendix D5

Terrestrial Ecology

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D5.1 Introduction

This appendix supports the description in the main document of the affected environment (Section 4.10) and environmental consequences (Section 5.10) for terrestrial ecology.

The area of the Tennessee River system within 0.25 mile of reservoir shorelines was the study area for terrestrial ecology, since this zone contains several plant and animal communities that depend on or are otherwise associated with current reservoir conditions.

The Tennessee Valley Authority (TVA) has identified a number of terrestrial plant and animal communities that occur in the study area. Several of these communities that depend on current reservoir conditions or are otherwise associated with the Tennessee River system could be affected by changes in TVA's reservoir operations policy. Direct impacts on habitats for these resources could result from manipulation of reservoir levels. In addition, some TVA lands are vulnerable because of their proximity to lands desirable for residential or industrial development. Habitats in these areas could be indirectly affected by changes in land use resulting from changes in the reservoir operation policy.

This technical appendix describes the vegetation communities and wildlife communities associated with habitats that could be affected by changes in the reservoir operations policy.

D5.2 Vegetation Communities

Vegetation communities in the Tennessee River Valley (Valley) can be grouped into two broad categories: lowland and upland. The following qualitative descriptions of plant communities in the study area emphasize uncommon plant communities because potential impacts on these communities were considered potentially more harmful than impacts on more regionally abundant plant communities. The plant communities influenced by reservoir levels and river flows were considered to have the greatest potential to be affected by changes in reservoir operations. Consequently, plant communities associated with wetlands and other lowland habitats form the majority of the discussion. However, some uncommon upland plant communities that are not directly influenced by reservoir levels were also addressed, because changes in reservoir operations could affect these resources indirectly (e.g., through changes in land use).

D5.2.1 Lowland Plant Communities

Lowland plant communities include those communities that are most likely to be directly influenced by changes in reservoir operations and habitats associated with creeks, streams, rivers, and reservoirs in the study area. Examples of communities associated with these habitats include bottomland hardwood forests, scrub/shrub wetlands, and flats vegetation. Plant communities occurring in riparian habitats adjacent to floodplain areas (e.g., streambank forests situated on terraces or levees) are also included in this category. The majority of globally imperiled communities identified from the wetlands subset of the NatureServe Explorer database (2001) fall in this category (see Tables 4.10-01 and 4.10-02 in Section 4.10, Terrestrial Ecology).

Bottomland hardwood forests occur in the floodplains of streams and rivers and in remnant floodplains and other low-elevation sites adjacent to reservoirs. These forests can also extend along terraces, natural levees, and back-lying sloughs. In the Valley, species commonly observed in these forests include black gum (*Nyssa sylvatica*); black willow (*Salix nigra*); water (*Quercus nigra*), willow (*Q. phellos*), and white (*Q. alba*) oaks; sweet-gum (*Liquidambar styraciflua*); hackberry (*Celtis occidentalis*); sugarberry (*C. laevigata*); sycamore (*Platanus occidentalis*); red (*Acer rubrum*) and silver (*A. saccharinum*) maples; box elder (*A. negundo*); cottonwood (*Populus deltoides*); green ash (*Fraxinus pennsylvanica*); river birch (*Betula nigra*); sycamore; and, in extremely wet areas, water tupelo (*Nyssa aquatica*) and bald cypress (*Taxodium distichum*). Five globally imperiled floodplain forest communities reported from the seven-state TVA region are known from the study area. The Appalachian montane alluvial forest and the swamp forest-bog complex are known from portions of the study area in the Blue Ridge Physiographic Region, the eastern Highland Rim rich floodplain terrace forest and the maple-hickory mesic floodplain forest are known from portions of the study area in the Highland Rim Physiographic Region, and the beech-mixed hardwood floodplain forest is known from portions of the study area in the Coastal Plain Physiographic Region. (Figure 4.1-02 in the main document illustrates the physiographic regions in the study area.)

Although not known to correspond with any of the globally imperiled wetland plant communities recognized by NatureServe, noteworthy stands of water tupelo forested wetlands have been described from Guntersville Reservoir along Dry Creek and inland on Bellefonte Island (TVA 2001). Several water tupelo stands also exist on portions of Wheeler Reservoir near Huntsville and Decatur, Alabama. In addition, a globally imperiled plant community dominated by giant cane (*Arundinaria gigantea*) (the giant cane shrubland) occurs in association with floodplain forests at scattered locations throughout the study area.

Four other globally imperiled floodplain forest communities reported from the seven-state TVA region have potential to occur in the study area, although specific locations of these communities have not been identified. The montane floodplain slough forest and the southern Appalachian bog (rhododendron type) could occur in portions of the study area in the Blue Ridge Physiographic Region, the pin oak–post oak lowland flatwoods could occur in portions of the study area in the Highland Rim and Coastal Plain Physiographic Regions, and the interior forested acid seep could occur in portions of the study area in the Coastal Plain Physiographic Region.

Scrub/shrub communities are often associated with bottomland hardwood forests but lack a well-defined forest canopy. In the study area, woody species commonly observed in scrub/shrub communities include black willow, buttonbush (*Cephalanthus occidentalis*), silky dogwood (*Cornus amomum*), river alder (*Alnus* sp.), Virginia willow (*Salix* sp.), swamp loosestrife (*Decodon verticillatus*), red and silver maples, box elder, sycamore, and green ash. One globally imperiled scrub/shrub plant community, Hiwassee/Ocoee bedrock scour vegetation, occurs in the study area along the Hiwassee and Ocoee Rivers in the Blue Ridge

Physiographic Region. The great rhododendron/peatmoss species shrubland could occur in portions of the study area in the Blue Ridge, but specific locations have not been identified.

Two globally imperiled herbaceous wetland communities that often occur in association with scrub/shrub wetlands could occur in the study area, although specific locations of these communities are not currently known from the area. The floodplain pool community could occur in portions of the study area in the Blue Ridge Physiographic Region, and the Kentucky prairie cordgrass marsh community could occur in portions of the study area in the Highland Rim Physiographic Region.

Reservoir flats occur in the drawdown zone between maximum summer and minimum winter pool elevations. As with other wetlands associated with the reservoir system, the cycle of flooding and soil exposure experienced by these flats communities is reversed from the natural pattern of summer drawdown and winter flooding that typifies most freshwater wetlands. Webb et al. (1988) reported on the flats flora and vegetation of six mainstem reservoirs. Amundsen (1994) reported on the ecology and dynamics of flats and riparian communities on Watts Bar Reservoir. These studies found these flats communities to be dominated by annual plant species, several of which complete their life cycle between the start of each annual winter drawdown and frost. These species include lowland rotala (*Rotala ramosior*), grasslike fimbry (*Fimbristylis miliacea*), yellow false pimpernel (*Lindernia dubia*), and both variable (*Cyperus difformis*) and white-edge (*C. flavicomus*) flatsedge. None of the globally imperiled wetland plant communities reported from the seven-state TVA region are known to be associated with reservoir flats in the study area.

Islands that are exposed at maximum summer pool typically support remnant upland plant communities toward the interior while being surrounded by a fringe of mesic- to hydrophytic- (and often early successional) woody species such as willow, sycamore, and yellow poplar (*Liriodendron tulipifera*) toward the water's edge. In contrast, if vegetated at all, islands exposed during winter drawdown are fringed by an emergent aquatic plant community (see Section 4.9, Aquatic Plants). None of the globally imperiled wetland plant communities reported from the seven-state TVA region are known to be associated with islands in the study area.

Springs, seeps, and vernal pools occur in lowland and upland habitats throughout the study area. They exhibit a range of connectivity to the reservoir system that depends on the underlying geology as well as the topographic setting. In the lowland habitats, species associated with springs include watercress (*Nasturtium officinale*), speedwell (*Veronica* sp.), loosestrife, and duckweed (*Limna minor)*. Lowland seeps tend to be associated with the terraces or floodplains of small ravines and are often characterized by herbaceous wetland vegetation, such as sedges, rushes, jewel weed (*Impatiens capensis*), knotweed (*Polygonum* sp.), and royal (*Osmunda regalis*) and cinnamon (*O. cinnamomea*) ferns.

None of the globally imperiled wetland plant communities reported from the seven-state TVA region are known to be associated with lowland seeps, springs, or vernal pools in the study area. However, four globally imperiled plant communities for which specific locations have not been identified in the study area could be associated with these habitats in the area. The floodplain pool could occur in portions of the study area in the Blue Ridge Physiographic Region, the Kentucky prairie cordgrass marsh could occur in portions of the study area in the Highland Rim Physiographic Region, the midwest acid seep could occur in portions of the study area in the Highland Rim or Coastal Plain Physiographic Region, and the interior forested acid seep could occur in portions of the study area in the Coastal Plain Physiographic Region.

D5.2.2 Upland Plant Communities

Upland plant communities include all other terrestrial habitats lacking an aboveground hydrologic connection to a waterbody. These areas are typically situated at or above maximum summer pool levels. For the most part, the upland plant communities addressed in this appendix are located on, or immediately adjacent to, TVA reservoirs.

This category includes plant communities ranging from mountain ridge tops and valley slopes to glades, barrens, and bluffs that may occur along reservoir shorelines but are situated above maximum summer pool. The category also includes plant communities exhibiting a range of variation in seasonal moisture, such as wet prairies and meadows, upland ponds or other depressions, and rock shelters associated with seasonal precipitation. Some of these latter communities appear in the wetlands subset of the NatureServe Explorer database because they are characterized by species with high moisture requirements. In the majority of cases, these communities are not likely to be directly influenced by changes in reservoir operations; however, they could be subject to indirect impacts that might result from changes in reservoir operations.

Construction of reservoirs in the Valley raised water levels into areas that were formerly upland sites. In general, reservoir margins that remain predominately characterized by upland vegetation indicate that the adjacent reservoir exerts minimal influence on the composition of the shoreline vegetation. Although located immediately adjacent to the reservoir, these communities are unlikely to be directly affected by changes in reservoir levels. In contrast, areas formerly supporting upland vegetation that now consist of riparian vegetation indicate at least some reservoir influence on plant community composition (see the preceding discussion of lowland communities).

Glades and barrens are upland habitats that have been, in some cases, flooded or encroached on by reservoirs. Consequently, these upland communities often occur immediately adjacent to a waterbody. They may occur on sandstone or limestone and are less common in the Blue Ridge and Coastal Plain Physiographic Regions than in other regions. Limestone cedar glades support several regional endemics that are restricted to these habitats, many of which are federally or state-listed (see Section 4.13, Threatened and Endangered Species). Two globally imperiled wetland plant communities reported from the seven-state TVA region are known from limestone glade habitats in the study area. Both the limestone seep glade and the limestone glade streamside meadow occur along the Duck River in the Nashville Basin. The Cumberland sandstone flatrock glade could also occur along the Duck River in the Nashville Basin, but specific locations are not currently known from the area.

Rock shelters are also widely distributed through the Valley, particularly on the Cumberland Plateau. Like glades and barrens, these habitats tend to support regional endemics, many of which are either federally or state-listed (see Section 4.13, Threatened and Endangered Species). Bluffs are abundant on most reservoirs and stream reaches in the Valley; many of their lower reaches have been flooded or partly flooded by impoundment. Seepage areas associated with these rock shelters, cliff faces, or bluffs often support uncommon plant communities. Three globally imperiled wetland plant communities (the Cumberland Plateau rockhouse; the Cumberland Plateau wet sandstone cliff; and the Cumberland River limestone seep cliff) are known to occur in association with such habitats along Bear Creek and Upper Bear Creek Reservoirs.

Upland depressions, including those associated with seeps, springs, and vernal ponds, may lack an aboveground hydrologic connection to a waterbody but can be connected to these water sources via groundwater systems. None of the globally imperiled wetland plant communities reported from the seven-state TVA region are currently known from upland seeps, springs, or vernal pools in the study area. However, five globally imperiled plant communities for which specific locations are not currently known from the study area could be associated with these habitats in this area. The southern Appalachian acid seep, the southern Appalachian bog (rhododendron type), and the upland sweetgum–red maple pond could occur in portions of the study area in the Blue Ridge Physiographic Region; the white oak sandstone ridgetop depression forest could occur in portions of the study area in the Cumberland Plateau Physiographic Region; and the water tupelo sinkhole pond swamp could occur in portions of the study area in the Highland Rim Physiographic Region.

In addition, the globally imperiled Cumberland Plateau mesic hemlock-hardwood forest occurs in the study area along Bear Creek and Upper Bear Creek Reservoirs. This community is found along steep, mesic sandstone ravines.

D5.3 Associated Wildlife Communities

Ecological data on the terrestrial animals and their habitats that occur along TVA reservoirs were gathered from field interviews with subject matter experts, published reports, TVA land use plans and environmental assessments, and biological data collection centers. After a review of the broad context of the terrestrial ecology of TVA's reservoirs, the scope of the terrestrial ecology analysis was narrowed to focus on those animals and habitats closest to the reservoirs and most likely to be affected by operational changes. For the most part, these affected habitats consisted of lowland communities; therefore, these communities make up the majority of the discussion that follows.

The Tennessee River and its associated riparian zone provide habitat for a diversity of wildlife. Approximately 60 species of reptiles, 70 species of amphibians, 180 species of breeding birds, and 60 species of mammals occur in the Tennessee Valley region (modified from Ricketts et al. 1999). In addition, a variety of species of terrestrial invertebrates, such as spiders, insects, and land snails, occur in the region.

Factors such as habitat type and size, food availability, surrounding land use, and other constraints, determine the diversity and abundance of wildlife that occur in the vicinity of the reservoir system. Habitats types include emergent, scrub/shrub, and forested wetlands; upland and riparian forests; and early successional habitats. Shoreline features occurring in these habitats include caves and sinkholes, vernal ponds, river islands, and flats. In many cases, the highest diversity of species in an area occurs at the interface of high-quality wildlife habitats and the river.

Wildlife of the Tennessee River can be grouped into two broad categories: those that occur in upland communities and those that occur in lowland communities. Within each of these divisions, the following animal groups occur: migratory birds, game mammals, and non-game wildlife—including small mammals, reptiles, and amphibians. The dependence of each of these animal groups on habitats and changes in reservoir levels and river flow is discussed in the following sections. Although there is no clear distinction between plants and animals that occur in either upland or lowland communities, the following discussion groups species of animals into the habitat categories they are most closely associated with.

D5.3.1 Associated Wildlife in Lowland Areas

Wildlife habitats in lowland areas include bottomland hardwood forests, riparian forests, wetlands, shorelines, river islands, and flats. Riparian forests and other terrestrial habitats associated with aquatic resources, such as vernal ponds, rivers, and wetlands, are often the most productive habitats in a given area.

Wading birds of the Valley include great blue heron (*Ardea herodias*), great egret (*Ardea alba*), little blue heron (*Egretta caerulea*), black-crowned night-heron (*Nycticorax nycticorax*) and snowy egret (*Egretta thula*). While the larger colonies of breeding herons occur along the mainstem river system, tributary reservoirs also contain heron colonies. In addition to their importance to breeding wading birds, TVA reservoirs are important in late summer when juvenile birds in the region begin to disperse. Exposed flats and pockets of shallow water created by drawdowns afford foraging areas for these birds (Nicholson pers. comm.). Wetlands and river islands provide nesting, foraging, and roosting opportunities for wading birds and other species, such as the double-crested cormorant (*Phalacrocoras auritus*) and green heron (*Butorides virescens*).

During annual reservoir drawdowns, thousands of acres of flats are exposed along TVA reservoirs. Migrating and resident waterfowl, shorebirds, terns, and herons use flats for resting and foraging, primarily during the spring and fall migration periods. These birds prefer areas ranging from moist flats to shallow water (0 to 4 inches) and moist soils in the drawdown zone. Shorebirds found on inland shores concentrate on flooded fields, muddy freshwater ponds, river flats, and shallow-water areas along the shoreline with limited vegetation that provide invertebrate prey. Numbers of these birds vary by reservoir and largely depend on weather patterns and reservoir levels.

The most extensive flats are located on Kentucky Reservoir. These flats begin to appear as the water levels on Kentucky Reservoir drop to the 356.5-foot elevation. The larger flats on the reservoir are located at the mouth of the Duck River and in Birdsong, Blood River, Big Sandy, and Jonathan Creek embayments. Additional flats occur on Pickwick, Wheeler, Chickamauga, and Douglas Reservoirs.

The largest concentrations of shorebirds in the Valley typically occur during the fall migration period. In contrast to spring migration, agricultural fields are typically dry in fall due to seasonally low precipitation. Shorebirds that migrate through the Valley include spotted sandpiper (*Actitis macularia*), solitary sandpiper (*Tringa solitaria*), least sandpiper (*Calidris minutilla*), pectoral sandpiper (*C. melanotos*), semipalmated plover (*C. pusilla*), and greater (*T. melanoleuca*) and lesser (*T. flavipes*) yellowlegs. Some of these species, such as dunlin (*C. alpina*) and some sandpipers, often winter on TVA reservoirs (Simbeck pers. comm.).

In general, shorebirds need moist flats exposed by early August. These areas are important foraging areas during fall migration. The best conditions occur when the drawdown is slow and continuous. The prevalence of a continuous amount of moist soil conditions supports a prey base by not allowing all of the flats to dry out at the same time (Nicholson pers. comm.). Several reservoirs, such as Kentucky and Douglas, are currently operated at levels that are favorable to shorebirds. Pickwick and Wheeler Reservoirs also attract shorebirds but to a lesser extent, as flats on these reservoirs become exposed later in the migratory season.

Ring-billed (*Larus delawarensis*), herring (*L. argentatus*), and other gulls roost and feed in the immediate vicinity of several TVA hydroelectric dams. Although some gulls use these areas during summer, the highest abundance of gulls is during winter (December to March). These birds have become accustomed to feeding on shad and other forage fish that are killed or are otherwise stunned by dam releases (Simbeck pers. comm.). Gull feeding activity therefore may depend on the timing and duration of dam spillage.

Most waterfowl in the Valley are migratory and usually are present during fall and winter. While dabbling ducks (such as mallard [*Anas platyrhynchos*], gadwall [*Anas strepera*], American black duck [*Anas rubripes*], and blue-winged teal [*Anas discors*]) prefer more shallow waters, diving ducks (such as scaup [*Aythya* sp.], redhead [*Aythya americana*], and canvasback [*Aythya valisineria*]) forage in deeper waters. Depending on the species, the following conditions along reservoirs provide habitat for a favorable diversity of waterfowl: a mixture of water depths, wetlands, riparian vegetation, aquatic macrophytes, shallow-flooded overbank, vegetated flats, and agricultural fields.

Migrating waterfowl of the Valley include blue-winged teal, northern pintail (*Anas acuta*), ring-necked duck (*Aythya collaris*), American widgeon (*Anas americana*), common loon (*Gavia immer*), Northern shoveler (*Anas clypeata*), and gadwall. Nesting waterfowl in the Valley includes wood duck (*Aix sponsa*), Canada goose (*Branta canadensis*), mallard, and occasionally pied-billed grebe (*Podilymbus podiceps*), blue-winged teal, and hooded merganser (*Lophodytes cucullatus*). Numbers of migrating and wintering waterfowl vary in the region, depending on weather conditions, flyway populations, and other factors. Waterfowl tend to favor reservoirs with a mixture of vegetated flats and abundant emergent vegetation that provides cover and foraging opportunities. The majority of the waterfowl use on the Tennessee River occurs on the mainstem. The largest concentrations of waterfowl are observed on Kentucky, Wheeler, and Guntersville Reservoirs.

Game birds found in lowland communities include Common snipe (*Gallinago gallinago*), American woodcock (*Scolopax minor*), and eastern wild turkey (*Meleagris gallopavo* spp.). Raptors that use these habitats and nearby reservoirs include osprey (*Pandion haliaetus*), red-shouldered hawk (*Buteo lineatus*), barred owl (*Tyto alba*), and screech owl (*Otus asio*). Bottomland hardwood forests have been ranked among the highest priority of areas that provide optimal habitat for Neotropical songbirds (Hunter et al. 1993). Neotropical songbirds found in lowland habitats in the study area include prothonotary warbler (*Protonotaria citrea*), red-eyed vireo (*Vireo olivaceus*), wood thrush (*Hylocichla mustelina*), northern parula (*Parula americana*), yellow-throated warbler (*Dendroica dominica*), Louisiana waterthrush (*Seiurus motacilla*), and Baltimore oriole (*Icterus galbula*). Species such as the common yellowthroat (*Geothlypis trichas*), indigo bunting (*Passerina cyanea*) and belted kingfisher (*Ceryle alcyon*) use river islands in the study area.

Furbearers, such as muskrat (*Ondatra zibethicus*), mink (*Mustela vison*), river otter (*Lontra canadensis*), beaver (*Castor canadensis*), and raccoon (*Procyon lotor*), use wetlands, river islands, and shoreline habitats in the study area for foraging and shelter. Beaver are prevalent in the Valley; their dams, which often create wetland habitats, can be found along the tributaries to TVA reservoirs. Beaver may be associated with changes in reservoir levels, especially in areas where low-gradient streams are influenced by a reservoir (Atkins pers. comm.). Areas influenced by beaver flooding often contain standing dead trees, which provide habitat for cavity-nesting birds and den sites for mammals, and serve as perches for foraging birds. Larger mammals (such as white-tailed deer [*Odocoileus virginianus*] and black bear [*Ursus americanus*]) also depend on lowland communities (such as riparian forests, vegetated shorelines, and wetlands) for food and cover.

Both game and non-game wildlife species found along the reservoirs depend on riparian forests as travel corridors. Dead wood from these forests provides floating logs along the shorelines. Wood accumulation creates basking sites and cover for turtles, snakes, and other species of wildlife (NAS 2002). Small mammals, birds, turtles, and snakes may also find foraging opportunities on these logs.

Some non-game species, such as frogs, toads, and salamanders, are highly dependent on habitats that support moist conditions. Non-game wildlife commonly occurring in lowland communities associated with reservoirs include small mammals, such as little brown bat (*Myotis lucifugus*), least shrew (*Cryptotis parva*), southern flying squirrel (*Glaucomys volans*), and white-footed mouse (*Peromyscus leucopus*). Amphibians found in lowland communities associated with reservoirs include bullfrog (*Rana catesbiana*), green frog (*Rana clamitans*), southern leopard frog (*Rana utricularia*), gray treefrog (*Hyla versicolor*), eastern newt (*Notophthalmus viridescens*), southern two-lined salamander (*Eurycea bislineata*), and several species in the mole salamander group—including mole (*Ambystoma talpoideum*), spotted (*Ambystoma maculatum*), and marbled

(*Ambystoma opacum*) salamanders. Reptiles found in lowland communities associated with reservoirs include common snapping turtle (*Chelydra serpentina*), red-eared slider (*Trachemys scripta*), painted turtle (*Chrysemys picta*), Ouachita map turtle (*Trachemys scripta*), common musk turtle (*Sternotherus odoratus*), spiny softshell (*Apalone spnifera*), northern water snake (*Nerodia sipedon*), eastern worm snake (*Carphophis amoenus*), and eastern cottonmouth (*Agkistrodon piscivorus*).

Like other species of wildlife, aquatic turtles have adapted to the dynamic conditions of the reservoir system. Most species of turtles in the Valley are highly aquatic; however, they depend on riparian habitats for nesting. Features such as shallow water with emergent vegetation, overhanging banks, expose sandbars, muskrat lodges, and rotting stumps along the shoreline provide nesting and basking habitat for turtles. The food habitats of aquatic turtles vary by species, but aquatic invertebrates, aquatic plants, and small fish are important components of their diet.

Important habitats in lowland communities in the study area that are used by non-game wildlife include vernal ponds, waterholes, and caves. Vernal ponds are temporary shallow pools, often found in woodlands. These areas are seasonally to semi-permanently flooded by rainfall, groundwater movement or reservoir overflow. Vernal ponds are often used as breeding sites for insects, salamanders, turtles, frogs, and toads.

Caves are sensitive ecological communities that are strongly influenced by conditions that limit light and nutrients and also maintain somewhat stable temperature and humidity levels. Many terrestrial animals depend on caves during all or part of their life cycle. These animals include birds, bats, rodents, salamanders, and insects. While caves are not restricted to lowland communities, the microclimate of many caves along the Tennessee River is influenced by reservoir levels. Numerous caves and rock shelters are located at the reservoir water level; therefore, water fluctuations within caves often determine the extent of wildlife use of a particular cave. Caves are habitats that are used by rare animals as well as more common species. Many caves in the Valley are threatened by recreational activities and uninformed human activities that cause disturbance to these environments. For the most part, cave-dwelling species have adapted to the dynamic changes in reservoir levels as a result of periodic flooding, and raising and lowering reservoir levels.

Water resources with subsurface connections to the reservoir, such as sinkholes, ponds, and quarries, are also used by wildlife. For example, bats often occupy crevices in sinkholes, and vultures can be found nesting around abandoned rock quarries.

D5.3.2 Associated Wildlife in Upland Areas

Upland communities include deciduous and coniferous woodlands, agricultural lands, old fields, and other early successional habitats. These areas may have an aquatic component, such as a wetland or a stream; however, they are generally located on dry sites and are not affected by periodic flooding. Seeps, springs, and streams that occur within upland communities provide a source of water for terrestrial animals that live there and may provide the very component that creates breeding and foraging habitat for invertebrates, reptiles, amphibians, birds, and mammals of the area. In many cases, drier upland habitats contain a lower diversity of wildlife species and are less productive from a wildlife standpoint than are lowland moist habitats. However, distinctive animal species are associated with upland communities, and it is important to note that many upland species regularly rely on lowland habitats for food, refuge, reproduction, and migration. Important habitat features found in upland communities include bluffs, rock outcrops, rock shelters, caves, and rock debris.

Migratory birds typically associated with uplands fall into the category of game birds, raptors, and neotropical songbirds. Game birds found in upland fields and forests include northern bobwhite (*Colinus virginianus*), mourning dove (*Zenaida macroura*), ruffed grouse (*Bonasa umbellus*), and American crow (*Corvus brachyrhynchos*). Raptors associated with fields and forests include red-tailed hawk (*Buteo jamaicensis*), broad winged hawk (*Buteo platypterus*), great horned owl (*Bubo virginianus*), Cooper's hawk (*Accipiter cooperii*), and American kestrel (*Falco sparverius*).

Southern Appalachian forests support some of the richest bird diversity in North America (Simons et al. 1998). Neotropical songbirds found in upland forests include summer tanager (*Piranga olivacea*), scarlet tanager (*Piranga rubra*), ovenbird (*Seiurus aurocapillus*), Kentucky warbler (*Oporornis formosus*), hooded warbler (*Wilsonia citrina*), black-and-white warbler (*Mniotilta varia*), and worm-eating warbler (*Helmitheros vermivorus*). Neotropical songbirds found in field communities include barn swallow (*Hirundo rustica*), prairie warbler (*Dendroica discolor*), common yellowthroat, white-eyed vireo (*Vireo griseus*), and field sparrow (*Spizella pusilla*).

Game mammals that occur in fields and forest of the Valley include elk (*Cervus elaphus*), black bear, white-tailed deer, bobcat (*Lynx rufus*), coyote (*Canis latrans*), and gray (*Urocyon cinereoargenteus*) and red (*Vulpes vulpes*) fox. Smaller game animals include woodchuck (*Marmota monax*), eastern gray squirrel (*Sciurus carolinensis*), and eastern cottontail (*Sylvilagus floridana*). Fox squirrel (*Sciurus niger*), coyote, and striped skunk (*Mephitis mephitis*) are found in both wet and drier habitats.

As with lowland communities, habitat features such as caves, vernal ponds, and waterholes are important in producing habitat diversity in upland communities in the study area. Non-game wildlife found in upland communities of the Valley includes small mammals such as eastern mole (*Scalopus aquaticus*), eastern chipmunk (*Tamias striatus*), eastern pipestrille (*Pipistrellus subflavus*), red bat (*Lasiurus borealis*), short-tailed shrew (*Blarina brevicauda*), deer mouse (*Peromyscus maniculatus*), and cotton rat (*Sigmodon hispidus*).

Reptiles and amphibians found in upland communities include spring peeper (*Pseudacris crucifer*), eastern narrowmouth toad (*Gastrophryne carolinensis*), eastern spadefoot (*Scaphiopus holbrookii*), American toad (*Bufo americanus*), upland chorus frog (*Pseudacris triseriata*), fence lizard (*Sceloporus undulatus*), eastern box turtle (*Terrapene carolina*), slimy salamander (*Plethodon glutinosus*), ringneck snake (*Diadophis punctatus*), black racer (*Coluber *constrictor*), northern copperhead (*Agkistrodon contortix*), gray rat snake (*Elaphe obsoleta*), and eastern hognose snake (*Heterodon platirhinos*).

D5.3.3 Terrestrial Animal Resources Unique to the Physiographic Regions in the Tennessee River Watershed

Because of their size, the mainstem reservoirs contain more wildlife habitat than tributary reservoirs. Mainstream reservoirs contain more flats, wintering waterfowl and gulls, heron colonies and wetlands than the tributary reservoirs. Several noteworthy terrestrial resources are associated with the physiographic regions in the study area.

In the Blue Ridge Physiograhic Region, the isolated and riverine conditions of Wilbur Reservoir attract large numbers of waterfowl, such as bufflehead (*Bucephala albeola*), hooded merganser, common golden-eye (*Bucephala clangula*), and white-winged scoter (*Melanitta fusca*) (Cottrell pers. comm.).

A population of green anoles (*Anolis carolinensis*), a lizard species that reaches its northernmost distribution in the Ridge and Valley Physiographic Region, occurs along Tellico Reservoir. Douglas Reservoir provides extensive flats and shallow-water habitats that are used heavily by migrating shorebirds and wading birds. Agricultural areas along Chickamauga Reservoir provide valuable habitat for migrating sandhill cranes (*Grus canadensis*). Watts Bar Reservoir is known to support large numbers of osprey.

In the Cumberland Plateau Physiographic Region, large stands of bottomland hardwoods/ forested wetlands occur on Guntersville Reservoir. Guntersville supports a large number of wintering ducks, and particularly large beaver impoundments are found on this reservoir. Guntersville Reservoir also supports an extensive network of caves and sandstone shelters and a large number of islands that are critical breeding areas for wading birds and amphibians. Upper Bear Creek Reservoir contains unique habitats, such as sandstone outcrops and remnant cove hardwood habitats, which are extremely rare in northwest Alabama. These communities provide habitat for a variety of amphibians, birds, and mammals.

Large tracts of bottomland hardwoods occur on Kentucky Reservoir in the Highland Rim and Coastal Plain Physiographic Regions. Kentucky Reservoir supports more waterfowl than any other impoundment in the Tennessee River system. Large numbers of gulls are known to congregate at Kentucky Dam during winter. Beaver impoundments on Kentucky Reservoir play an important role in wildlife habitat diversity there.

On Pickwick Reservoir, in the Coastal Plain Physiographic Region, gravel bars provide foraging areas for gulls and bald eagles (*Haliaeetus leucocephalus*) during fall and winter. A large number of gulls spend the winter foraging near Pickwick Dam. Numerous flooded sinkholes adjacent to Pickwick Reservoir provide habitat for wading birds and amphibians.

Wheeler Dam, in the Highland Rim Physiographic Region, supports a large wintering gull population. Large numbers of waterfowl winter on Wheeler Reservoir. American alligators

(*Alligator mississippiensis*) use waterholes near Wheeler Reservoir in winter (Atkins pers. comm.).

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Appendix D6

Threatened and Endangered Species

D6a. Threatened and Endangered Species List

D6b. Threatened and Endangered Species Evaluation

Tennessee Valley Authority

Reservoir Operations Study – Final Programmatic EIS

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Table D6a-01 Threatened and Endangered Species List

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (311)		**(10)**	**(311)**			**(72)**
Acalypha deamii	Deam's copperleaf		TS	F, E, A		3
Acer saccharum ssp. *leucoderme**	Chalk maple		TS	W, A	U	44*, 45*
*Acorus calamus**	Sweetflag		AP	E	S	7*, 9*
Adlumia fungosa	Climbing fumitory		TT	W, C		72
Agalinis auriculata	Earleaf foxglove		TE	D		51
Amsonia tabernaemontana var. *gattingeri**	Blue star ~		TS	G, O	X	20*
Anemone quinquefolia	Wood anemone		MP	W		23, 27
Apios priceana	Price potato-bean	E	KE, TE	W, A		2, 19, 78
Aplectrum hyemale	Putty-root		MP	W		4
*Aquilegia canadensis**	Wild Columbine		MP	C	U	4*
Arabis canadensis	Rockcress ~		MP	W, C		23
Arabis glabra	Tower mustard		TS	O, D		3
Arabis patens	Spreading rockcress		TE	C, W		18, 74
*Arenaria fontinalis**	Sandwort		TT	G, E	X	20*
Arenaria godfreyi	Godfrey sandwort		TE	E		70
Arenaria lanuginosa	Sandwort ~		TE	C, X, W		32
Asarum canadense	Wild ginger ~		MP	W		4, 27
Asplenium pinnatifidum	Pinnatifid spleenwort		MP	C		23
*Asplenium resiliens**	Blackstem spleenwort		MP	C	U	4*
Asplenium rhizophyllum	Walking fern		MP	C		4, 23
Asplenium trichomanes	Maidenhair spleenwort		MP	C		23
Aster pratensis	Barrens silky aster		TT	D		3

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (continued)						
Aster schreberi	Shreber aster		TS	W		62
Aster surculosus	Creeping aster		AP	X		9
Astragalus tennesseensis	Tennessee milk-vetch		TS	O		20
Athyrium thelypterioides	Silvery glade fern		MP	W		4
*Aureolaria patula**	False foxglove ~		TT	C, A	U	11*, 13*, 14*, 15*, 16*, 17*, 34*, 51*, 52*, 53*, 54*, 55*
Baptisia bracteata var. *leucophaea*	Cream wild indigo		KS, TS	X, D		2, 78
Bartonia virginica	Screwstem		KT	F		2
Berberis canadensis	American barberry		TS	C, G, W		54, 63, 64, 67
Bigelowia nuttallii	Nuttall's rayless golden-rod		AP	O		9
Botrychium jenmanii	Alabama grapefern		TT	X, D		63
Boykinia acontifolia	Brook saxifrage		AP	W, A		24
Bryoxiphium norvegicum	Sword moss		AP	C		26
*Buckleya distichophylla**	Sapsuck		TT	X	U	67*, 69*, 71, 72
Cacalia muehlenbergii	Great indian-plantain		MP	W		27
Callirhoe triangulata	Poppy-mallow ~		MP	X, D		23
*Camassia scilloides**	Wild hyacinth		MP	W	U	4*, 23*
Cardamine clematitis	Mountain bitter-cress		TT	F		12, 36
*Cardamine flagellifera**	Bitter-cress ~		TT	W, A	S	18*, 37*
Carex comosa	Bristly sedge		TT	F		78
Carex decomposita	Epiphytic sedge		KT	F		2
Carex gravida	Sedge ~		TS	C		14, 51, 52
Carex hitchcockiana	Sedge ~		TT	W		72
Carex jamesii	Sedge ~		MP	W		4

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (continued)						
Carex picta	Sedge ~		MP	X		4, 23
Carex oxylepis var. *pubescens*	Sedge ~		TS	A, C		3, 51
*Carex prasina**	Sedge ~		MP	F, A	U	4*
Carex purpurifera	Sedge ~		AP	W		9
*Carex seorsa**	Weak stellate sedge		MP	W	X	23*
Carex stricta	Sedge ~		MP	E		4
Carex virescens	Ribbed sedge		MP	W		23
Carya aquatica	Water hickory		KT	F		1
*Celastrus scandens**	Climbing bittersweet		AP	W, A	U	6*
Cerastium velutinum	Starry cerastium		TE	C		20
Cheilanthes lanosa	Wooly lip-fern		MP	C, O		4
*Chelone glabra**	Turtlehead ~		MP	F, E, A	X	23*
*Chelone lyonii**	Turtlehead ~		AP, MP	W	S	9*
Chimaphila maculata	Spotted wintergreen		MP	X		27
*Cimicifuga racemosa**	Black bugbane		MP	W	U	4*
*Cimicifuga rubifolia**	Bugbane ~		TT	W	U	14*, 15, 17, 51, 52*, 53, 54, 61, 62, 63, 64, 65, 78
Cladrastis kentukea	Yellowwood		MP	C, W		4
Claytonia caroliniana	Carolina spring-beauty		AP	W		9
*Clematis beadlei**	Clematis ~		MP	A, F	X	23*
*Clematis glaucophylla**	Leather-flower		TE	W, A	U	57*
*Conradina verticillata**	Cumberland rosemary	T	TT	G	I	51*
Corallorhiza wisteriana	Wister coral-root		AP	W		9
Coreopsis auriculata	Tickseed ~		MP	W		23
Coreopsis pulchra	Tickseed ~		AP	O		9

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (continued)						
Corydalis sempervirens	Pale corydalis		TE	O		71
Cotinus obovatus	Smoketree		AP, TS	X, O		8, 9, 11
Crataegus ashei	Ashe's hawthorn		AP	D		25
Cuscuta harperi	Dodder ~		AP	O		9, 26
Cymphyllus fraserianus	Fraser sedge		TS	W		72
*Cyperus dentatus**	Toothed cyperus		TS	A	S	37*
*Cyperus engelmannii**	Engelmann cyperus		TS	A, E	S	17*
Cypripedium acaule	Pink lady-slipper		GE, TE	X, W		37, 44, 45, 47, 50, 51, 52, 54, 63, 69, 72
Cypripedium kentuckiense	Lady-slipper		MP, TE	A, W		34
*Cypripedium reginae**	Showy lady-slipper		TE	F	U	72*
*Cystopteris tennesseensis**	Bladder-fern		AP	C	U	9*
Dalea candida	White prairie clover		TE	D, O		13
Dalea foliosa	Prairie clover	E	TE	O, D		20
Delphinium exaltatum	Tall larkspur		TE	O, D		13, 51, 52
Delphinium tricorne	Dwarf larkspur		MP	W		4, 23, 27
*Dentaria diphylla**	Broadleaf toothwort		MP	W	U	4*, 23*, 27*
*Dentaria heterophylla**	Toothwort ~		MP	W	U	4, 23, 27
Dicentra cucullaria	Dutchman breeches		AP, MP	W		4, 5, 27
*Didiplis diandra**	Water purslane		TT	E	S	70*
*Diervilla lonicera**	Bush honeysuckle ~		TT	C, W	U	11*, 12*, 14*, 15*, 51*, 52*, 53*
*Diervilla rivularis**	Riverbank bush honeysuckle		TT	A, C	U	44*
Dirca palustris	Leatherwood		MP	W		4
Disporum maculatum	Spotted mandrin		AP	W		9

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (continued)						
Dodecatheon meadia	Shooting star ~		MP	W, O		4, 27
Draba cuneifolia	Wedge-leaf whitlow-grass		TS	O		3
Draba ramosissima	Branching whitlow-wort		TS	C		36, 51, 52, 57, 58, 66, 67
Dryopteris cristata	Crested woodfern		TT	E		68
*Eleocharis intermedia**	Spike-rush ~		TS	E	S	54*, 78*
*Eleocharis wolfii**	Wolf spikerush		TS	F, E	X	20*, 22*
*Elodea canadensis**	Waterweed ~		AP	B, A	S	9*
*Elodea nuttallii**	Waterweed		TS	B, A	S	51*, 52*
Elymus svensonii	Wild rye ~		TE	C		19
Epilobium ciliatum	Willow-herb ~		TS	E		52
Eriogonum longifolium var. *harperi*	Harper umbrella plant		AP	C		8, 28
Erythronium albidum	White dogtooth-violet		AP	W		27
Erythronium rostratum	Dogtooth-violet ~		MP	W, A		4
Euonymus atropurpureus	Wahoo		MP	W, A		4, 27
Euonymus obovatus	Running strawberry bush		TS	W, A		4, 27
Eupatuorium steelei	Steele's joe-pye weed		TS	X		72
Festuca paradoxa	Fescue ~		TS	D, F		34
Fimbristylis puberula	Hairy fimbristylis		TT	D, F		3
Fothergilla major	Witch-alder ~		TT	C		12, 52
Frasera caroliniensis	American columbo		AP	D, W, O		31
Fraxinus quadrangulata	Blue ash		MP	X, W		4
*Fuirena squarrosa**	Umbrella grass		TS	E, A	S	37*
Galium asprellum	Rough bedstraw		TS	E		32
*Gelsemium sempervirens**	Yellow jessamine		TS	O	U	11*, 12*, 13*, 37*

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (continued)						
Gentiana austromontana	Gentian ~		TS	D		72
*Geum laciniatum**	Rough avens		TS	A	S	71*
Glyceria acutiflora	Manna-grass ~		TS	E		11
Gnaphalium helleri	Everlasting ~		TS	X		43, 51
Gymnocladus dioicus	Kentucky coffee-tree		MP	W		4
*Halesia carolina**	Carolina silverbell		AP	A	U	9*
Halesia tetraptera var. *tetraptera**	Common silverbell		KT	W	U	1*, 2*
Hedeoma hispida	Rough pennyroyal		KT	X		2
Helianthemum bicknellii	Sunrose ~		TE	X		57
Helianthus glaucophyllus	Sunflower ~		AP	W, X, D		9
Heteranthera dubia	Grassleaf mud-plantain		KS	A, E		78
*Heteranthera limosa**	Smaller mud-plantain		KS,TT	E	S	2*, 78*
Heuchera villosa var. *macrorhiza*	Alumroot ~		MP	C		4
Hexastylis contracta	Wild ginger ~		TS	W		75
Homaliadelphus sharpii	Sharp's homaliadelphus		TE	C		53, 54, 73
*Hottonia inflata**	Featherfoil		AP, TS	E	S	8*, 10*
Hybanthus concolor	Green violet		MP	W		4, 27
Hydrastis canadensis	Goldenseal		AP, TS	W		9, 11, 18, 19, 20, 22, 31, 51, 52, 54, 55, 67, 78
Hydrophyllum appendiculatum	Waterleaf ~		MP	W		4
Hydrophyllum macrophyllum	Waterleaf ~		MP	W		4
*Hydrophyllum viriginianum**	Virginia waterleaf		TT	W, A	U	69*
Hymenophyllum tayloriae	Gorge filmy fern		AP	C		26
*Hypericum adpressum**	Creeping St. John-wort		TT	E, F	S	11*

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (continued)						
Ilex montana	Mountain winterberry		MP	W, X		4
*Iris brevicaulis**	Lamance iris		TE	E	S	2*
*Iris fulva**	Red iris		TT	E, F	S	52*
Isoetes engelmannii	Quillwort ~		MP	E, A		23
*Isoetes lacustris**	Western quillwort		TE	B	S	36*, 55*
Isoetes melanopoda	Quillwort ~		TE	E		2
Isotria medeoloides	Small-whorled pogonia	T	GE, TE	W, X		48
Jamesianthus alabamensis	Jamesianthus		AP	F, A		29
Jeffersonia diphylla	Twinleaf		AP	W		8, 9
*Juglans cinerea**	Butternut		KS, TT	W, A	U	2*, 20*, 34*, 36*, 51*, 52*, 53*, 64*, 67*, 69*, 70*, 72*, 78*
Juncus brachycephalus	Short-head rush		TS	F		52, 75
*Juncus gymnocarpus**	Naked-fruit rush		TS	F, E	S	45*
Leavenworthia alabamica	Alabama glade-cress		AP	D, O		5
Leavenworthia exigua var. *exigua*	Glade cress ~		TS	O		3, 20
Leavenworthia exigua var. *lutea*	Pasture glade cress		AP	O		9
Lejeunea sharpii	Sharp's lejeunea		TE	C		34
Lesquerella densipila	Duck River bladderpod		AP, TT	D		19, 20, 32
Lesquerella lescurii	Lescur's bladder-pod		KS	D, E		78
*Leucothoe racemosa**	Fetterbush ~		TT	E	U	15*
Liatris cylindracea	Cylindric blazing star		TT	D		3, 11, 15, 51, 52
Ligusticum canadense	Lovage ~		MP	W		4
Lilium canadense	Canada lily		TT	E, F, W		51, 52, 54
Lilium michiganense	Michigan lily		TT	E, F		3, 52, 78

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (continued)						
Lilium philadelphicum	Wood lily		TE	E, F		12
Lilium superbum	Turkscap lily		KT, MP	D		2, 4, 23
Liparis loeselii	Loesel twayblade		TE	F, E		2
Lobelia amoena	Southern lobelia		TE	E, A		37, 44, 45, 46
*Lonicera canadensis**	American fly honeysuckle		TS	W, F	U	67*
Lonicera dioica	Smoothleaf honeysuckle		TS	W, C		16, 51, 52, 54, 64
Lonicera flava	Yellow honeysuckle		TS	W, C		11, 12
Luzula acuminata	Woodrush ~		MP	W		4, 23
Lycopodium porophilum	Rock clubmoss		AP, MP	C		26
Lysimachia fraseri	Loosestrife ~		KE, TE	A		2, 4, 12, 43, 44
Magnolia virginiana	Sweetbay		TT	F		65
Malus angustifolia	Crab apple		KS, TS	X, D		2, 78
Marshallia grandiflora	Barbara buttons ~		TE	G		51
*Marshallia obovata**	Barbara buttons ~		TT	W, A	S	36*
Marshallia trinervia	Barbara buttons ~		NS, TT	A		34
Meehania cordata	Meehan mint		TT	W		53, 54, 65
Melanthium latifolium	Broadleaf bunchflower		TE	W		22
Melanthium parviflorum	False hellebore ~		AP	W		9
*Melanthium woodii**	Ozark bunchflower		TE	F, E	U	54*
Melanthum virginicum	Bunchflower ~		KE	W		54
Menispermum canadense	Yellow parilla		MP	W, A		4
Mertensia virginica	Bluebells		MP	A		27
Mirabilis albida	Pale umbrella-wort		AP, TT	O		20, 28
Monarda clinopodia	Horsemint ~		AP	W		4
Monotropsis odorata	Pigmy-pipes		TT	X		1

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (continued)						
Muhlenbergia glabrifloris	Muhly ~		KS, TS	X, D		20, 78
Muhlenbergia tenuiflora	Muhly ~		MP	C, W		4
Najas gracillima	Thread-like naiad		KS	A, B		78
*Neobeckia aquatica**	Lake-cress		AP, KT, TS	B, E	S	2*, 7*, 78*
Neviusia alabamensis	Snow-wreath		AP, MP, TT	W, C		4, 7, 9, 33
Oenothera macrocarpa ssp. *macrocarpa*	Missouri primrose		TT	O		20
Oenothera perennis	Small sundrops		KE	E, A		2
*Oldenlandia uniflora**	Oldenlandia ~		KE	E, D	S	2*
Onosmodium molle ssp. *hispidissimum*	Hairy false gromwell		TS	X		11
Ophioglossum engelmannii	Adder-tongue ~		AP	O, D		3, 13, 18
Orobanche uniflora	One-flower cancer-root		AP	W		9
Osmorhiza longistylis	Anise-root		MP	W		4, 23, 27
Oxalis grandis	Wood-sorrel ~		AP	W		8, 9
Pachysandra procumbens	Allegheny-spurge		AP, MP	W		4, 6, 24, 26, 31
Panax quinquefolius	Ginseng		MP, TS	W		2, 4, 11, 12, 13, 17, 18, 22, 23, 34, 36, 44, 51, 52, 54, 63, 64, 69, 72, 78
Panicum acuminatum var. *leucothrix*	Panic-crass		TS	D, E		47
Parnassia grandifolia	Largeleaf grass-of-parnassus		TS	F, A		53, 54, 70
Paxistima canbyi	Cliff-green		TE	D, E		64
Pedicularis lanceolata	Swamp lousewort		TT	E		54
Pellaea atropurpurea	Purple cliff-brake		MP	C		4, 23

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (continued)						
Perideridia americana	Perideridia ~		MP	D, C		4
Phacelia bipinnatifida	Phacelia ~		MP	W		4
Phacelia dubia	Scorpion-weed		MP	O		4
Phacelia ranunculacea	Blue scorpion-weed		TS	W		78
*Philadelphus hirsutus**	Mock-orange ~		MP	C	U	4*
Philadelphus inodorus	Mock-orange ~		KT	C		2, 78
Phlox pilosa ssp. *ozarkana*	Downy phlox		TS	X, D		2
Phlox subulata	Moss phlox		TT	X, C		63
*Pinus virginiana**	Virginia pine		MP	X	U	4*, 23
*Pityopsis ruthii**	Ruth golden aster	E	TE	G	A	37*, 44*
Platanthera cristata	Crested fringed orchid		MP	E, D		4, 23
Platanthera flava var. *flava**	Southern rein orchid		AP, TS	F, E, A	S	7*, 9*, 34*
Platanthera integrilabia	Monkey-face orchid	C	AP, MP	F, A		4, 25
Platanthera orbiculata	Large roundleaf orchid		TT	W		69
Polemonium reptans	Greek valerian		MP	W, A		4, 23, 27
Polygala boykinii	Boykin milkwort		TS	O		20
Polygala mariana	Milkwort ~		TS	D		3, 13
Polymnia laevigata	Smooth leafcup		AP	C, W		9
Porella wataugensis	Liverwort ~		TT	C		58
*Potamogeton amplifolius**	Largeleaf pondweed		TT	B, A	S	55*
*Potamogeton epihydrus**	Creekgrass		TS	B, A	A	12*, 37*, 55*, 56*, 57*
*Potamogeton tennesseensis**	Pondweed ~		TT	A	A	37*, 55*
Prenanthes barbata	Barbed rattlesnake-root		TS	D, X		3
Prenanthes crepidinea	Nodding rattlesnake-root		TE	W, D, O		78
Ptilimnium capillaceum	Hair-like mock bishop-weed		KT	E		2, 78

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (continued)						
Ptilimnium nuttallii	Nuttall's mock bishop's-weed		KE	E, F, W		78
Radula voluta	Liverwort ~		TS	C		73
Ranunculus flabellaris	Buttercup ~		AP, TT	E		34
Rhamnus alnifolia	Alder-leaf buckthorn		TE	E, F		54
Rhododendron minus	Carolina rhododendron		AP	X, C		9
Rhynchospora capillacea	Capillary beakrush		TE	A		54
Ribes curvatum	Gooseberry ~		AP	W, X		9
Ruellia purshiana	Pursh petunia		TS	X		17, 51, 52, 63
Sabatia campestris	Prairie pink		MP	W, D		80
Sabatia capitata	Rose-gentian		TE	X, D		12
*Sacciolepis striata**	Gibbous panic-grass		TS	E	A	13*, 37*
Sagittaria brevirostra	Short-beaked arrowhead		TT	F, E		78
*Sagittaria platyphylla**	Ovate-leaved arrowhead		TS	E	S	13*
*Salix caroliniana**	Coastal plain willow		MP	G, A	X	4, 23*
Salvia azurea var. *grandiflora*	Blue sage		TS	D		2, 3
Salvia urticifolia	Sage ~		MP	X, D		23
*Sarracenia oreophila**	Green pitcher plant	E	GE, NE	E, A	S	42*
Saxifraga caroliniana	Saxifrage ~		TE	F, C		72
Schoenolirion croceum	Sunnybell ~		TT	O		20
*Scirpus fluviatilis**	River bulrush		AP	E	S	2*, 51*
Scutellaria montana	Mountain skullcap	E	TE	X		11, 12, 13, 37, 69
Scutellaria saxatilis	Rock skullcap		TT	X, W, C		37, 69
Sedum nevii	Stonecrop ~		AP, TE	C		9, 44, 45
Sedum ternatum	Stonecrop ~		MP	C, W		4, 27

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (continued)						
Selaginella arenicola ssp. *riddellii*	Spikemoss ~		AP	O		25, 26
Silene caroliniana ssp. *pensylvanica*	Wild pink ~		TT	C		67, 70
Silene ovata	Ovate catchfly		TE	W		22
Silphium brachiatum	Rosinweed ~		AP	X		8, 9
Silphium wasiotense	Kentucky rosin-weed		TE	W		53, 54
Smilacina stellata	Starflower solomons-seal		TE	W, A		65
Solidago flaccidifolia	Goldenrod ~		MP	W		4
Solidago ptarmicoides	Goldenrod ~		TE	D		14, 51, 52
Solidago sphacelata	Goldenrod ~		MP	X, C		4
Solidago uliginosa	Goldenrod ~		TS	F, E		66
*Sparganium androcladum**	Branching burreed		TE	E, A	S	70*, 71*
Sphenopholis pensylvanica	Swamp oats		KS	E, F		2
Spiraea virginiana	Virginia spiraea	T	TE	G		51
Spiranthes lucida	Shining ladies-tresses		TT	A, F		51
Sporobolus clandestinus	Rough dropseed		KT	D		77
Staphylea trifolia	Bladdernut		MP	W		4, 27
*Stellaria longifolia**	Longleaf stitchwort		KS	F, E	U	2*
Stellaria pubera	Giant chickweed		MP	W		4, 27
Stewartia ovata	Mountain-camellia		AP, MP	W, A		23, 25, 26
Stylisma humistrata	Southern morning-glory		TT	X		12
Sullivantia sullivantii	Sullivantia		TE	C		54
Symplocarpus foetidus	Skunk cabbage		TE	E		68, 70
Symplocos tinctoria	Horse sugar		TS	A, W		36, 37, 44, 45

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (continued)						
Synosma suaveolens	Sweet-scented indian-plantain		TT	X, W		78
Talinium calcaricum	Limestone fame-flower		TS	O		20, 32
Talinum mengesii	Fame-flower ~		AP	O		26
Tetragonotheca helianthoides	False-sunflower ~		TE	X		55
*Thalictrum mirabile**	Little mountain meadow-rue		AP	C	X	26*
Thuja occidentalis	Northern white cedar		TS	C, F		51, 52, 54, 67, 69, 72
Tiarella cordifolia	Foamflower		MP	W		4, 27
Tradescantia ernestiana	Spiderwort ~		MP	C, W		4
Trautvetteria caroliniensis	False-bugbane		MP	A, E		4
*Trepocarpus aethusae**	Trepocarpus		KE	A	S	2*, 78*
Trichomanes boschianum	Bristle fern		MP, TT	C		23, 27, 58
*Trichomanes petersii**	Dwarf filmy-fern		AP, TT	C	S	9, 36*, 58*
Trifolium calcaricum	Leo's trifolium		TE	O		20
Trifolium reflexum	Buffalo clover		TE	X, D		58
Trillium flexipes	Bent trillium		MP	W		4
Trillium lancifolium	Lance-leaf trillium		TE	W, A		12
Trillium recurvatum	Prairie trillium		AP	W		31
Trillium rugelli	Southern nodding trillium		TE	W		44
Trillium sessile	Toadshade ~		AP	W		32
Trillium sulcatum	Southern red trillium		AP	W		9
Triosteum angustifolium	Horse-gentian ~		AP, MP	D		9, 23, 27, 31, 80
Triphora trianthophora	Three-birds-orchid		MP	W		23
Tsuga caroliniana	Carolina hemlock		TT	X, O		8, 23
Ulmus serotina	September elm		KS	W, X, O		78

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Plants (continued)						
Vaccinium macrocarpon	American cranberry		TT	E		46
Viola canadensis	Canada violet		AP	W		9
Viola pubescens var. *eriocarpa*	Downy yellow violet		MP	W		4
Viola tripartita var. *tripartita*	Three-parted violet		TS	W		11, 12, 52
*Woodsia appalachiana**	Appalachian woodsia		TS	C	U	71*
Xerophyllum asphodeloides	Turkey-beard		TT	X		44
Xyris tennesseensis	Tennessee yellow-eyed grass	E	AP	F, A		28
Zigadenus elegans ssp. *glaucus**	White camas		TE	C	U	72*
Snails (14)		**(4)**	**(14)**			**(11)**
*Athearnia anthonyi**	Anthony's river snail	E	AS, TE	B, S	F	7, 10*
Campeloma decampi	Slender campeloma	E	AP	M, S		7
*Elimia interrupta**	Knotty elimia		NE	M	F	37*
*Lithasia armigera**	Armored rocksnail		AT, KS	B	F	1*, 3*, 5*, 78*
*Lithasia geniculata**	Ornate rocksnail		AT, KS	B	F	1*, 3*, 5*
*Lithasia lima**	Warty rocksnail		AT	B, M	F	5*
*Lithasia salebrosa**	Muddy rocksnail		AT, KS	B	F	1*, 5*, 78*
*Lithasia verrucosa**	Varicose rocksnail		AT, KS	B, M	F	1*, 3*, 5*, 10*, 23*, 32*
Mesodon clarki nantahala	Noonday globe	T	NT	W		60
*Pleurocera alveare**	Rugged hornsnail		AT	B, M	F	3*, 5*, 6*
*Pleurocera corpulenta**	Corpulent hornsnail		AT	B	F	5*, 10*
*Pleurocera curta**	Shortspire hornsnail		AT	B, M	F	1*, 3*, 5*, 8*
*Pleurocera walkeri**	Telescope hornsnail		AT	B, M	F	5*
Pyrgulopsis pachyta	Armored snail	E	AP	M, S		7

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Mussels (49)		**(26)**	**(49)**			**(42)**
*Alasmidonta raveneliana**	Appalachian elktoe	E	NE, TE	M	I	58*, 60*
Alasmidonta viridis	Slippershell mussel		NE	S		60
*Cumberlandia monodonta**	Spectaclecase		AP, TS	B, M	F	3*, 5*, 7*, 32*, 52*, 53*, 54
*Cyprogenia stegaria**	Fanshell	E	AP, KE, TE	B, M	F	1*, 3*, 5*, 8*, 14*
*Dromus dromas**	Dromedary pearlymussel	E	AP, TE	B, M	F	14*
*Ellipsaria lineolata**	Butterfly		AS	B, M	F	4*, 5*, 6*, 7*, 8*, 9*, 10*, 23*, 32*
*Elliptio dilatata**	Spike		AS, NS	B, M	F	5*, 8*, 10*, 32*, 33*, 37*, 40*, 60
*Epioblasma brevidens**	Cumberlandian combshell	E	AP, TE	M	X	20*, 23*, 30*
*Epioblasma capsaeformis**	Oyster mussel	E	TE	M	X	20*
*Epioblasma florentina walkeri**	Tan riffleshell	E	TE, VE	M	A	20*, 36, 37*
*Fusconaia barnesiana**	Tennessee pigtoe		AS, NE, VS	M	X	23*, 30*, 69
*Fusconaia cor**	Shiny pigtoe pearlymussel	E	AP, TE	M	F	32*, 33*
*Fusconaia cuneolus**	Fine-rayed pigtoe	E	AP, TE	M	F	32*, 33*, 53*
*Fusconaia subrotunda subrotunda**	Long solid		KT	B	F	1*
*Hemistena lata**	Cracking pearlymussel	E	AP, TE	B, M	F	3*, 5*, 32*, 33*
*Lampsilis abrupta**	Pink mucket	E	AP, KE, TE	B	F	1*, 2*, 3*, 5*, 7*, 8*, 10*, 12*, 14*, 16*, 23*, 51*, 61*, 73*
*Lampsilis fasciola**	Wavy-rayed lampmussel		AS, NS	M, S	F	23*, 41*, 60
*Lampsilis ovata**	Pocketbook		AS, KE	B, M	F	1*, 5*, 8*, 10*, 23*, 25*, 28*, 30*, 32*, 33*, 77*
*Lasmigona complanata**	White heelsplitter		MS	B, M	X	23*
*Lemiox rimosus**	Birdwing pearlymussel	E	TE, AS	M	F	19*, 20*, 32*, 33*

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Mussels (continued)						
*Lexingtonia dolabelloides**	Slabside pearlymussel	C	AP	M	F	19*, 20*, 21*, 23*, 32*, 33*, 34, 37*, 53*
*Ligumia recta**	Black sandshell		AS	B, M	F	4*, 5*, 6*, 8*, 10*, 23*
*Obovaria retusa**	Ring pink	E	AP, TE	B	F	1*, 3*, 4*
*Obovaria subrotunda**	Round hickorynut		AS	B, M	F	5*, 23*, 30*
Pegias fabula	Little-wing pearlymussel	E	TE, NS	M, S		60, 76
*Plethobasus cicatricosus**	White wartyback	E	AP, TE	B	F	3*, 5*
*Plethobasus cooperianus**	Orange-footed pimpleback	E	AS, KE, TE	B	F	1*, 3*, 5*, 8*, 14*, 16*
*Plethobasus cyphyus**	Sheepnose		AP	B, M	F	1*, 5*, 8*, 9*
*Pleurobema clava**	Clubshell	E	AP, TE	B, M	F	3*
*Pleurobema cordatum**	Ohio pigtoe		AS	B, M	F	4*, 5*, 6*, 8*, 10*, 23*
Pleurobema gibberum	Cumberland pigtoe	E	TE	M, S		76
*Pleurobema oviforme**	Tennessee clubshell		AS, TS	B, M	F	8*, 14*, 16*, 20*, 23*, 33*, 36, 37*
*Pleurobema plenum**	Rough pigtoe	E	AP, TE	B, M	F	3*, 4*, 5*, 7*, 8*, 14*
*Pleurobema rubrum**	Pyramid pigtoe		AP, KE	B, M	F	1*, 5*, 8*
*Potamilus alatus**	Pink heelsplitter		MS	B, M	X	23*
*Potamilus capax**	Fat pocketbook	E	KE	B	F	77*
*Potamilus ohiensis**	Pink papershell		AS	B	F	4*, 7*
*Ptychobranchus fasciolaris**	Kidneyshell		AS	M	F	5*, 10*, 23*
Ptychobranchus subtentum	Fluted kidneyshell	C	AS	M		54
*Quadrula cylindrica cylindrica**	Rabbitsfoot		AS, KT, TE	B, M	F	1*, 3*, 5*, 10*, 19*, 20*, 23*, 32*, 33*
Quadrula cylindrica strigillata	Rough rabbitsfoot	E	TE, VE	M		54
*Quadrula intermedia**	Cumberland monkeyface	E	AP, TE	M	F	20*, 32*, 33*
*Quadrula metanevra**	Monkeyface		AS	B, M	F	5*, 6*, 8*, 9*, 10*, 32*

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Mussels (continued)						
Toxolasma cylindrellus	Pale lilliput	E	TE	S		20
*Toxolasma lividus**	Purple lilliput		AS	B, S	F	4*, 5*, 6*, 7*, 8*, 23*
*Truncilla truncata**	Deertoe		AE	B, M	F	4*, 5*, 8*, 23*
Villosa perpurpurea	Purple bean	E	TE	M, S		64
Villosa trabalis *	Cumberland bean	E	TE	M, S	A	37*, 64*
*Villosa vanuxamensis**	Mountain creekshell		NT	M, S	F	41*
Insects (6)		**(0)**	**(6)**			**(0)**
Batriasymmodes spelaeus	A beetle		AS	C		6, 8
Batrisodes jonesi	A beetle		AS	C		5, 23
Folsomia candida	A springtail		AS	C		5
Ptomaphagus episcopus	A cave obligate beetle		AS	C		9
Ptomaphagus valentinei	A beetle		AS	C		9
Rhadine caudata	A ground beetle		AS	C		8
Crayfish (6)		**(0)**	**(6)**			**(0)**
Cambarus hamulatus	Troglobitic crayfish		AS	U		9
Cambarus hiwasseensis	Hiwassee crayfish		NS	M, S		41, 49
Cambarus jonesi	Troglobitic crayfish		AS	U		5, 7, 8
Cambarus veitchorum	A troglobitic crayfish		AT	U		7
Orconectes wrighti	A crayfish		TE	S		3
Procambarus pecki	Troglobitic crayfish		AS	U		5, 8
Other Arthropods (3)		**(0)**	**(3)**			**(1)**
Coras lamellosus	A pseudoscorpion		AS	C		9
Nesticus barri	A cave obligate spider		AS	C		9
Palaemonias sp.*	Undescribed caveshrimp		AS	U	Q	6*

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Fish (66)		**(11)**	**(66)**			**(29)**
*Acipenser fulvescens**	Lake sturgeon		KE, TE	B	F	17*, 18*, 61*, 62*, 73*
*Alosa alabamae**	Alabama shad		KE	B	F	1*
Ammocrypta clara	Western sand darter		TS	M, S		54
Atractoseus spatula	Alligator gar		KE, TS	B		2, 77
*Carpiodes velifer**	Highfin carpsucker		TS	M	F	3*, 13*, 19*, 32*, 36*, 52*, 64*, 73*, 74
Clinostomus funduloides ssp. *1*	Smoky dace		NS, TS	M, S		57, 60
*Cycleptus elongatus**	Blue sucker		TT	B, M	F	3*, 15, 16, 17, 19*, 52, 62, 73*, 78
*Cyprinella monacha**	Spotfin chub	T	AP, NT, TT	M	F	51, 57, 60, 64*, 65
Cyprinella spiloptera	Spotfin shiner		MS	M, S		4, 23
*Cyprinella whipplei**	Steelcolor shiner		MS	B, M, S	X	4, 23, 27*
*Elassoma alabamae**	Spring pygmy sunfish		AP	S	S	4, 7*
Erimystax cahni	Slender chub	T	TT	M		54
Erimystax insignis	Blotched chub		GT	M		50
*Esox niger**	Chain pickerel		KS	B, M	F	2*
*Etheostoma aquali**	Coppercheek darter		TT	M	X	19*, 20*, 21*
Etheostoma blennioides newmanni	Greenside darter		MS	M, S		23
Etheostoma boschungi	Slackwater darter	T	AP	M, S		5
*Etheostoma cinereum**	Ashy darter		TT	M, S	X	20*, 21*, 22, 33
*Etheostoma denoncourti**	Golden darter		TS	M	X	19*, 20*
Etheostoma flabellare	Fantail darter		MS	M, S		4
Etheostoma gutselli	Tuckasegee darter		TE	S		58
Etheostoma kennicotti	Stripetail darter		MS	M, S		4

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Fish (continued)						
*Etheostoma luteovinctum**	Redband darter		TS	S	X	20*, 21*
Etheostoma parvipinne	Goldstripe darter		KS	S		2
Etheostoma percnurum	Duskytail darter	E	TE	M, S		55
Etheostoma pseudovulatum	Egg-mimic darter		TE	S		19
*Etheostoma rufilineatum**	Redline darter		MS	M, S	X	4, 23, 27*
Etheostoma sp. *D**	Bluemask darter	E	TE	M, S	I	76*
*Etheostoma striatulum**	Striated darter		TT	S	X	20*, 21
*Etheostoma tuscumbia**	Tuscumbia darter		AP, TS	S	S	4, 7*, 8
Etheostoma vulneratum	Wounded darter		GE, NS	M		47, 48, 60
*Etheostoma wapiti**	Boulder darter	E	AP, TE	M	F	32*, 33*
Etheostoma zonistium	Bandfin darter		MS	S		4
Fundulus julisia	Barrens topminnow		TE	S		22
Hemitremia flammea	Flame chub		TS	S		20, 33, 34
Ichthyomyzon castaneus	Chestnut lamprey		KS	B		78
*Ichthyomyzon unicuspis**	Silver lamprey		TS	M	F	2*, 3*
Ictiobus niger	Black buffalo		KS	B, M		78
Lepomis miniatus	Spotted sunfish		KT	M		2
Lythrurus fasciolaris	Rosefin shiner		MS	M, S		4, 23
*Moxostoma carinatum**	River redhorse		GS	B, M	F	47*
Moxostoma duquesnei	Black redhorse		MS	B, M		23
*Moxostoma macrolepidotum**	Shorthead redhorse		MS	B	X	23*, 27*
Moxostoma sp. 2*	Sicklefin redhorse		NS	B, M	I	41*, 60*
Notropis boops	Bigeye shiner		MS	S		23
Notropis rubellus micropteryx	Rosyface shiner		MS	M, S		23
Notropis rupestris	Bedrock shiner		TS	S		21, 76

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Fish (continued)						
Noturus baileyi	Smoky madtom	E	TE	M		55
Noturus flavipinnis	Yellowfin madtom	T	TE	M		54, 55, 56
Noturus flavus	Stonecat		NE	M, S		60
Noturus sp. *3*	Duck River saddled madtom		TT	M, S		20
*Noturus stanauli**	Pygmy madtom	E	TE	M	X	19*
*Percina aurantiaca**	Tangerine darter		GT, TS	M	A	36*, 37*, 47*, 51, 55, 64*, 65, 70, 72, 73*
*Percina burtoni**	Blotchside logperch		TS	M	X	2, 22, 36, 55
Percina macrocephala	Longhead darter		TT	M		21, 72
*Percina phoxocephala**	Slenderhead darter		TS	M	X	2,19*, 20*, 21
Percina sciera	Dusky darter		GS	M, S		48
Percina squamata	Olive darter		GT, NS	M		48, 60
*Percina tanasi**	Snail darter	T	TT	M	F	10*, 11, 12*, 14*, 16*, 17*, 18*, 32, 35*, 36*, 43*, 61*, 73*
Phenacobius crassilabrum	Fatlips minnow		VS	M, S		69
Phenacobius mirabilis	Suckermouth minnow		MS	M, S		23
Phoxinus tennesseensis	Tennessee dace		TS	S		36, 44, 51, 55, 64
*Polyodon spathula**	Paddlefish		AS	B	F	4*, 7
Rhinichthys atratulus	Blacknose dace		MS	M, S		4
*Speoplatyrhinus poulsoni**	Alabama cavefish	E	AP	U	Q	5*
*Typhlichthys subterraneus**	Southern cavefish		AP, TS	U	Q	3*, 5*, 7*, 75*, 76*
Amphibians (18)		**(0)**	**(18)**			**(2)**
Ambystoma talpoideum	Mole salamander		NS	A, W		49
Aneides aeneus	Green salamander		AP, ME	C		9, 23, 26, 27

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Amphibians (continued)						
*Cryptobranchus a. alleganiensis**	Eastern hellbender		AP, GS, MS, NS, TS	B, M, S	F	3*, 8, 17*, 18*, 19, 20*, 21, 23, 30*, 36*, 41, 42*, 47*, 49, 51*, 52*, 54*, 55*, 72, 76, 78
Desmognathus ocoee	Mountain dusky salamander		AS	S, F		9
Eurycea guttolineata	Three-lined salamander		KT	A, F, W		2
Eurycea junaluska	Junaluska salamander		TS	A, S		55
Eurycea l. longicauda	Longtail salamander		NS	A, C, F		58
Eurycea lucifuga	Cave salamander		ME	C, A, S		23, 27
Gyrinophilus palleucus	Tennessee cave salamander		AP, TT	U, C		5, 8, 9, 11, 13, 16, 18
Gyrinophilus porphyriticus	Spring salamander		ME	A, C, F		23
Hemidactylium scutatum	Four-toed salamander		MS, NS	A, F		23, 49
Hyla avivoca	Bird-voiced treefrog		KT	A, F		1
*Hyla cinerea**	Green treefrog		KS	A, F	S	2*
Hyla gratiosa	Barking treefrog		KS	A, W, F		78
Plethodon dorsalis	Zigzag salamander		MS	A, C		23
Pseudacris brachyphona	Mountain chorus frog		MS, NS	A, F		4, 23
Pseudotriton ruber	Red salamander		MS	A, F, S		4, 23
Rana areolata circulosa	Northern crawfish frog		KS	A, D, E		1
Reptiles (14)		**(0)**	**(14)**			**(3)**
*Apalone mutica mutica**	Midland smooth softshell		KS	B, M	F	2*
Apalone s. spinifera	Eastern spiny softshell		VS	B, M		69
Eumeces anthracinus pluvialis	Southern coal skink		AS, MS	A		4, 5, 23
Eumeces inexpectatus	Southeastern five-lined skink		KS	O, X		2, 78
*Graptemys ouachitensis**	Ouachita map turtle		MS	B, M	F	4*, 23*

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Reptiles (continued)						
Lampropeltis getula nigra	Black kingsnake		MS	D, E, X		4
Lampropeltis triangulum elapsoides	Scarlet kingsnake		KS	X, W		78
Lampropeltis triangulum triangulum	Eastern milk snake		AS	D		9
Macrochelys temmenckii	Alligator snapping turtle		AP, TS	B, M		2, 3, 5, 6, 27, 28, 78
Ophisaurus attenuatus longicaudus	Eastern slender glass lizard		TS	D, X		55
Pituophis m. melanoleucus	Northern pine snake		AS, KT, TT	X		10, 19, 43, 57, 78
Regina septemvittata	Queen snake		MS	A, S		23
*Sistrurus miliarius streckeri**	Western pigmy rattlesnake		KT, TT	A, F	S	2*, 3, 4, 20
Thamnophis sauritus	Eastern ribbon snake		KS	A, E		78
Birds (23)		**(6)**	**(22)**			**(8)**
Accipiter striatus	Sharp-shinned hawk		TS	X		54
Anhinga anhinga	Anhinga		TS	B		2
Aquila chrysaetos	Golden eagle		TT	C, X		78
Ardea herodias	Great blue heron		KS	A, B, E		1, 2, 77, 78
Bubulcus ibis	Cattle egret		KS	A, E		78
*Casmerodius albus**	Great egret		KE, TE	B, E, F	S	2*, 13*, 78*
*Charadrius melodus**	Piping plover	E/T		B, G	S	2*
Dendroica cerulea	Cerulean warbler		NS, TS	W		52, 60, 78
Egretta caerulea	Little blue heron		KE, TS	A, B, E		2, 78
*Falco peregrinus**	Peregrine falcon		AP, TE	A,C	R	8*, 12*, 18*

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Birds (continued)						
*Haliaeetus leucocephalus**	Bald Eagle	T	AP, KE, TS	A, B	R	2*, 3*, 4*, 8*, 9*, 10*, 13*, 14*, 15*, 16*, 22*, 31*, 54*, 55*, 63*, 64*, 73*, 78*
Ixobrychus exilis	Least bittern		TS	E		12, 13, 19, 34
*Limnothlypis swainsonii**	Swainson's warbler		TS	A, W	U	36*, 54, 69, 71
*Mycteria americana**	Wood stork	E	GE, ME	A, B	S	2*
Nictanassa violacea	Yellow-crowned night-heron		KT	A, B, E		2
Nicticorax nycticorax	Black-crowned night-heron		KT	A, B		78
Pandion haliateus	Osprey		AP, KT	A, B		2, 5, 9, 29, 78
Petrochelidon pyrrhonota	Cliff swallow		MS	C		4
Picoides borealis	Red-cockaded woodpecker	E	AP, ME, TS	X		9
Rallus elegans	King rail		TS	E		12
Riparia riparia	Bank swallow		KS	A		77
*Grus americana**	Whooping crane	E		D, E	S	13*
*Sterna antillarum**	Least Tern	E	KE	B, G	S	1*, 77*
Mammals (16)		**(2)**	**(16)**			**(4)**
*Corynorhinus rafinesquii**	Eastern big-eared bat		AP, NS, TS	C, W	R	6*, 9*, 54*, 60*, 69*
Mustela frenata	Long-tailed weasel		AP	W, D, F		5
Myotis austroriparius	Southeastern bat		KE	A, C		77
*Myotis grisescens**	Gray bat	E	AP, ME, TE, KE	C, B, A	R	2*, 3*, 4*, 5*, 6*, 7*, 8*, 9*, 11*, 12*, 13*, 14*, 15*, 16*, 17*, 19*, 20*, 22*, 26*, 33*, 34*, 53*, 54*, 62*, 68*, 76*, 77*, 78*
*Myotis leibii**	Eastern small-footed bat		NS, TS	C, W, X	R	11*, 53*, 59*

Table D6a-01 Threatened and Endangered Species List (continued)

Scientific Name	Common Name	Federal Status	State Status	Habitat Codes	Direct Effects Analysis	Reaches
Mammals (continued)						
Myotis septentrionalis	Northern long-eared bat		AS, MS, NS	C, W, X		4, 26, 58
*Myotis sodalis**	Indiana bat	E	AP, ME, TE, KE	A, C, W	R	9*, 11*, 19*, 22*, 33*, 53*, 54*, 58*, 59*, 62*, 76*, 77*, 78*
Napaeozapus insignis	Woodland jumping mouse		TS	A, W		34, 46, 64
Neotoma floridana haematoreia	Southern Appalachian woodrat		NS	C, W		60
Neotoma magister	Allegheny woodrat		TS	C		3, 11, 19, 20, 75
Parascalops breweri	Hairy-tailed mole		TS	W		65
Sorex cinereus	Common shrew		TS	A, F		11, 34
Sorex fumeus	Smoky shrew		TS	A, W		46, 53, 54, 69
Sorex longirostris	Southeastern shrew		TS	A, D, W		2, 3, 17, 18, 34, 51, 52, 53, 54, 64, 69, 78
Synaptomys cooperi	Southern bog lemming		TS	E, F, W		68
Zapus hudsonius	Meadow jumping mouse		TS	A, E		3, 19, 34, 78
Totals (526)		**(59)**	**(525)**			**(172)**

Table D6a-01 Threatened and Endangered Species List (continued)

Symbol Codes:

~ = Common name for group, not just this species.
* = In states where it is protected, this species is known from areas within the waterbodies where it could be directly affected by ROS alternatives.

Federal Status Codes:

C = Identified candidate.
E = Endangered.
T = Threatened.

State Status Codes:

First letter = State designation:
A = Alabama, G = Georgia, K = Kentucky, M = Mississippi, N = North Carolina, T = Tennessee, V = Virginia.
Second letter = Status in that state:
E = Endangered.
P = Protected (Alabama) - level of endangerment not specified.
S = Various "special concern" categories (e.g., in need of management, potential, and rare).
T = Threatened.

Habitat Codes:

B = Big rivers.
M = Small rivers and large creeks.
S = Small creeks.
U = Underground aquifers.
A = Riparian areas along streams and ponds.
G = Gravel bars or boulders in large creeks or rivers.
E = Non-forested seeps, wetlands, or wet meadows.
F = Forested seeps or wetlands.
W = Moist woodlands.
X = Xeric hardwood or coniferous forests, or mountain woods.
D = Prairies, fields, roadsides, fencerows, or early successional woodlands.
O = Limestone, sandstone, or granite outcrops (including cedar glades).
C = Caves, sinkholes, rock houses, boulders, bluffs, or cliff faces.

Direct Effects Analysis Codes:

A = Apalachia tailwater.
F = Flowing water habitats.
I = Reservoir inflow areas.
Q = Underground aquifers.
R = Wide-ranging species.
S = Shorelines and associated wetlands.
U = Upland habitats.

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D6b.1 Introduction

The largest cluster of protected species identified during the threatened and endangered species evaluation for the Reservoir Operations Study (ROS) Environmental Impact Statement (EIS) consists of 60 species that typically occur in the main channels of the rivers and streams, including at least some parts of the impounded mainstem Tennessee and Cumberland Rivers. Nearly all of these species are mollusks and fish; however, this cluster also includes two turtles and a large, completely aquatic, salamander (the hellbender). All of these species are typically found in habitats out in the river or stream, where the water is obviously moving.

Holding water in reservoirs can modify habitat conditions important to flowing-water species because temperature and dissolved oxygen (DO) levels stratify in reservoirs during late spring, summer, and early fall; and those changes affect the water released from the dams. During late fall, winter, and early spring, reservoir stratification does not occur and water released from dams is more likely to have temperature and DO characteristics similar to what occurs in unregulated streams. As described in Section 2.3 in the main document, the various types of changes could occur under TVA policy alternatives focus on when reservoir elevations would be raised or lowered, and when and how much water would be released from the dams. TVA aquatic biologists used these basic concepts to help identify 15 specific evaluation measures (metrics) that would indicate differences in direct effects of the policy alternatives. The metrics were designed to focus on specific locations and specific times of the year that are important to the reproduction and survival of federal-protected species living in flowing-water habitats. Times of the year when operations changes would be unlikely to affect flowing-water species were not addressed. Metrics were developed for each of the four types of waterbodies that are involved (warm tributary tailwaters, flowing mainstem reaches, pooled mainstem reaches, and cool-to-warm tributary tailwaters). The following paragraphs describe which metrics were selected for use with regard to each waterbody category, why each metric is pertinent to the evaluation for that waterbody type, and the results of those comparisons. All of this information is summarized and used in the threatened and endangered species evaluation presented in Section 5.13, Threatened and Endangered Species.

Data used to address all but one of these metrics (Metric #3) were derived from the hourly results of the Water Quality modeling work described in Section 4.4, Water Quality. The Water Quality modeling results predict the physical and chemical attributes of the reservoirs and regulated stream reaches, using the weather conditions and rainfall events that would have occurred during each of the 8 consecutive years included in the modeled period (1987 through 1994). In all of these evaluations, a two-tailed, paired mean similarity (t statistic) test was used to compare the results from each policy alternative with the Base Case. Alternatives found to be less than 5 percent likely to have an average value similar to the Base Case average (the 95-percent confidence level) were considered to be substantially different from the Base Case. Alternatives found to be between 5 and 20 percent likely to have an average value similar to the Base Case average (the 80-percent confidence level) were considered to be slightly different from the Base Case. While this latter confidence level is less rigorous than the 95-percent level often used in statistical analyses, it represents a more conservative approach that is appropriate when considering the protection of federal-listed species. Recognizing differences up to the

20-percent similarity level increases the likelihood of identifying changes that could affect habitats and species more often than would occur if only a much lower similarity level (e.g., 5 percent) was used. The biological interpretations of any differences identified during these comparisons were based on whether the change from the Base Case average was toward or away from what would be expected to occur in free-flowing stream habitats supporting populations of the pertinent protected species. The basis for each biological interpretation is included in the paragraph on the specific evaluation metric.

The specific sites where the metrics would be evaluated were selected based primarily on where protected aquatic species have been encountered in each of the affected waterbody types. In each of the four waterbody types, TVA biologists identified three or four specific sites where larger numbers of protected aquatic species were known to occur. For all metrics except Metric #3, results from the water quality model runs were used to generate the requested output data that would occur at or near those sites under the Base Case and each of the action alternatives. On the mainstem Tennessee River, the evaluation focused on sites at the upstream end of Kentucky Reservoir (the Pickwick Landing Dam tailwater), the upstream end of Pickwick Reservoir (the Wilson Dam tailwater), the upstream end of Wheeler Reservoir (the Guntersville Dam tailwater), and the upstream end of Chickamauga Reservoir (the Watts Bar Dam tailwater). On the tributaries, the evaluation focused on sites on the lower Elk River (both warm and cool-to-warm reaches downstream from Tims Ford Dam), the lower Holston River (both warm and cool-to-warm reaches downstream from Cherokee Dam), and the lower French Broad River (the warm reach downstream from Douglas Dam). Because no cool-to-warm reach had been identified on the lower French Broad River, the cool-to-warm reach on the Hiwassee River (downstream from Apalachia Dam) was added to complete the cool-to-warm comparison.

D6b.2 Pooled Mainstem Reaches

Most of the protected species that occur in the pooled reaches of the mainstem reservoirs are freshwater mussels or fish that live in parts of the impounded river channel where some current still keeps the bottom relatively silt-free. The extent of any changes in water level or water temperature in these impounded areas was not considered likely to affect the resident protected species populations; however, changes in water flow patterns and, especially, any resulting changes in the amount of DO present near the bottom could increase or decrease the amount of suitable habitat for these protected species. The one metric developed for this waterbody category was: **Metric #1. The total volume of water with DO less than 2 mg/L during the year**. Data from the Water Quality modeling work were requested for three mainstem reservoirs (Kentucky, Guntersville, and Chickamauga)—indicating the sum of daily reservoir volumes with DO less than 2 milligrams per liter (mg/L) during each of the 8 modeled years. Alternatives that were represented by average low DO volumes smaller than under the Base Case average (at the 80-percent confidence level or higher) were considered to provide more suitable habitat for protected aquatic species. Alternatives represented by average values larger than under the Base Case average (again, at the 80-percent confidence level or higher) were considered to provide less suitable habitat for these protected species. The results of this comparison (presented in the Metric #1 tables) indicate that all of the policy alternatives except the Tailwater Habitat Alternative would result in low DO volumes comparable to what would occur under the

Base Case. The Tailwater Habitat Alternative would result in larger volumes of low DO water (slightly less suitable habitat conditions for protected aquatic species) in Kentucky and Chickamauga Reservoirs.

D6b.3 Flowing Mainstem Reaches

As indicated in Table 4.12-03, 44 protected mollusks and fishes occur in flowing reaches of the mainstem Tennessee River downstream from the various dams and in the mainstem Cumberland River downstream from Barkley Dam. These species occur in or over rocky substrates where the current typically maintains at least moderate DO levels and minimizes the amount of sedimentation that stays on the bottom. Changes in the reservoir operations policy under the various alternatives might affect water levels; flow patterns; and, possibly, the duration of low DO concentrations in these waterbodies. Two metrics were developed to evaluate the potential effects of the alternatives in this waterbody category: **Metric #2. The amount of time when the water downstream from a dam held DO less than 2 mg/L during the summer period (July through October)**, and **Metric #3. The minimum water level achieved 90 percent of the time during the year at a given point downstream from a dam.**

Data to address Metric #2 came from the results of the Water Quality modeling work in the form of hours during the summer period in each of the 8 modeled years when the discharge from the upstream dam contained less than 2 mg/L DO. The number of hours calculated for each alternative in the releases from Pickwick, Wilson, Guntersville, and Watts Bar Dams are presented in the Metric #2 tables. Alternatives found to have lower average values in comparison with the Base Case (at the 80-percent confidence level or higher) were considered to provide more DO benefit to resident protected species. The results of this comparison indicate that the Equalized Summer/Winter Flood Risk Alternative, Commercial Navigation Alternative, and Tailwater Recreation Alternative would produce DO conditions in mainstem tailwater releases similar to those under the Base Case at all four of these dams. Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Summer Hydropower Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative resulted in modeled DO conditions similar to the Base Case at most of these dams; however, Reservoir Recreation Alternative A yielded higher values in the Guntersville discharge, Reservoir Recreation Alternative B yielded higher values in the Pickwick discharge, the Tailwater Habitat Alternative yielded higher values in the Wilson Dam discharge, and the Preferred Alternative yielded higher values in the Watts Bar discharge. Three of these higher values would result in slightly adverse effects on protected species habitats in those tailwaters; the value for the Preferred Alternative could result in substantially adverse effects over what could occur under the Base Case. Watts Bar, however, is one of two TVA mainstem dams (Fort Loudoun Dam is the other) where TVA committed to providing a minimum of 4 mg/L DO in the discharge as a part of the 1990 Lake Improvement Plan (see Section 4.4.2). While additional effort would be required to meet the minimum DO commitment at Watts Bar Dam if the Preferred Alternative was adopted, TVA would expend the money and effort to make sure that DO concentrations in the discharge would not be adversely affected.

Data to address Metric #3 are calculations made from the results of the Weekly Scheduling Model concerning the water elevations at locations where protected aquatic species occur that would be achieved 90 percent of the time during each of the 8 modeled years. These calculated water elevations for specific sites in the Pickwick, Wilson, Guntersville, and Watts Bar Dam tailwaters are presented in the Metric #3 tables. Alternatives found to have higher minimum water levels than those under the Base Case (at the 80-percent confidence level or higher) were considered to provide more wetted area in which protected aquatic species could occur. As indicated in the Metric #3 tables, two of the policy alternatives (the Equalized Summer/Winter Flood Risk Alternative and the Preferred Alternative) would result in mainstem tailwater elevations similar to what would occur under the Base Case at most or all of the comparison locations. All of the other alternatives would result in minimum tailwater elevations that would be higher (slightly or substantially more habitat for protected species) than would occur under the Base Case. The Equalized Summer/Winter Flood Risk Alternative was the only alternative that would yield lower minimum tailwater elevations (slightly less habitat) at any location; that effect would occur downstream from Watts Bar Dam.

D6b.4 Mainstem Summary

Most of the policy alternatives would produce substantially higher minimum water elevations (substantially more potential habitat for protected aquatic species) downstream from the mainstem dams (Metric #3). The exceptions to this pattern are the Equalized Summer/Winter Flood Risk Alternative and the Preferred Alternative, both of which would typically produce minimum water elevations similar to those produced under the Base Case. Very few of the policy alternatives would produce any differences in the number of hours with DO less than 2 mg/L released from the mainstem dams (Metric #2). The major exception to this pattern was the expectation of more hours of low DO discharges (substantially adverse habitat conditions) downstream from Watts Bar Dam under the Preferred Alternative; however, TVA has committed to providing a minimum of 4mg/L DO in the discharge from this dam. Other exceptions were more hours of low DO discharges (slightly adverse conditions) from Guntersville Dam under Reservoir Recreation Alternative A, downstream from Pickwick Dam under Reservoir Recreation Alternative B, and downstream from Wilson Dam under the Tailwater Habitat Alternative. Only the Tailwater Habitat Alternative would result in more water volume with DO less than 2 mg/L in at least some of the downstream reservoirs (Metric #1); that alternative yielded indications of more water with low DO (slightly adverse habitat conditions) in Kentucky and Chickamauga Reservoirs. Overall, only the Tailwater Habitat Alternative would result in decreased DO levels in mainstem reservoirs (slightly adverse habitat conditions) in comparison to what would occur under the Base Case, and only the Equalized Summer/Winter Flood Risk Alternative and the Preferred Alternative would result in minimum water levels as low as what would occur under the Base Case. All of the other alternatives would yield higher minimum water levels (providing slightly or substantially more habitat for protected aquatic species). The Preferred Alternative could result in more hours of low DO water downstream from Watts Bar Dam (substantially adverse habitat conditions); however, TVA would ensure that discharge continued to meet its existing 4-mg/l DO target.

D6b.5 Warm Tributary Tailwaters

Mollusks and fishes make up most of the protected aquatic species that occur in the warmer parts of regulated Tennessee River tributary streams—the warm tributary tailwater waterbodies. These waterbodies include a fairly wide variety of stream sizes and considerable variation in length from their upstream limits to the next downstream reservoir. All of them, however, flow within distinct river beds, have present temperature regimes more or less similar to nearby free-flowing streams, and support relatively diverse and abundant aquatic communities. These waterbodies also often support populations of at least some protected species. Changes in the reservoir operations policy affecting the dams and reservoirs upstream from these waterbodies could result in modifications to both the daily and seasonal averages and ranges of flows, stream elevations, and water temperatures. Six metrics were developed to evaluate the potential effects of the policy alternatives on these warm tailwaters, all of which were modeled at sites on the Elk, Holston, and French Broad Rivers where protected aquatic species are known to occur. These six metrics include one focused on the minimum water level at the site, three focused on flow and water temperature conditions during late spring (when many protected species are reproducing), and two focused on water temperature conditions during late summer (when many native species are accumulating food reserves that would allow them to survive during the colder winter months). These metrics and their evaluations are discussed in the following paragraphs.

Metric #4. The minimum water level achieved 90 percent of the time during the year at the selected sites. The data to address this metric were derived from the Water Quality modeling work in the form of the 90-percent occurrence minimum water elevation at each site during each of the 8 modeled years. The calculated elevations for the sites on the Elk, Holston, and French Broad Rivers are presented in the Metric #4 tables. Alternatives found to have higher minimum water levels than under the Base Case (at or above the 80-percent confidence level) were considered to provide more wetted area that could be inhabited by protected aquatic species. The results of these comparisons indicate that most of the alternatives would result in minimum elevations in warm tributary tailwaters that are similar to the elevations produced under the Base Case. The Equalized Summer/Winter Flood Risk Alternative would result in higher minimum tailwater elevations (slightly beneficial habitat conditions for protected aquatic species) at the French Broad River site. The Tailwater Habitat Alternative would result in higher minimum tailwater elevations at the Holston River site (substantially beneficial conditions) and the French Broad River site (slightly beneficial conditions), while the level at the Elk River site would be similar to the elevations produced under the Base Case.

Metric #5. The difference between the 90- and 10-percent instantaneous flow rates at the selected sites during the second and third weeks in June. These data points were derived from the Water Quality modeling work as the 90- and 10-percent instantaneous flow levels (in cubic feet per second) estimated to occur at these sites during this 2-week period in each of the 8 modeled years. Subtracting the smaller of these values (the 90-percent flow rate) from the larger describes the range in flows that would have existed at each of these sites during that 2-week period in each modeled year. The calculated range values and paired mean similarity test results are presented in the Metric #5 tables. Alternatives that yielded smaller flow ranges than under the Base Case (at or above the 80-percent confidence level) were considered to produce more stable flow conditions during this period. The comparisons indicate that all but two of the alternatives would result in flow ranges that would be similar to the Base Case at all three sites. Under the Equalized Summer/Winter Flood Risk Alternative, the flow range would be smaller (substantially beneficial habitat conditions) at the Holston River site and would remain similar to the Base Case at the Elk River and French Broad River sites. The Tailwater Habitat Alternative would result in smaller flow ranges (substantially beneficial habitat conditions) at both the Holston River and French Broad River sites, and would remain similar to the Base Case at the Elk River site.

Metric #6. The average water temperature at the selected sites during the second and third weeks in June. These data points were derived from the Water Quality modeling work as the estimated 50-percent occurrence water temperatures at these sites during this 2-week period in each of the 8 modeled years. These values and the associated paired t-test results are presented in the Metric #6 tables. Alternatives that resulted in higher average water temperatures than under the Base Case (at or above the 80-percent confidence level) were considered to be more similar to free-flowing stream reaches where protected aquatic species would be reproducing. As indicated in the tables, all but two of the alternatives would result in average late spring water temperatures at these sites that would be similar to what would occur under the Base Case. The Equalized Summer/Winter Flood Risk Alternative would result in higher average temperatures at all three sites (substantially beneficial habitat conditions at both the Holston River and French Broad River sites, and slightly beneficial conditions at the Elk River site). The Commercial Navigation Alternative would result in higher average temperatures (slightly beneficial habitat conditions) at the Holston River site and average temperatures similar to what would occur under the Base Case at both the French Broad River and Elk River sites.

Metric #7. The difference between the 90- and 10-percent instantaneous water temperatures at the selected sites during the second and third weeks in June. These data points were derived from the same Water Quality modeling work used for Metric #6; however for this metric, the extracted information focuses on the difference between the estimated 90- and 10-percent occurrence interval water temperatures at these sites during this 2-week period in each of the modeled years. The resulting temperature ranges and T-test results are presented in the Metric #7 tables. Alternatives that yielded narrower temperature ranges than under the Base Case (at or above the 80-percent confidence level) were considered to produce more stable temperature conditions during this period. These comparisons indicate that the temperature ranges produced under all but two of the modeled alternatives would be similar to the range produced under the Base Case. The Equalized Summer/Winter Flood Risk Alternative would produce temperature ranges at the Elk River and Holston River sites similar to the Base Case but would produce a wider temperature range (substantially adverse habitat conditions) during this period at the French Broad River site. The Tailwater Habitat Alternative would produce temperature ranges similar to the Base Case at the Elk River and French Broad River sites but a more narrow temperature range than under the Base Case (slightly beneficial habitat conditions) at the Holston River site.

Metric #8. The average water temperature at the selected sites during the third and fourth weeks in August. These data were derived from the same Water Quality modeling work and considered in the same way as the data extracted for Metric #6; however, this metric focused on a time 2 months later during the year. Alternatives that resulted in higher average temperatures than under the Base Case (at or above the 80-percent confidence level) were considered to enhance the growth and likely survival of protected aquatic species. The results presented in the tables for Metric #8 indicate that the three warm tailwater sites included in this comparison provided different results with regard to this metric. At the Elk River site, all of the policy alternatives yielded average temperatures similar to the Base Case. At the site in the French Broad River, nearly all of the alternatives yielded similar averages to the Base Case, while the Equalized Summer/Winter Flood Risk Alternative yielded a higher average summer water temperature than under the Base Case (substantially beneficial habitat conditions). At the Holston River site, only the Commercial Navigation Alternative yielded average temperatures similar to those under the Base Case; all of the other alternatives yielded lower average summer water temperatures (each indicating substantially adverse habitat conditions than those under the Base Case).

Metric #9. The difference between the 90- and 10-percent instantaneous water temperatures at the selected sites during the third and fourth weeks in August. This comparison and data set are comparable to Metric #7; however, the focus here is on a late-summer period instead of mid-June. Alternatives that yielded narrower temperature ranges than under the Base Case average were considered to enhance the growth and likely survival of protected aquatic species. The information presented in the tables for Metric #9 indicates that all but two of the modeled alternatives resulted in temperature ranges that were similar to the range produced under the Base Case. The Equalized Summer/Winter Flood Risk Alternative produced ranges similar to the Base Case at both the Holston River and Elk River sites. At the French Broad River site, however, the temperature range was more narrow (slightly beneficial habitat conditions) than under the Base Case. The Tailwater Habitat Alternative resulted in temperature ranges similar to the Base Case at the sites on the Elk River and French Broad River, but the temperature range at the Holston River site was narrower (substantially beneficial temperature range) than what would occur at that site under the Base Case.

D6b.6 Cool-to-Warm Tributary Tailwaters

A variety of mollusks and fishes occurs in the parts of regulated Tennessee River tributary streams characterized as cool-to-warm tailwaters. Like the warm tributary tailwaters, these waterbodies include a fairly wide variety of stream sizes and a considerable range of stream lengths from the upstream dams to their downstream limits. All of the flow and temperature regimes in these waterbodies are directly affected by the timing and volume of relatively cold releases from the upstream dams. In addition, these waterbodies support relatively sparse aquatic communities, even though populations of some protected species may be present. Changes in the operations policy affecting the dams and reservoirs upstream from these waterbodies could result in modifications to the daily and seasonal variations in flows, stream elevations, and water temperatures that could be more substantial than would occur in the warm tailwaters.

TVA aquatic biologists decided to use the same six metrics to evaluate the potential effects of the policy alternatives in these cool-to-warm tailwater waterbodies that were used to evaluate the warm tailwater reaches. The only differences in the data sources or use of these metrics were the locations of the sites where they would be applied. For the cool-to-warm tailwaters, the evaluation sites include locations on the Elk River and Holston River upstream from the warm tailwater sites evaluated on those same rivers. The other evaluation site is located on the Hiwassee River, in part because the French Broad River downstream from Douglas Dam does not have a recognized cool-to-warm reach. As before, the six metrics include one focused on the minimum water level at the site (Metric #10), three focused on flow and water temperature conditions during the same 2-week period in late spring (Metrics #11, 12, and 13), and two focused on water temperature conditions during the same 2-week period in late summer (Metrics #14 and 15).

The results and summary statistics associated with **Metric #10. The minimum water level achieved 90 percent of the time during the year at the selected sites**, are presented in the Metric #10 tables. As indicated in the description of companion Metric #4, alternatives found to have higher minimum water levels than under the Base Case (at or above the 80-percent confidence level) were considered to provide more wetted area that could be inhabited by protected aquatic species. The results of these comparisons indicate that nearly all of the alternatives would result in minimum water levels similar to those under the Base Case. The one exception to this uniform relationship occurred under the Tailwater Habitat Alternative, which yielded a higher minimum water level (substantially beneficial) at the Holston River site.

Results and summary statistics associated with **Metric #11. The difference between the 90- and 10-percent instantaneous flow rates at the selected sites during the second and third weeks in June**, are presented in the Metric #11 tables. Like the description for companion Metric #5, alternatives that yielded narrower flow ranges than under the Base Case (at or above the 80-percent confidence level) were considered to provide more stable streamflow conditions during this period. The comparisons indicate that all but two of the alternatives would result in mid-June flow ranges in cool-to-warm tributary tailwaters that are similar to ranges under the Base Case. The Equalized Summer/Winter Flood Risk Alternative would result in flow ranges similar to the Base Case at the Hiwassee River site but would produce a narrower flow range (slightly beneficial habitat conditions) at the Elk River site and a more narrow flow range (substantially beneficial) at the Holston River site. The Tailwater Habitat Alternative would result in flow ranges similar to the Base Case at the Elk River site but narrower (substantially beneficial) flow ranges at both the Holston River and Hiwassee River sites.

Results and statistics associated with **Metric #12. The average water temperature at the selected sites during the second and third weeks in June**, are presented in the Metric #12 tables. Alternatives that resulted in higher average water temperatures than under the Base Case (at or above the 80-percent confidence level) were considered to be more similar to free-flowing stream reaches where protected aquatic species would be spawning. As indicated in the tables for Metric #12, the Hiwassee River site reacted differently to this metric than the sites on both the Elk and Holston Rivers. The Hiwassee River site yielded higher (substantially beneficial) average water temperatures during this period for all of the policy alternatives compared with the Base Case. At the sites on the Elk and Holston Rivers, only the Equalized Summer/Winter Flood Risk Alternative yielded higher (substantially beneficial) average temperatures; all of the other alternatives yielded average temperatures similar to what would occur under the Base Case.

Data and statistics related to **Metric #13. The difference between the 90- and 10-percent instantaneous water temperatures at the selected sites during the second and third weeks in June**, are presented in the Metric #13 tables. As described for Metric #7, alternatives that yielded more narrow temperature ranges than under the Base Case (at or above the 80-percent confidence level) were considered to produce more stable temperature conditions during this period. These comparisons indicate that most of the policy alternatives would produce temperature ranges similar to those under the Base Case. The Tailwater Habitat Alternative would result in temperature ranges similar to the Base Case at the Holston River and Elk River sites but a more narrow (slightly beneficial) range at the Hiwassee River site. The Equalized Summer/Winter Flood Risk Alternative would produce temperature ranges similar to the Base Case at the Hiwassee River site, narrower (substantially beneficial) temperature ranges at the Elk River site, and wider (substantially adverse) temperature ranges at the Holston River site.

Results and statistics associated with **Metric #14. The average water temperature at the selected sites during the third and fourth weeks in August**, are presented in the Metric #14 tables. Alternatives that resulted in higher average temperatures than under the Base Case (at or above the 80-percent confidence level) were considered to enhance the growth and likely survival of protected aquatic species (same as for Metric #8). The results indicate that each cool-to-warm tributary tailwater reacted differently to this metric. At the Hiwassee River site, all of the policy alternatives would produce higher (substantially beneficial) average temperatures than would occur under the Base Case. At the Elk River site, Reservoir Recreation Alternative A, the Commercial Navigation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative would produce average temperatures similar to what would occur under the Base Case; while Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, and the Tailwater Recreation Alternative would produce averages higher (slightly more beneficial) than would occur under the Base Case. At the Holston River site, all of the policy alternatives except the Commercial Navigation Alternative would produce lower (substantially adverse) average temperatures than would occur under the Base Case. The Commercial Navigation Alternative yielded average temperatures similar to what would be produced under the Base Case at the Holston River site.

Data and statistics related to **Metric #15. The difference between the 90- and 10-percent instantaneous water temperatures at the selected sites during the third and fourth weeks in August**, are presented in the tables for Metric #15. As described for Metric #9, alternatives that yielded more narrow temperature ranges than under the Base Case (at or above the 80-percent confidence level) were considered to produce more stable temperature conditions when protected aquatic species were growing and accumulating fat that might help them better survive the winter. These results also indicate that each of the three cool-to-warm tributary tailwaters reacted somewhat differently to this metric. At the Hiwassee River site, all of the policy alternatives yielded temperature ranges similar to what would occur under the Base Case. At the Elk River site, Reservoir Recreation Alternative A, the Commercial Navigation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative yielded ranges similar to the Base Case; while Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, and the Tailwater Recreation Alternative yielded more narrow ranges (substantially beneficial) than would occur under the Base Case. At the Holston River site, the Commercial Navigation Alternative and the Preferred Alternative yielded ranges similar to the Base Case; while all of the other alternatives yielded ranges more narrow than would occur under the Base Case (slightly beneficial under Reservoir Recreation Alternative A and the Equalized Summer/Winter Flood Risk Alternative and substantially beneficial under Reservoir Recreation Alternative B, Tailwater Recreation Alternative, and the Tailwater Habitat Alternative).

D6b.7 Tributary Summary

With regard to the minimum water level metrics (Metrics #4 and #10), only the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would produce effects different from what would occur under the Base Case. The Equalized Summer/Winter Flood Risk Alternative would result in higher minimum water levels (slightly more minimum wetted area) at the (warm) French Broad River site, while the Tailwater Habitat Alternative would result in higher minimum water levels at the site on the French Broad River (slightly beneficial habitat conditions) and at both sites on the Holston River (substantially beneficial conditions).

With regard to the mid-June flow range metrics (Metrics #5 and #11), only the Equalized Summer/Winter Flood Risk Alternative and the Tailwater Habitat Alternative would produce effects different from what would occur under the Base Case. The Equalized Summer/Winter Flood Risk Alternative would produce less variation in mid-June flow ranges at both sites on the Holston River (substantially beneficial habitat conditions for protected species) and at the cool-to-warm site on the Elk River (slightly beneficial conditions). The Tailwater Habitat Alternative would produce less variation in flow ranges (substantially beneficial conditions) at the sites on the Holston, French Broad, and Hiwassee Rivers but did not result in flow ranges any different from the Base Case at either site on the Elk River.

The four average temperature metrics (Metrics #6 and #12 concerning mid-June, and Metrics #8 and #14 concerning late August) tend to follow consistent patterns, at least on the individual rivers. All of the policy alternatives would produce higher (substantially beneficial) average temperatures than under the Base Case at the Hiwassee River site during both periods. All of the policy alternatives except the Commercial Navigation Alternative would produce lower (substantially adverse) average temperatures than under the Base Case at both Holston River sites in late August (Metric #14). The Equalized Summer/Winter Flood Risk Alternative would produce higher (substantially beneficial conditions) average temperatures at the cool-to-warm site on the Elk River during both periods, higher (slightly beneficial) average temperatures at the warm site on the Elk River in mid-June, and higher (substantially beneficial) average temperatures at both Holston River sites in mid-June.

Concerning the four temperature range metrics, the policy alternatives would produce very few differences from the ranges under the Base Case at the warm tailwater sites during either mid-June (Metric #7) or late August (Metric #9). Two of the exceptions to this pattern would occur under the Tailwater Habitat Alternative, which would produce less temperature variation at the warm reach site on the Holston River during both mid-June (slightly beneficial habitat conditions) and in late August (substantially beneficial conditions). The other exceptions would occur at the French Broad River site under the Equalized Summer/Winter Flood Risk Alternative, which would produce more temperature variation (substantially adverse conditions) in mid-June and less variation (slightly beneficial conditions) in late August than would occur under the Base Case.

In the cool-to-warm tailwater reaches, the effects of the alternatives on the temperature range metrics would differ, depending on which month was being examined. During mid-June (Metric #13), the Tailwater Habitat Alternative would produce less variation (slightly beneficial conditions) at the Hiwassee River site. Also during mid-June, the Equalized Summer/Winter Flood Risk Alternative would produce more temperature variation (substantially adverse habitat conditions) at the Holston River site and less temperature variation (substantially beneficial conditions) at the Elk River site. During late August (Metric #15), none of the alternatives would produce temperature variations different from the Base Case at the Hiwassee River site. At the Elk River site, Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, and the Tailwater Recreation Alternative would produce less temperature variation (substantially beneficial conditions) during this period. At the Holston River site, five of the alternatives would produce less temperature variation during late August (slightly beneficial habitat conditions under Reservoir Recreation Alternative A and the Equalized Summer/Winter Flood Risk Alternative; substantially beneficial conditions under Reservoir Recreation B, the Tailwater Recreation Alternative, and the Preferred Alternative).

EVALUATION ABBREVIATIONS USED IN THE METRIC TABLES	
Abbreviation	**Definition**
A	Adverse effects on protected aquatic species
B	Beneficial effects on protected aquatic species
N	Not statistically different from the Base Case
S	Slightly (80- to 95-percent confidence level)
SS	Substantially (95-percent confidence level or higher)

Mainstem Reservoirs

Metric #1: Sum of daily volumes in mainstem reservoirs with DO less than 2 mg/L during January through December.

Data Units: Million cubic meters.

Evaluation Perspective: Smaller volumes of low DO water would indicate better habitat conditions for protected benthic species.

Kentucky Reservoir

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	3,285	4,582	5,518	4,430	1,777	5,346	11,547	4,863
1988	14,155	11,147	19,377	18,844	6,584	19,973	34,943	13,909
1989	174	351	1,143	906	180	1,233	1,371	253
1990	2,502	4,296	6,680	5,451	1,434	6,612	10,813	4,070
1991	1,535	2,356	2,448	2,012	1,232	2,496	2,561	2,087
1992	210	637	626	515	185	526	673	323
1993	6,033	9,757	11,078	10,403	3,741	11,048	20,392	7,955
1994	473	936	1,245	1,015	463	1,307	1,369	725
Average	**3,545.9**	**4,257.8**	**6,014.4**	**5,447.0**	**1,949.5**	**6,067.6**	**10,458.6**	**4,273.1**
Similarity		75.35%	39.80%	50.74%	40.05%	39.60%	15.41%	76.25%
Evaluation		**N**	**N**	**N**	**N**	**N**	**SA**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Guntersville Reservoir

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	4,407	7,757	7,667	6,044	4,836	6,876	8,140	4,395
1988	10,739	9,688	11,676	8,566	7,895	11,432	12,522	6,922
1989	27	40	114	70	36	120	95	60
1990	608	2,036	2,623	2,036	666	2,374	2,112	1,073
1991	270	636	655	599	270	665	734	475
1992	846	1,236	1,018	6,55	655	1,068	1,291	1,542
1993	5,238	7,022	8,866	6,621	5,237	8,770	8,450	5,734
1994	275	417	387	2,360	275	345	166	386
Average	**2,801.2**	**3,604.0**	**4,125.8**	**3,368.9**	**2,483.8**	**3,956.2**	**4,188.8**	**2573.4**
Similarity		68.21%	53.82%	75.23%	85.61%	58.39%	53.11%	89.18%
Evaluation		**N**	**N**	**N**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Chickamauga Reservoir

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	2,019	1,824	1,742	1,491	2,304	1,811	3,522	1,753
1988	1,919	2,278	2,411	1,586	1,963	2,389	3,444	2,143
1989	335	363	366	368	323	358	392	429
1990	1,626	1,329	1,226	1,124	1,644	1,254	1,968	1,403
1991	1,451	1,546	1,505	1,147	1,479	1,490	2,303	1,610
1992	1,173	1,321	1,294	1,170	1,214	1,314	1,683	1,267
1993	3,069	3,216	3,133	2,801	3,119	3,123	6,183	2,983
1994	870	1,018	1,050	899	866	1,041	1,491	1,054
Average	**1,557.8**	**1,611.9**	**1,590.9**	**1,323.2**	**1,614.0**	**1,597.5**	**2,623.2**	1,580.2
Similarity		89.94%	93.82%	55.05%	89.61%	92.57%	14.43%	95.56%
Evaluation		**N**	**N**	**N**	**N**	**N**	**SA**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Mainstem Tailwaters

Metric #2: Number of hours of dam release with DO less than 2 mg/L during July through October.

Data Units: Hours.

Evaluation Perspective: Shorter amounts of time when the DO was low would indicate better conditions for protected benthic species.

Pickwick Dam Releases

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	0	2	2	0	0	0	0	2
1988	1	0	0	0	5	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	2	2	2	0	2	0	0
1991	0	0	5	0	0	0	0	0
1992	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0
Average	**0.1**	**0.5**	**1.1**	**0.3**	**0.6**	**0.3**	**0.0**	0.3
Similarity		30.26%	14.69%	66.16%	44.58%	66.16%	33.43%	66.16%
Evaluation		**N**	**SA**	**N**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Wilson Dam Releases

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	76	80	183	45	72	152	481	69
1988	228	235	236	196	323	243	495	41
1989	0	0	1	0	0	0	1	0
1990	32	47	66	96	30	60	277	34
1991	1	3	4	1	0	6	22	3
1992	0	11	13	8	2	18	69	6
1993	18	24	21	19	15	24	74	19
1994	0	1	1	1	0	1	0	1
Average	**44.4**	**50.1**	**65.6**	**45.8**	**55.3**	**63.0**	**177.4**	**21.6**
Similarity		88.66%	62.81%	97.09%	82.44%	66.34%	11.73%	44.83%
Evaluation		**N**	**N**	**N**	**N**	**N**	**SA**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Guntersville Dam Releases

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	0	0	0	0	0	0	0	0
1988	0	2	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	4	5	0	0	0	0	0
1991	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0
Average	**0.0**	**0.8**	**0.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Similarity		17.59%	33.43%	100.00%	100.00%	100.00%	100.00%	100.00%
Evaluation		**SA**	**N**	**N**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Watts Bar Dam Releases

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	67	150	32	153	74	28	0	147
1988	73	77	59	0	10	21	741	130
1989	2	6	27	11	2	35	0	113
1990	41	87	57	103	43	72	0	332
1991	17	52	95	83	21	109	0	443
1992	109	85	144	70	130	156	645	370
1993	144	131	37	151	139	32	24	173
1994	3	34	40	65	3	54	0	230
Average	**57.0**	**77.8**	**61.4**	**79.5**	**52.8**	**63.4**	**176.3**	**242.3**
Similarity		41.62%	85.16%	41.86%	87.63%	79.99%	31.58%	0.16%
Evaluation		**N**	**N**	**N**	**N**	**N**	**N**	**SSA**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Mainstem Tailwaters

Metric #3 - Minimum water level achieved 90 percent of the time during the year at a given location.

Data Units: Elevation in feet above mean sea level.

Evaluation Perspective: Higher minimum water levels would indicate more available habitat for protected species.

Pickwick Dam Tailwater (TRM 190)

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	354.6	354.6	356.3	354.6	356.8	356.3	355.8	354.6
1988	354.6	354.6	356.0	354.6	356.4	356.0	355.3	354.6
1989	357.3	357.4	358.6	357.3	358.6	358.6	358.1	357.2
1990	355.7	356.7	357.8	355.7	358.4	357.8	357.4	355.8
1991	355.7	357.3	358.1	355.9	358.6	358.1	357.4	355.8
1992	355.7	356.7	357.5	355.7	357.4	357.7	357.3	355.7
1993	355.0	356.3	357.5	354.8	358.6	357.5	357.0	355.2
1994	356.3	357.3	358.6	355.9	358.6	358.6	357.7	356.26
Average	**355.6**	**356.4**	**357.6**	**355.6**	**357.9**	**357.6**	**357.0**	**355.6**
Similarity		17.00%	0.10%	91.37%	0.02%	0.09%	1.01%	95.57%
Evaluation		**SB**	**SSB**	**N**	**SSB**	**SSB**	**SSB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Wilson Dam Tailwater (TRM 256)

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	409.5	411.1	411.0	409.2	410.7	411.0	411.0	409.7
1988	409.4	410.8	410.8	409.3	410.7	410.8	410.8	409.4
1989	411.1	411.9	412.2	410.7	411.7	412.1	411.8	411.1
1990	410.7	412.1	412.1	410.0	411.1	412.1	412.3	411.3
1991	410.5	412.1	412.1	410.8	411.1	412.1	412.0	411.1
1992	410.6	411.9	411.9	410.4	411.4	411.9	411.7	410.8
1993	410.3	411.7	411.9	410.2	411.0	411.9	411.9	410.8
1994	410.9	412.1	412.1	410.5	411.5	412.1	412.2	411.2
Average	**410.4**	**411.7**	**411.8**	**410.1**	**411.2**	**411.8**	**411.7**	**410.7**
Similarity		0.03%	0.03%	45.10%	0.86%	0.03%	0.04%	40.65%
Evaluation		**SSB**	**SSB**	**N**	**SSB**	**SSB**	**SSB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Guntersville Dam Tailwater (TRM 349)

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	552.1	553.4	553.7	551.6	553.1	553.7	553.8	552.1
1988	551.8	553.2	553.2	551.4	552.7	553.2	553.3	551.9
1989	555.7	555.9	556.0	555.4	555.7	556.0	556.0	556.1
1990	554.3	555.3	555.5	553.8	554.6	555.5	555.3	555.1
1991	554.3	555.7	555.6	555.0	554.4	555.6	555.3	555.4
1992	554.8	555.7	555.7	554.1	555.1	555.7	555.4	555.7
1993	553.7	554.6	555.1	553.4	553.9	555.0	554.9	554.6
1994	555.7	555.8	555.7	554.8	555.8	555.7	555.3	555.8
Average	**554.1**	**555.0**	**555.1**	**553.7**	**554.4**	**555.1**	**554.9**	**554.6**
Similarity		18.71%	13.34%	63.29%	58.95%	13.79%	17.91%	50.43%
Evaluation		**SB**	**SB**	**N**	**N**	**SB**	**SB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Watts Bar Dam Tailwater (RM 530)

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	676.0	677.6	677.9	675.0	677.5	677.9	678.0	676.4
1988	676.0	677.5	677.5	675.0	677.5	677.5	677.8	676.0
1989	678.2	678.6	679.3	677.6	678.6	679.3	678.9	677.4
1990	678.2	679.6	679.4	676.8	678.7	679.4	679.7	679.0
1991	679.1	680.0	680.0	678.2	679.3	680.0	680.0	679.1
1992	677.0	679.1	679.1	676.8	678.0	679.1	678.8	678.2
1993	677.7	679.1	679.6	677.4	678.5	679.4	679.9	678.2
1994	679.1	679.9	679.4	676.7	679.3	679.3	680.4	678.7
Average	**677.7**	**678.9**	**679.0**	**676.7**	**678.4**	**679.0**	**679.2**	**677.9**
Similarity		3.89%	2.29%	12.53%	15.24%	2.51%	1.55%	72.91%
Evaluation		**SSB**	**SSB**	**SA**	**SB**	**SSB**	**SSB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Warm Tributary Tailwaters

Metric #4 - Minimum water level achieved 90 percent of the time during the year at a given location.

Data Units: Elevation in feet above mean sea level.

Evaluation Perspective: Higher minimum water levels would indicate more available habitat for protected aquatic species.

Holston River Mile 30

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	865.0	864.8	864.9	864.8	864.6	864.9	865.6	864.8
1988	863.9	863.9	864.0	863.8	863.8	863.9	864.2	863.8
1989	863.8	863.9	863.9	864.4	863.8	863.9	864.8	863.8
1990	863.9	863.9	863.9	863.9	863.9	863.9	865.1	863.9
1991	863.9	863.9	863.9	864.0	863.9	863.9	864.8	863.9
1992	863.8	863.8	863.9	864.4	863.9	863.9	864.9	863.9
1993	864.0	864.4	864.4	864.6	864.0	864.4	865.0	863.9
1994	864.9	864.9	865.0	864.7	864.9	865.0	865.5	864.8
Average	**864.16**	**864.19**	**864.24**	**864.32**	**864.11**	**864.25**	**864.99**	**864.10**
Similarity		88.24%	73.71%	45.86%	84.72%	71.12%	0.23%	81.27%
Evaluation		**N**	**N**	**N**	**N**	**N**	**SSB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

French Broad River Mile 18

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	843.76	843.5	843.6	843.4	843.6	843.6	843.6	843.5
1988	843.4	843.4	843.4	843.4	843.4	843.4	843.4	843.4
1989	843.6	843.6	843.6	843.7	843.6	843.7	844.5	843.6
1990	843.6	843.4	843.4	843.5	843.6	843.5	843.7	843.5
1991	843.7	843.7	843.6	843.6	843.7	843.6	844.2	843.6
1992	843.7	843.6	843.6	843.6	843.7	843.6	844.3	843.6
1993	843.6	843.7	843.6	843.4	843.6	843.6	843.4	843.7
1994	843.8	843.7	843.7	843.6	843.8	843.7	844.7	843.8
Average	**843.62**	**843.57**	**843.57**	**843.52**	**843.62**	**843.59**	**843.97**	**843.59**
Similarity		37.04%	31.93%	10.75%	92.80%	54.55%	7.96%	58.44%
Evaluation		**N**	**N**	**SB**	**N**	**N**	**SB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Elk River Mile 73

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	611.2	611.2	611.2	611.2	611.2	611.2	611.2	611.2
1988	611.0	611.0	611.0	611.0	611.0	611.0	611.0	611.0
1989	612.6	612.6	612.6	612.5	612.6	612.6	612.6	612.6
1990	611.9	611.9	611.3	611.2	611.9	611.3	611.9	611.9
1991	611.9	611.8	611.5	611.4	611.9	611.5	611.8	611.8
1992	611.9	611.9	611.7	611.6	611.9	611.7	611.9	611.9
1993	611.8	611.8	611.4	611.3	611.8	611.4	611.8	611.8
1994	612.3	612.3	612.3	611.8	612.3	612.3	612.3	612.3
Average	**611.81**	**611.81**	**611.62**	**611.48**	**611.82**	**611.62**	**611.81**	**611.81**
Similarity		98.74%	49.06%	22.17%	97.43%	49.06%	98.80%	98.50%
Evaluation		**N**	**N**	**N**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Warm Tributary Tailwaters

Metric #5: Difference between 90 and 10 percentile instantaneous flows at a given location during second through third weeks of June.

Data Units: Flow range in cubic feet per second.

Evaluation Perspective: Less variation in flow rates during this period would indicate better spring conditions for protected species reproduction and growth.

Holston River Mile 30

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	8,212	4,682	4,682	1,920	5,427	5,383	2,529	6,227
1988	10,679	11,258	12,332	6,815	14,869	12,219	469	9,667
1989	13,407	13,155	13,155	13,255	13,131	13,156	4,380	13,096
1990	9,250	5,871	5,871	327	9,250	5,869	2,209	8,653
1991	10,942	8,268	8,268	1,986	10,942	8,222	1,681	9,025
1992	9,448	12,662	13,073	8,480	5,537	12,411	2,588	7,406
1993	6,254	4,065	4,087	725	6,254	4,065	2,578	2,943
1994	9,442	6,316	6,316	70	9,442	6,370	1,249	8,933
Average	**9,704.4**	**8,284.6**	**8,473.1**	**4,197.1**	**9,356.6**	**8,461.8**	**2,210.2**	**8,243.8**
Similarity		35.41%	43.88%	1.01%	81.38%	41.47%	0.00%	26.95%
Evaluation		**N**	**N**	**SSB**	**N**	**N**	**SSB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

French Broad River Mile 18

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	10,199	8,764	8,764	9,436	8,380	8,764	4,376	10,517
1988	9,396	9,996	10,629	9,352	10,720	11,787	1,157	9,438
1989	18,119	18,119	18,119	19,384	18,119	18,119	8,640	18,012
1990	8,614	7,832	7,832	8,844	8,614	7,832	3,390	8,547
1991	14,620	13,095	13,095	17,196	14,620	13,095	2,900	14,522
1992	16,843	17,227	17,227	18,794	18,464	17,227	8,169	17,103
1993	8,594	8,210	8,210	9,335	8,594	8,037	3,138	8,577
1994	14,791	13,322	13,322	14,297	14,791	13,322	2,175	14,804
Average	**12,646.9**	**12,070.6**	**12,149.8**	**13,329.8**	**12,787.8**	**12,272.8**	**4,243.2**	**12,690.0**
Similarity		77.51%	80.42%	75.35%	94.58%	85.17%	0.02%	98.26%
Evaluation		**N**	**N**	**N**	**N**	**N**	**SSB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Elk River Mile 73

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	104	104	104	104	104	104	104	104
1988	22	22	22	22	22	22	22	22
1989	5,539	5,539	5,458	7,119	5,539	5,458	5,359	5,539
1990	1,258	1,258	1,204	716	1,258	1,204	1,258	1,258
1991	3,217	3,217	3,072	899	3,217	3,072	3,118	3,217
1992	1,144	1,144	1,051	1,051	1,144	1,051	1,144	1,144
1993	1,169	1,169	996	520	1,169	996	1,169	1,169
1994	1,084	1,084	941	141	1,084	941	1,084	1,084
Average	**1,692.1**	**1,692.1**	**1,606.0**	**1,321.6**	**1,692.1**	**1,606.0**	**1,657.2**	**1,692.1**
Similarity		100.00%	92.61%	73.21%	100.00%	92.61%	96.97%	100.00%
Evaluation		**N**	**N**	**N**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Warm Tributary Tailwaters

Metric #6: The average instantaneous water temperatures at a given location during the second through third weeks in June.

Data Units: Water termpaturature range in degrees Celsius.

Evaluation Perspective: Higher mean water temperatures during this period would indicate better spring conditions for protected species reproduction and growth.

Holston River Mile 30

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	13.4	14.0	14.0	18.9	14.3	13.9	14.0	13.4
1988	12.0	10.9	11.6	11.0	16.2	11.8	9.9	10.1
1989	8.9	9.6	10.5	13.5	10.9	10.2	9.5	9.2
1990	13.3	13.8	14.2	24.5	13.3	14.1	13.6	13.4
1991	12.6	12.8	13.3	21.6	12.6	13.4	12.6	12.9
1992	12.9	13.4	11.5	13.0	17.9	11.9	12.7	14.0
1993	11.1	12.3	12.7	21.6	11.1	12.8	12.2	15.9
1994	14.0	14.6	14.6	25.4	14.0	14.7	14.3	14.1
Average	**12.28**	**12.67**	**12.80**	**18.69**	**13.79**	**12.84**	**12.35**	**12.90**
Similarity		64.77%	51.55%	0.74%	16.32%	48.32%	93.58%	53.07%
Evaluation		**N**	**N**	**SSB**	**SB**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

French Broad River Mile 18

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	14.8	14.9	14.9	18.7	15.5	14.9	15.1	14.8
1988	19.2	18.1	17.8	20.3	20.5	17.9	18.6	18.5
1989	16.9	16.9	16.9	18.5	16.9	16.9	17.0	17.0
1990	17.4	17.5	17.6	19.8	17.4	17.4	17.6	17.2
1991	16.6	16.6	16.6	18.6	16.6	16.6	16.8	16.6
1992	16.6	16.5	16.5	17.8	16.6	16.6	16.6	16.6
1993	17.0	17.1	17.1	18.6	17.0	17.1	17.2	16.8
1994	17.39	17.3	17.4	19.2	17.2	17.4	17.4	17.4
Average	**16.96**	**16.86**	**16.84**	**18.94**	**17.21**	**16.85**	**17.05**	**16.85**
Similarity		85.08%	82.32%	0.17%	71.94%	83.20%	87.40%	83.73%
Evaluation		**N**	**N**	**SSB**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Elk River Mile 73

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	26.7	26.7	26.7	26.6	26.7	26.7	26.7	26.7
1988	24.7	24.7	24.7	24.6	24.8	24.6	24.6	24.7
1989	18.8	18.8	18.9	20.2	18.8	18.8	18.8	18.8
1990	24.1	24.3	24.8	26.9	24.1	24.8	24.0	24.1
1991	21.5	21.4	21.6	25.6	21.5	21.7	21.4	21.5
1992	24.4	24.4	24.6	24.6	24.4	24.6	24.4	24.3
1993	22.7	22.9	23.7	26.9	23.0	23.6	22.8	22.8
1994	23.6	23.8	24.2	27.1	23.7	24.1	23.5	23.5
Average	**23.31**	**23.38**	**23.64**	**25.32**	**23.38**	**23.61**	**23.29**	**23.31**
Similarity		95.31%	78.34%	10.83%	95.07%	80.37%	98.94%	99.65%
Evaluation		**N**	**N**	**SB**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Warm Tributary Tailwaters

Metric #7: Difference between 90 and 10 percentile instantaneous water temperatures at a given location during the second through third weeks in June.

Data Units: Water Temperature range in degrees Celsius.

Evaluation Perspective: Less variation in water temperatures during this period would indicate better spring conditions for protected species reproduction and growth.

Holston River Mile 30

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	3.1	3.5	3.5	4.8	3.2	3.3	1.8	3.2
1988	4.3	4.3	4.7	4.5	5.7	4.4	3.4	4.6
1989	2.6	2.6	2.7	8.1	10.0	2.6	2.3	2.7
1990	3.4	3.7	3.8	5.6	3.4	3.7	2.2	3.5
1991	2.9	3.3	3.3	9.3	2.9	3.2	1.7	3.4
1992	11.4	11.2	3.6	3.8	11.9	3.6	3.2	11.0
1993	4.2	4.4	4.4	7.0	4.2	4.5	3.1	13.6
1994	3.7	4.6	4.6	4.3	3.7	4.5	2.5	4.2
Average	**4.44**	**4.70**	**3.81**	**5.92**	**5.62**	**3.72**	**2.53**	**5.77**
Similarity		85.16%	55.40%	24.72%	46.59%	50.03%	8.76%	46.47%
Evaluation		**N**	**N**	**N**	**N**	**N**	**SB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

French Broad River Mile 18

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	2.4	2.5	2.5	2.3	2.3	2.5	1.7	2.4
1988	3.2	3.2	2.6	3.6	3.6	2.8	3.3	3.4
1989	2.6	2.6	2.6	3.7	2.6	2.6	2.6	2.8
1990	2.8	2.9	2.9	6.1	2.8	2.9	2.3	2.9
1991	2.1	2.3	2.3	5.3	2.1	2.3	2.1	2.2
1992	2.0	1.9	1.9	2.1	2.1	2.0	2.2	2.2
1993	3.2	3.1	3.1	5.5	3.2	3.1	2.2	3.1
1994	2.9	3.2	3.2	6.0	3.0	3.2	2.8	3.0
Average	**2.64**	**2.72**	**2.64**	**4.32**	**2.71**	**2.68**	**2.40**	**2.74**
Similarity		74.08%	99.34%	1.40%	79.71%	86.99%	31.44%	68.00%
Evaluation		**N**	**N**	**SSA**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Elk River Mile 73

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	2.3	2.3	2.2	2.2	2.3	2.2	2.2	2.4
1988	5.5	5.5	5.8	5.4	5.1	5.7	5.6	5.6
1989	4.0	4.1	4.1	6.0	3.8	4.1	4.0	4.1
1990	3.7	3.2	3.6	2.5	3.8	3.5	3.6	3.6
1991	4.6	4.7	4.5	3.0	4.8	4.5	4.7	4.8
1992	5.1	5.1	5.0	5.0	5.0	4.9	4.8	5.0
1993	3.5	3.2	2.5	1.9	3.2	2.6	3.4	3.5
1994	6.1	5.2	5.8	3.7	5.8	5.9	5.3	5.6
Average	**4.34**	**4.15**	**4.17**	**3.72**	**4.22**	**4.18**	**4.19**	**4.32**
Similarity		75.35%	79.32%	38.70%	84.19%	80.64%	79.92%	96.18%
Evaluation		**N**	**N**	**N**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Warm Tributary Tailwaters

Metric #8: The average instantaneous water temperatures at a given location during the third through fourth weeks in August.

Data Units: Water temperature range in degrees Celsius.

Evaluation Perspective: Higher mean water temperatures during this period would indicate better summer conditions for protected species survival and growth.

Holston River Mile 30

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	24.7	19.2	18.1	20.5	24.5	18.7	16.9	21.6
1988	29.2	29.0	26.5	29.8	28.6	27.6	26.8	29.0
1989	23.0	19.6	19.5	19.3	22.3	19.4	18.8	20.5
1990	24.6	17.7	17.7	18.9	24.6	18.0	17.4	18.8
1991	25.6	17.1	17.3	20.5	25.6	17.7	16.8	19.1
1992	23.4	16.7	15.8	18.0	23.3	15.7	15.0	18.1
1993	23.5	16.6	15.4	17.8	23.5	15.4	14.7	18.0
1994	23.3	18.0	17.9	18.3	23.3	18.0	17.4	18.6
Average	**24.66**	**19.23**	**18.53**	**20.39**	**24.46**	**18.83**	**17.98**	**20.45**
Similarity		0.46%	0.07%	1.65%	84.45%	0.19%	0.06%	1.35%
Evaluation		**SSA**	**SSA**	**SSA**	**N**	**SSA**	**SSA**	**SSA**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

French Broad River Mile 18

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	22.7	23.1	22.3	26.1	22.6	22.5	21.8	23.2
1988	26.8	26.8	26.0	26.8	27.3	26.3	26.2	26.5
1989	24.3	24.2	24.2	24.2	24.3	24.2	24.4	24.0
1990	22.4	21.2	21.2	24.6	22.4	21.2	21.4	21.8
1991	23.9	22.8	22.8	24.8	23.9	22.8	22.9	23.6
1992	23.2	22.3	21.3	24.4	23.2	21.3	21.5	22.7
1993	21.1	21.6	20.7	25.8	21.1	20.7	20.7	21.5
1994	23.8	23.8	23.8	24.7	23.8	23.8	23.8	24.0
Average	**23.52**	**23.23**	**22.79**	**25.19**	**23.57**	**22.86**	**22.84**	**23.41**
Similarity		74.03%	41.27%	2.66%	95.89%	46.49%	44.95%	88.75%
Evaluation		**N**	**N**	**SSB**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Elk River Mile 73

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	27.3	27.3	27.3	27.2	27.3	27.3	27.3	27.4
1988	28.6	28.6	28.7	28.7	28.0	28.7	28.6	28.7
1989	24.2	23.5	25.8	24.1	23.7	25.7	23.5	24.0
1990	27.0	26.2	28.5	28.6	26.8	28.4	26.4	26.7
1991	24.4	24.0	26.4	26.4	24.5	26.4	24.0	24.1
1992	21.2	21.0	23.6	24.6	21.4	23.7	21.0	21.1
1993	26.8	26.1	29.4	29.3	26.8	29.3	26.1	26.8
1994	21.9	21.6	23.7	23.9	22.0	23.6	21.8	21.6
Average	**25.19**	**24.79**	**26.66**	**26.60**	**25.04**	**26.64**	**24.84**	**25.04**
Similarity		77.47%	24.90%	26.74%	91.39%	25.59%	79.87%	91.56%
Evaluation		**N**	**N**	**N**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Warm Tributary Tailwaters

Metric #9: Difference between 90 and 10 percentile instantaneous water temperatures during third through fourth weeks of August at a given location.

Data Units: Temperature range in degrees Celsius.

Evaluation Perspective: Less variation in water temperature during this period would indicate better spring conditions for protected species survival and growth.

Holston River Mile 30

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	3.8	3.6	3.0	3.4	3.8	3.1	2.3	3.9
1988	3.0	3.0	2.9	2.2	2.4	2.7	3.2	3.4
1989	2.9	3.1	3.3	3.2	3.3	3.2	1.9	2.7
1990	3.2	3.6	4.2	3.6	3.2	4.1	2.6	3.2
1991	3.2	3.3	3.3	9.3	3.2	3.2	2.5	3.2
1992	2.6	3.1	2.8	3.1	2.7	2.9	2.3	3.3
1993	5.8	3.9	3.6	3.6	5.8	3.5	1.9	3.7
1994	6.7	3.1	3.1	2.9	6.7	3.4	3.0	3.3
Average	**3.89**	**3.33**	**3.27**	**3.91**	**3.89**	**3.26**	**2.46**	**3.34**
Similarity		32.10%	28.62%	98.92%	99.29%	27.47%	2.20%	33.33%
Evaluation		**N**	**N**	**N**	**N**	**N**	**SSB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

French Broad River Mile 18

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	2.6	2.5	2.5	1.7	2.6	2.5	2.2	2.4
1988	1.7	1.9	1.7	1.9	2.0	1.7	1.5	1.8
1989	1.1	1.5	1.5	1.3	1.1	1.5	1.7	1.4
1990	2.4	2.6	2.9	1.7	2.4	2.9	1.8	2.7
1991	1.3	1.8	1.9	1.4	1.3	1.9	2.0	1.4
1992	1.8	1.9	1.7	1.1	1.8	1.7	2.0	1.8
1993	2.5	2.5	2.4	1.7	2.5	2.3	1.8	2.3
1994	1.5	1.6	1.6	1.5	1.5	1.6	1.9	1.4
Average	**1.87**	**2.02**	**2.03**	**1.54**	**1.91**	**2.02**	**1.86**	**1.90**
Similarity		56.82%	56.78%	15.43%	89.55%	58.58%	94.94%	91.78%
Evaluation		**N**	**N**	**SB**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Elk River Mile 73

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	2.6	2.7	2.6	2.7	2.6	2.6	2.6	2.7
1988	2.6	3.0	2.8	2.6	3.2	2.6	2.8	2.6
1989	4.0	4.1	2.7	3.9	3.7	2.8	3.9	4.0
1990	3.4	3.5	3.4	3.6	3.4	3.3	3.6	3.3
1991	2.6	2.7	2.8	2.8	2.4	2.9	2.8	3.4
1992	4.4	4.5	4.2	2.8	4.6	4.0	4.7	4.4
1993	3.4	3.4	3.0	3.1	3.2	3.1	3.4	3.4
1994	3.2	3.6	2.5	5.7	3.5	2.5	2.7	3.0
Average	**3.27**	**3.43**	**2.99**	**3.40**	**3.32**	**2.98**	**3.32**	**3.34**
Similarity		62.93%	39.79%	76.57%	87.15%	35.10%	89.20%	82.85%
Evaluation		**N**	**N**	**N**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Cool-to-Warm Tributary Tailwaters

Metric #10: Minimum water level achieved 90 percent of the time during the year at a given location.

Data Units: Elevation in feet above mean sea level.

Evaluation Perspective: Higher minimum water levels would indicate more available habitat for protected aquatic species.

Holston River Mile 48

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	911.47	911.35	911.47	911.38	911.39	911.48	912.15	911.44
1988	911.13	911.13	911.16	911.11	911.10	911.14	911.21	911.10
1989	911.11	911.13	911.14	911.27	911.11	911.14	911.49	911.12
1990	911.15	911.15	911.15	911.14	911.16	911.15	911.79	911.14
1991	911.14	911.14	911.15	911.16	911.14	911.15	911.42	911.13
1992	911.11	911.12	911.16	911.20	911.12	911.17	911.57	911.13
1993	911.17	911.19	911.19	911.29	911.17	911.20	911.59	911.14
1994	911.46	911.50	911.58	911.28	911.47	911.54	912.24	911.37
Average	**911.22**	**911.21**	**911.25**	**911.23**	**911.21**	**911.25**	**911.68**	**911.20**
Similarity		95.96%	69.86%	86.89%	87.55%	73.20%	0.44%	76.50%
Evaluation		**N**	**N**	**N**	**N**	**N**	**SSB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Hiwassee River Mile 48

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	743.81	743.81	743.81	743.81	743.81	743.81	743.88	743.80
1988	743.81	743.81	743.81	743.81	743.81	743.81	743.86	743.80
1989	744.15	744.70	744.42	744.52	743.94	744.15	745.40	744.52
1990	743.93	743.93	743.88	743.93	743.93	743.88	744.10	743.88
1991	745.09	744.88	744.43	744.10	745.03	744.45	745.33	744.54
1992	743.88	743.86	743.86	743.87	743.89	743.87	744.13	743.84
1993	743.91	743.93	743.88	743.86	743.91	743.87	744.01	743.86
1994	745.33	745.36	745.82	745.33	745.33	746.17	745.51	745.13
Average	**744.24**	**744.29**	**744.24**	**744.15**	**744.21**	**744.25**	**744.53**	**744.17**
Similarity		88.27%	99.58%	76.94%	91.62%	97.68%	41.25%	80.95%
Evaluation		**N**	**N**	**N**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Elk River Mile 125

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	720.25	720.25	720.25	720.25	720.25	720.25	720.26	720.25
1988	720.22	720.22	720.22	720.22	720.22	720.22	720.22	720.22
1989	720.37	720.37	720.36	720.36	720.37	720.36	720.37	720.37
1990	720.26	720.26	720.24	720.24	720.26	720.24	720.26	720.26
1991	720.29	720.29	720.28	720.27	720.29	720.28	720.29	720.29
1992	720.25	720.25	720.24	720.23	720.25	720.24	720.27	720.25
1993	720.26	720.26	720.25	720.24	720.26	720.25	720.26	720.26
1994	720.31	720.31	720.32	720.27	720.31	720.32	720.31	720.31
Average	**720.28**	**720.28**	**720.27**	**720.26**	**720.28**	**720.27**	**720.28**	**720.28**
Similarity		98.19%	86.00%	47.94%	99.70%	86.00%	82.01%	97.89%
Evaluation		**N**	**N**	**N**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Cool-to-Warm Tributary Tailwaters

Metric #11: Difference between 90- and 10-percent instantaneous flows during second through third weeks of June at a given location.

Data Units: Flow range in cubic feet per second.

Evaluation Perspective: Less variation in flow rates during this period would indicate better spring conditions for protected species reproduction and growth.

Holston River Mile 48

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	9,431	5,746	5,746	2,791	6,375	6,302	2,938	6,701
1988	11,242	11,191	12,142	7,245	15,858	11,733	469	10,935
1989	14,256	14,222	14,225	13,766	13,224	14,221	4,380	14,093
1990	9,775	6,327	6,327	148	9,775	6,330	2,737	9,714
1991	13,158	9,500	9,500	2,991	13,158	9,602	1,358	9,737
1992	9,820	13,493	13,736	10,152	6,413	13,737	3,030	7,604
1993	6,562	4,676	4,737	611	6,562	4,660	2,945	3,042
1994	9,765	6,619	6,619	95	9,765	6,818	966	9,707
Average	**10,501.0**	**8,972.1**	**9,129.0**	**4,724.9**	**10,141.2**	**9,175.4**	**2,353.0**	**8,914.6**
Similarity		34.07%	40.21%	1.18%	81.84%	40.79%	0.00%	29.26%
Evaluation		**N**	**N**	**SSB**	**N**	**N**	**SSB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Hiwassee River Mile 48

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	2,465	2,465	2,465	2,616	2,465	2,400	992	2,398
1988	2,660	2,645	2,610	2,636	2,573	2,400	340	2,668
1989	4,260	4,260	4,260	2,072	4,259	4,361	4,406	3,380
1990	2,657	2,495	2,495	2,490	2,657	2,391	1,058	2,652
1991	2,402	2,550	2,551	2,635	2,402	2,456	397	2,061
1992	2,465	2,570	2,640	2,495	2,451	2,400	992	2,345
1993	2,661	2,489	2,489	2,480	2,661	2,391	770	2,684
1994	1,028	1,532	1,532	1,730	1,028	2,158	618	1,039
Average	**2,574.8**	**2,625.7**	**2,630.2**	**2,394.1**	**2,562.2**	**2,619.8**	**1,196.6**	**2,399.0**
Similarity		90.21%	89.33%	59.10%	97.74%	91.13%	2.76%	65.76%
Evaluation		**N**	**N**	**N**	**N**	**N**	**SSB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Elk River Mile 125

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	6	6	6	6	6	6	6	6
1988	1	1	1	1	1	1	1	1
1989	3,844	3,844	3,842	3,905	3,844	3,842	3,628	3,844
1990	1,542	1,542	934	50	1,542	934	1,542	1,542
1991	3,694	3,694	3,496	65	3,694	3,496	3,455	3,694
1992	82	82	63	63	82	63	82	82
1993	2,216	2,216	1,843	28	2,216	1,843	2,216	2,216
1994	1,434	1,434	1,227	9	1,434	1,227	1,434	1,434
Average	**1,602.3**	**1,602.3**	**1,426.4**	**515.78**	**1,602.3**	**1,426.4**	**1,545.5**	**1,602.3**
Similarity		100.00%	82.39%	16.22%	100.00%	82.39%	94.17%	100.00%
Evaluation		**N**	**N**	**SB**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Cool-to-Warm Tributary Tailwaters

Metric #12: The average instantaneous water temperatures at a given location during the second through third weeks in June at a given location.

Data Units: Water temperature in degrees Celsius.

Evaluation Perspective: Higher mean water temperatures during this period would indicate better spring conditions for protected species reproduction and growth.

Holston River Mile 48

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	11.9	11.8	11.8	14.7	12.0	11.9	11.8	11.8
1988	10.0	8.8	9.7	9.0	14.6	9.8	8.4	8.1
1989	8.0	8.8	9.8	10.6	8.0	9.5	9.0	8.6
1990	11.6	11.6	12.0	15.4	11.6	12.0	11.7	11.7
1991	11.2	11.1	11.6	14.5	11.2	11.7	11.1	11.2
1992	9.1	9.9	10.4	11.3	10.9	10.5	10.3	10.3
1993	8.8	8.9	9.4	12.9	8.8	9.4	8.8	9.7
1994	12.4	12.4	12.4	16.1	12.4	12.4	12.3	12.2
Average	**10.39**	**10.42**	**10.88**	**13.06**	**11.19**	**10.91**	**10.42**	**10.44**
Similarity		97.07%	50.06%	2.51%	40.24%	48.21%	96.47%	94.56%
Evaluation		**N**	**N**	**SSB**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Hiwassee River Mile 48

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	12.0	14.3	14.4	15.5	14.8	15.6	14.9	14.8
1988	13.0	14.4	14.4	15.4	15.2	15.4	14.4	14.6
1989	12.8	14.5	14.5	15.1	14.4	14.4	14.4	14.9
1990	14.2	16.0	16.0	16.4	15.8	16.5	16.2	16.0
1991	14.2	15.9	15.9	16.6	15.7	15.9	15.8	15.9
1992	13.4	13.9	13.5	14.4	14.6	14.8	14.2	14.5
1993	12.4	15.1	15.1	15.4	14.5	15.6	14.9	14.8
1994	13.8	15.5	15.5	16.5	15.4	15.7	15.4	15.6
Average	**13.21**	**14.95**	**14.90**	**15.64**	**15.05**	**15.48**	**15.00**	**15.12**
Similarity		0.07%	0.12%	0.00%	0.01%	0.00%	0.03%	0.01%
Evaluation		**SSB**	**SSB**	**SSB**	**SSB**	**SSB**	**SSB**	**SSB**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Elk River Mile 125

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	18.9	18.9	18.9	19.1	19.0	18.9	18.9	18.9
1988	18.6	18.6	18.7	18.8	18.6	18.7	18.6	18.6
1989	13.0	13.0	13.1	15.4	13.1	13.1	12.9	13.1
1990	17.2	17.1	17.6	21.6	17.2	17.6	17.1	17.3
1991	16.2	16.2	16.4	21.4	16.2	16.4	16.2	16.3
1992	18.4	18.4	19.1	19.3	18.4	19.1	18.4	18.4
1993	14.9	14.9	15.1	20.2	15.0	15.1	14.9	14.9
1994	17.1	17.2	17.5	21.3	17.2	17.5	17.2	17.2
Average	**16.79**	**16.80**	**17.05**	**19.65**	**16.84**	**17.05**	**16.78**	**16.83**
Similarity		99.56%	80.25%	1.35%	96.22%	80.43%	98.97%	97.01%
Evaluation		**N**	**N**	**SSB**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Cool-to-Warm Tributary Tailwaters

Metric #13: Difference between 90 and 10 percentile instantaneous water temperatures at a given location during the second through third weeks in June at a given location.

Data Units: Water temperature range in degrees Celsius.

Evaluation Perspective: Less variation in water temperatures during this period would indicate better spring conditions for protected species reproduction and growth.

Holston River Mile 48

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	1.0	1.4	1.4	3.3	1.3	1.3	1.2	1.2
1988	3.5	2.6	2.9	2.4	7.0	3.0	2.2	2.2
1989	2.1	2.6	2.8	2.4	2.4	2.6	2.2	2.2
1990	2.0	1.5	1.4	5.0	1.9	1.4	1.5	1.5
1991	1.8	1.4	1.3	4.2	1.8	1.4	1.3	1.3
1992	2.3	2.2	0.9	1.1	4.1	1.0	1.2	1.2
1993	1.4	1.9	1.9	5.1	1.4	1.9	1.5	1.5
1994	1.4	1.2	1.2	5.3	1.4	1.2	1.4	1.4
Average	**1.95**	**1.85**	**1.72**	**3.59**	**2.66**	**1.73**	**1.57**	**1.57**
Similarity		77.49%	55.90%	1.70%	35.06%	56.69%	23.47%	23.47%
Evaluation		**N**	**N**	**SSA**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Hiwassee River Mile 48

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	12.1	10.1	10.1	7.6	9.7	7.6	5.5	9.4
1988	7.0	6.3	6.8	5.8	4.9	6.8	5.7	6.5
1989	2.9	3.3	3.3	3.2	3.3	3.2	3.2	3.1
1990	6.2	7.0	7.0	7.6	5.8	5.5	5.2	5.5
1991	3.6	3.8	3.8	4.4	3.6	3.6	3.8	3.3
1992	8.8	7.7	5.1	6.3	7.4	5.9	4.8	7.5
1993	10.1	10.1	10.1	8.3	8.5	6.5	5.6	6.9
1994	3.7	3.6	3.6	3.8	3.5	3.5	4.0	3.4
Average	**6.80**	**6.48**	**6.24**	**5.89**	**5.83**	**5.33**	**4.73**	**5.71**
Similarity		83.98%	72.19%	51.58%	52.11%	28.75%	11.76%	46.20%
Evaluation		**N**	**N**	**N**	**N**	**N**	**SB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Elk River Mile 125

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	3.8	3.8	3.8	3.8	3.9	3.9	3.8	3.8
1988	6.8	6.4	6.6	6.7	6.7	6.7	6.5	6.1
1989	7.3	7.4	7.4	9.3	7.4	7.4	7.0	10.2
1990	9.3	9.4	9.2	4.2	9.3	9.2	9.4	9.3
1991	9.4	9.5	9.6	5.2	9.4	9.6	9.4	9.6
1992	6.2	6.1	5.9	5.8	6.2	5.9	6.2	5.4
1993	10.6	10.8	10.7	4.7	10.8	10.7	10.8	11.7
1994	9.8	10.0	9.9	5.1	9.9	9.8	10.0	8.5
Average	**7.89**	**7.92**	**7.88**	**5.59**	**7.96**	**7.90**	**7.88**	**8.08**
Similarity		98.20%	98.82%	4.00%	95.75%	99.66%	99.25%	88.29%
Evaluation		**N**	**N**	**SSB**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Cool-to-Warm Tributary Tailwaters

Metric #14: The average instantaneous water temperatures at a given location during the third through fourth weeks in August at a given location.

Data Units: Water temperatures in degrees Celsius.

Evaluation Perspective: Higher mean water temperatures during this period would indicate better summer conditions for protected species survival and growth.

Holston River Mile 48

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	23.6	17.9	16.5	19.0	23.4	17.1	15.6	20.4
1988	27.8	27.5	25.1	28.6	26.8	26.2	25.5	27.9
1989	22.2	18.3	17.7	17.9	21.5	17.8	17.2	19.4
1990	23.6	16.2	15.5	17.3	23.6	15.8	14.9	17.2
1991	24.6	15.2	15.0	16.6	24.6	15.5	14.7	17.7
1992	22.6	15.4	13.8	16.5	22.4	13.8	13.0	16.8
1993	22.3	14.9	13.3	16.0	22.3	13.4	12.6	16.2
1994	19.8	16.8	16.6	17.1	19.8	16.7	16.5	17.2
Average	**23.31**	**17.77**	**16.71**	**18.64**	**23.07**	**17.04**	**16.24**	**19.11**
Similarity		0.51%	0.07%	1.44%	82.60%	0.18%	0.07%	1.83%
Evaluation		**SSA**	**SSA**	**SSA**	**N**	**SSA**	**SSA**	**SSA**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Hiwassee River Mile 48

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	15.6	18.1	18.2	20.7	18.3	19.2	18.8	18.7
1988	18.4	20.3	19.5	21.1	21.4	19.7	20.0	20.3
1989	17.4	20.6	20.6	21.2	20.5	20.6	20.8	20.9
1990	18.3	19.7	19.7	20.8	20.1	20.0	20.0	20.1
1991	18.2	19.7	19.7	20.8	20.3	19.7	19.6	20.2
1992	16.6	17.8	17.8	19.0	18.4	17.9	17.3	18.1
1993	16.9	18.8	19.1	20.4	18.9	19.4	19.0	19.2
1994	18.0	20.6	20.6	21.4	20.6	20.6	20.6	21.1
Average	**17.42**	**19.46**	**19.41**	**20.66**	**19.81**	**19.64**	**19.51**	**19.83**
Similarity		0.04%	0.04%	0.00%	0.01%	0.01%	0.04%	0.03%
Evaluation		**SSB**	**SSB**	**SSB**	**SSB**	**SSB**	**SSB**	**SSB**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Elk River Mile 125

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	20.1	20.1	20.2	20.3	20.1	20.1	20.0	20.1
1988	20.2	20.2	20.4	20.6	19.0	20.4	20.2	20.2
1989	18.3	18.1	18.7	17.9	18.3	18.7	18.2	18.3
1990	18.4	18.0	21.6	21.7	18.3	21.6	18.1	18.2
1991	17.5	17.4	20.3	20.3	17.6	20.3	17.4	17.5
1992	14.4	14.2	15.7	18.0	14.4	15.7	14.3	14.4
1993	16.8	16.6	20.5	20.7	16.8	20.5	16.6	16.7
1994	16.7	16.6	17.0	17.1	16.7	17.0	16.6	16.6
Average	**17.81**	**17.66**	**19.30**	**19.58**	**17.64**	**19.28**	**17.68**	**17.76**
Similarity		87.78%	15.46%	6.94%	85.15%	15.81%	89.27%	95.65%
Evaluation		**N**	**SB**	**SB**	**N**	**SB**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Cool-to-Warm Tributary Tailwaters

<u>Metric #15</u>: Difference between 90- and 10-percent instantaneous water temperatures during third through fourth weeks of August at a given location.

<u>Data Units</u>: Temperature range in degrees Celsius.

<u>Evaluation Perspective</u>: Less variation in water temperature during this period would indicate better spring conditions for protected species survival and growth.

Holston River Mile 48

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	4.0	4.1	2.6	3.9	4.1	2.8	1.7	4.2
1988	2.0	3.2	2.4	2.7	2.5	2.4	2.4	4.7
1989	2.7	1.7	1.6	1.6	3.4	1.6	1.4	2.4
1990	3.7	1.7	1.7	1.8	3.7	1.7	1.5	2.5
1991	3.8	1.9	1.8	3.6	3.8	1.9	1.6	2.7
1992	2.8	2.4	1.7	2.4	2.9	1.6	1.3	3.3
1993	6.3	4.2	2.2	3.8	6.3	2.3	1.7	4.4
1994	2.8	1.7	1.7	1.8	2.9	2.0	1.7	2.3
Average	**3.52**	**2.60**	**1.96**	**2.67**	**3.70**	**2.04**	**1.65**	**3.30**
Similarity		15.04%	0.66%	16.64%	78.16%	0.98%	0.17%	70.50%
Evaluation		**SB**	**SSB**	**SB**	**N**	**SSB**	**SSB**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

Hiwassee River Mile 48

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	4.5	3.6	5.2	3.2	3.8	4.2	4.9	3.6
1988	7.0	3.9	4.7	4.6	5.7	4.1	4.8	3.2
1989	2.5	2.5	3.0	2.4	2.5	3.0	3.2	2.4
1990	3.2	4.1	6.2	3.0	3.1	4.7	4.7	3.6
1991	2.5	2.7	2.6	2.4	2.4	2.6	2.6	2.5
1992	2.3	2.4	3.0	2.3	2.2	2.8	2.6	2.2
1993	3.3	3.4	6.6	3.0	3.1	4.7	4.7	3.6
1994	2.4	2.2	2.2	1.6	2.2	2.2	2.2	1.6
Average	**3.48**	**3.09**	**4.18**	**2.82**	**3.13**	**3.52**	**3.71**	**2.85**
Similarity		55.16%	40.68%	33.02%	63.16%	94.61%	74.54%	34.08%
Evaluation		**N**	**N**	**N**	**N**	**N**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

Elk River Mile 125

Year	Base Case	Reservoir Recreation A	Reservoir Recreation B	Equalized Summer/ Winter Flood Risk	Commercial Navigation	Tailwater Recreation	Tailwater Habitat	Preferred
1987	4.6	4.6	4.5	4.5	4.6	4.6	4.7	4.6
1988	4.3	4.3	4.3	4.2	11.3	4.2	4.2	4.3
1989	7.8	7.8	7.4	8.1	7.8	7.4	7.8	7.9
1990	10.1	10.0	5.1	5.0	9.9	5.3	10.0	10.1
1991	7.9	7.9	4.5	4.6	7.8	4.6	7.8	7.8
1992	7.8	7.9	6.1	4.2	7.8	6.1	7.8	7.8
1993	9.8	10.0	4.3	4.3	9.7	4.3	9.9	9.8
1994	7.0	7.1	6.8	7.4	7.0	6.7	7.0	7.0
Average	**7.41**	**7.45**	**5.37**	**5.28**	**8.23**	**5.40**	**7.41**	**7.41**
Similarity		97.30%	3.15%	3.59%	44.20%	3.32%	99.63%	99.63%
Evaluation		**N**	**SSB**	**SSB**	**N**	**SSB**	**N**	**N**

Note: Data for the Summer Hydropower Alternative could not be generated for all modeled years.

See Evaluation Abbreviations Used in the Metric Tables on page D6b-12.

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Appendix D7

Cultural Resources

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D7.1 Cultural Resources

The following culture history summary has been abstracted from the TVA Technical Report, *Archaeological Data Analysis of the Tennessee River Valley Associated with the Tennessee Valley Authority's Reservoir Operations Study* (Ahlman et. al. 2003).

D7.1.1 Paleoindian Period (10,000-8000 BC)

The Paleoindian period is the earliest known era of human occupation in North America. A small number of Paleoindian sites with intact stratigraphy and extensive cultural material assemblages have been excavated in the TVA region, primarily in the Highland Rim region.

Paleoindian populations are characterized as small nomadic or semi-nomadic bands with settlement and subsistence strategies based on hunting and collecting wild foods. The principal subsistence appears to have been herd animals, such as caribou, although solitary animals, such as elk and moose, were hunted also.

D7.1.2 Archaic Period (8000-1000 BC)

The Paleoindian period was followed by the Archaic period that has three divisions: Early (8000-6000 BC), Middle (6000-3000 BC), and Late (3000-1000 BC). As the climate moderated from glacial conditions into temperate ranges, people diversified their subsistence economy and focused on seasonal hunting, fishing, and collecting wild plant foods. Increased efficiency resulted in more complex societies, regional variability, trade and exchange networks, and population growth.

The Early Archaic period is marked by adaptations to a changing environment and increased use of smaller species of fauna. Settlements consisted of a main residential base camp located on alluvial terraces with smaller specialized hunting and gathering camps located in the uplands.

The Middle Archaic period is associated with a warmer and drier climate and a decrease in the number of sites recorded in the upper Tennessee River Valley. In general, however, populations and territories gradually increased with a significant population increase in the Highland Rim, Coastal Plain, and Nashville Basin regions.

The Late Archaic marks an increase in population, which has been attributed to improved adaptive strategies for extracting food from the local environments. Evidence from the Watts Bar Reservoir indicates a fourfold increase in the number of sites with Late Archaic components relative to the Middle Archaic. Late Archaic sites are situated in a variety of environmental settings, but upland locations are typically small, diffuse, lithic scatters reflective of short-term extraction sites. Riverine sites are larger in size and artifact density.

D7.1.3 Gulf Formational Period (1200-600 BC)

The Gulf Formational period replaces Late Archaic and Early Woodland periods in the Cumberland Plateau and Coastal Plain regions. Subsistence during this period involved hunting and gathering with increased reliance on cultivated plants. Few Gulf Formational sites have been found within the Tennessee River Valley; most are in the western end of Wheeler Reservoir. Limited excavations of Gulf Formational and Early Woodland period components in the southern Cumberland Plateau and Coastal Plain regions have revealed a continuation of settlement from the Late Archaic with large multi-seasonal base camps and smaller base camps.

D7.1.4 Woodland Period (1000 BC-AD 900)

The Woodland period has three subperiods: Early (1000 BC-AD 100), Middle (AD 100-600), and Late (AD 600-900). Some regional variation exists, for example, in the Coastal Plain dates for the three subperiods: Early (600-200 BC); Middle (200 BC-AD 700); and Late (AD 700-900). In the southern Cumberland Plateau region, there are two, rather than three, subperiods: Middle (300 BC-AD 600) and Late (AD 600-900).

In general, shifts in settlement and subsistence patterns, as well as changes in social organization, characterize the Woodland period. Pottery and structural remains suggest a less nomadic lifestyle. Limited excavations of Early Woodland period components in the Little Tennessee River Valley revealed large multi-seasonal base camps and smaller base camps with small logistical camps located on the first, second, and older river terraces. Little is known about the Early Woodland in the Highland Rim, Coastal Plain, and Nashville Basin regions.

The Pee Dee culture, a localized manifestation of the South Appalachian Mississippian tradition, debuts in the Early Woodland in the southern Blue Ridge and Piedmont. The Pee Dee culture had palisaded villages that encompassed a habitation area, a central plaza, and a temple mound. A significant change was the introduction of maize agriculture.

Settlement and subsistence of the Middle Woodland in the Highland Rim region is fairly well known, as a result of excavated sites at Normandy Reservoir. These sites include earth ovens, large cylindrical storage pits, and summer/winter structures that indicate long-term, multi-season occupation.

The Late Woodland period is less well-known. It marks the end of the construction of burial mounds, elaborate mortuary treatments, and long-distance trade of exotic goods. Late Woodland period sites have not been widely examined. Burial mounds have been the main focus of archaeological investigation.

Late Woodland groups in North Carolina followed different trajectories. In some areas, Middle Woodland continued until the Mississippian period, while in other areas, Late Woodland developed complex social systems and agricultural economies. In some areas, Late Woodland persisted to European contact in the sixteenth century and continued through the eighteenth century, while in other areas Late Woodland was subsumed into the South Appalachian Mississippian tradition.

D7.1.5 Mississippian Period (AD 900-1600)

The Mississippian period is well known, except for the Highland Rim region. It is divided into three subperiods: Early (AD 900-1000), Middle (AD 1000-1300), and Late (AD 1300-1600). The Mississippian period marks profound changes in prehistoric settlement and subsistence patterns that reflect an increase in social complexity, the rise of chiefdoms, a reliance on maize agriculture, and an increase in population. The subperiods are characterized by changing material culture, especially pottery and personal artifacts.

This period is characterized by large village sites located on floodplains, as well as by earthen mounds, settlement hierarchy, social stratification, and agricultural economy. In addition to large villages, the Mississippian period had specialized procurement or hunting locations. In the Appalachian Summit, Mississippian sites range from small farmsteads to large palisaded villages, often with small nearby sites. Palisaded villages were located along major streams and in the tributary valleys, on or adjacent to fertile bottomland soils with houses in a circular or oval pattern around a central plaza.

The Early Mississippian is characterized by large permanent settlements situated along first terraces, square or rectangular wall-trench houses with central hearths, and occasionally platform mounds.

During the Middle Mississippian, settlements were located on high ground away from river bottoms. Houses were circular or rectangular wall-trench structures.

The peak in prehistoric social complexity and organization is represented by the Late Mississippian period. Settlements were located primarily on second terraces, and varied in size from small hamlets to large towns. During the Late Mississippian, houses were often located around a central plaza with a platform mound, and defensive palisades surrounding towns.

The Pisgah phase represents the local manifestation of the South Appalachian Mississippian tradition, and characterizes the climax of Mississippian influence in the Appalachian Summit. Pisgah phase habitation sites consist of small farmsteads and relatively large village/mound complexes, usually located on floodplains.

The localized and later Qualla phase (after AD 1300) in the Appalachian Summit is the expression of the Lamar culture, which occurs in the northern half of Georgia, Alabama, South Carolina, eastern Tennessee, and western North Carolina. In North Carolina, Qualla sites are located in the Little Tennessee and Hiwassee drainages and Pisgah sites are east of the Tuckasegee drainage.

D7.1.6 Historic Period

The historic period began with Hernando de Soto's explorations in the mid-sixteenth century. De Soto visited several Native American villages within the Tennessee River Valley watershed in western North Carolina, eastern Tennessee, and northern Georgia. Many of these villages were inundated by Fontana, Tellico, Douglas, Chickamauga, and Guntersville reservoirs. There was little European contact with Native American tribes following de Soto's journey until the early eighteenth century.

Extensive European, Euro-American, and African-American settlement in the Tennessee River Valley followed the Revolutionary War when the area was formally opened for Euro-American settlement. By this time, the Native American populations had dwindled as a result of diseases introduced by contact with Europeans. Continued Euro-American expansion in the early nineteenth century led to the forced removal of Native American groups (i.e., Cherokee, Chickasaw, and Creek).

The nineteenth century saw a division in the land-use and agricultural system between the lower and upper Tennessee River Valley. During the Antebellum period land use and agriculture in the lower valley focused on large cotton plantations. In the postbellum period many large plantations were fragmented into smaller sharecropper farms. In the upper valley, where there were few large plantations, the agricultural system was mainly small to large farmsteads with a diversified agricultural system.

The predominant agricultural economy that ruled the valley throughout the nineteenth and early twentieth centuries was replaced with an industrialized economy by the mid-twentieth century. Industrialization was quickened by the creation of TVA, the promise of cheap hydroelectric power, and a relatively cheap labor force coming out of a post-Depression era economy.

This change has replaced the historic rural agrarian culture, particularly in the area of the eastern reservoirs. The historic populations of rural, agricultural economic livelihoods are being replaced by commuting and retiree developments. Rural and agricultural landscapes are being lost to residential development, lakefront development and marina development.

Table D7-01 Chronological Sequence Summary by Physiographic Region

<table>
<tr><th rowspan="2">Broad Period</th><th colspan="6">Physiographic Region</th></tr>
<tr><th>Blue Ridge</th><th>Valley and Ridge</th><th>Cumberland Plateau</th><th>Highland Rim</th><th>Nashville Basin</th><th>Coastal Plain</th></tr>
<tr><td>Historic</td><td>AD 1600 +</td><td>AD 1600 +</td><td>AD 1600 +</td><td>AD 1600 +</td><td>AD 1600 +</td><td>AD 1600 +</td></tr>
<tr><td>Late Mississippian</td><td>AD 1600
Qualla
AD 1300</td><td>AD 1600
Mouse Creek
Dallas
AD 1300</td><td>AD 1600
Henry Island
Hobbs Island
Kogers Island
AD 1300</td><td>AD 1600
AD 1300</td><td>AD 1600
AD 1200</td><td>AD 1600
Walls
AD 1200</td></tr>
<tr><td>Middle Mississippian</td><td rowspan="2">AD 1300
Pisgah
AD 900</td><td>AD 1300
Hiwassee Island
AD 1000</td><td rowspan="2">AD 1300
Langston
AD 900</td><td rowspan="2">AD 1300
Mason
AD 900</td><td>AD 1200
Dowd
AD 1050</td><td rowspan="2">AD 1200
AD 900</td></tr>
<tr><td>Early Mississippian</td><td>AD 1000
Martin Farm
AD 900</td><td>AD 1050
Spencer
Ad 900</td></tr>
<tr><td>Late Woodland</td><td>AD 900
Pee Dee/
AD 700</td><td>AD 900
Hamilton
AD 700</td><td>AD 1100
Flint River
AD 700</td><td>AD 900
Mason
AD 600</td><td>AD 900
Mason
AD 700</td><td>AD 1000
McKelvay
AD 500</td></tr>
<tr><td>Middle Woodland</td><td>AD 700
Connestee
100 BC</td><td>AD 700
Candy Creek
100 BC</td><td>AD 500
Copena
Colbert
300 BC</td><td>AD 600
Owl Hollow
McFarland
AD 100</td><td>AD 700
Owl Hollow
McFarland
AD 100</td><td>AD 500
Copena
Colbert
300 BC</td></tr>
<tr><td>Early Woodland</td><td>100 BC
Swannanoa
1000 BC</td><td>100 BC
Long Branch
Watts Bar
1000 BC</td><td></td><td>AD 100
Long Branch
Watts Bar
1100 BC</td><td>AD 100
Wade
700 BC</td><td>300 BC
Long Branch
Watts Bar
1100 BC</td></tr>
<tr><td>Gulf Formational</td><td></td><td></td><td>300 BC
Alexander
Bluff Creek
1200 BC</td><td></td><td></td><td>300 BC
Hardin
Bluff Creek
Perry
2000 BC</td></tr>
</table>

Table D7-01 Chronological Sequence Summary by Physiographic Region (continued)

Broad Period	Physiographic Region					
	Blue Ridge	Valley and Ridge	Cumberland Plateau	Highland Rim	Nashville Basin	Coastal Plain
Late Archaic	1000 BC 3000 BC	1000 BC 3000 BC	1200 BC 3000 BC	1100 BC 3000 BC	700 BC Wade Little Bear Creek Ledbetter 3000 BC	1000 BC Wade Ledbetter Benton 3000 BC
Middle Archaic	3000 BC Bifurcate Tradition Kirk 6000 BC	3000 BC Bifurcate Tradition Kirk 6000 BC	3000 BC Bifurcate Tradition Kirk 6000 BC	3000 BC Bifurcate Tradition Kirk 6000 BC	3000 BC Bifurcate Tradition Kirk 6000 BC	3000 BC Bifurcate Tradition Kirk 6000 BC
Early Archaic	6000 BC Kirk Dalton 8000 BC	6000 BC Kirk Dalton 8000 BC	6000 BC Kirk Dalton 8000 BC	6000 BC Kirk Dalton 8000 BC	6000 BC Kirk Dalton 8000 BC	6000 BC Kirk Dalton 8000 BC
Paleoindian	8000 BC Dalton Clovis 10,000 BC	8000 BC Dalton Clovis 10,000 BC	8000 BC Dalton Clovis 10,000 BC	8000 BC Dalton Clovis 10,000 BC	8000 BC Dalton Clovis 10,000 BC	8000 BC Dalton Clovis 10,000 BC

Appendix D8

Recreation

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The recreation study was designed to provide system-wide estimates of recreation user days sufficient for understanding use of the 35 projects included in the TVA ROS EIS. The following table shows the relationship between former codes used to identify policy alternatives and the names used in the main document.

RESERVOIR OPERATIONS POLICY ALTERNATIVES EVALUATED IN DETAIL

Alternative Name	Former Number Code
Reservoir Recreation A	2A
Reservoir Recreation B	3C
Summer Hydropower	4D
Equalized Summer/Winter Flood Risk	5A
Commercial Navigation	6A
Tailwater Recreation	7C
Tailwater Habitat	8A

Table D8-01 Recreation Use (User Days) at Mainstem Projects during August, September, and October

Project	Month	Total Recreation Use	Public Access Use			Commercial Use	Private Access Use
			Reservoir	Below Dam	Combined		
Chickamauga	August	141,738	14,590	4,876	19,466	51, 133	71, 139
	September	112,362	17,274	3,787	21,061	35,560	55,741
	October	64,102	9,789	1,895	11,684	21,801	30,618
Fort Loudoun	August	68,566	7,041	2,519	9,560	24,676	34,330
	September	54,499	8,336	2,103	10,439	17,161	26,900
	October	31,070	4,724	1,049	5,773	10,521	14,776
Guntersville	August	262,204	19,356	1,033	20,389	185,413	56,401
	September	249,289	20,144	1,986	22,130	179,276	47,883
	October	145,310	15,404	1,140	16,544	92,814	35,952
Kentucky	August	414,796	24,781	4,876	29,657	345,747	39,391
	September	279,687	33,552	3,787	37,340	210,914	31,433
	October	158,549	15,109	1,895	17,003	118,138	23,407
Nickajack	August	33,651	3,327	2,443	5,770	11,659	16,221
	September	26,797	3,939	2,040	5,979	8,108	12,710
	October	15,202	2,232	1,018	3,250	4,971	6,981
Pickwick	August	89,697	19,506	3,708	23,214	26,114	40,370
	September	81,279	20,966	3,123	24,090	25,625	31,565
	October	56,902	13,683	2,053	15,736	18,245	22,920
Tellico	August	52,465	9,421	0	9,421	32,151	10,892
	September	41,591	6,118	0	6,118	26,413	9,061
	October	26,418	6,324	0	6,324	13,401	6,692
Watts Bar	August	271,784	25,193	2,519	27,711	136,201	107,872
	September	188,833	25,345	2,103	27,448	90,911	70,474
	October	116,924	9,935	1,049	10,984	62,424	43,515
Wheeler	August	181,904	19,123	2,519	21,642	67,020	93,242
	September	144,412	22,641	2,103	24,744	46,608	73,060
	October	82,585	12,831	1,049	13,880	28,574	40,131

Table D8-01 Recreation Use (User Days) at Mainstem Projects during August, September, and October (continued)

Project	Month	Total Recreation Use	Public Access Use			Commercial Use	Private Access Use
			Reservoir	Below Dam	Combined		
Wilson	August	33,901	3,094	4,876	7,970	10,844	15,086
	September	26,813	3,663	3,787	7,450	7,541	11,821
	October	15,087	2,076	1,895	3,971	4,623	6,493
Mainstem Projects	**August**	**1,550,705**	**145,433**	**29,369**	**174,802**	**890,957**	**484,945**
	September	**1,205,563**	**161,979**	**24,820**	**186,799**	**648,118**	**370,646**
	October	**712,149**	**92,108**	**13,043**	**105,151**	**375,513**	**231,486**
All Projects	**August**	**3,123,864**	**257,151**	**93,296**	**350,447**	**1,916,286**	**857,131**
	September	**2,163,347**	**271,953**	**72,941**	**344,894**	**1,204,538**	**613,915**
	October	**1,282,124**	**141,457**	**37,126**	**178,583**	**723,732**	**379,808**

Table D8-02 Recreation Use (User Days) at Run-of-River Projects during August, September, and October

Project	Month	Total Recreation Use	Public Access Use			Commercial Use	Private Access Use
			Reservoir	Below Dam	Combined		
Apalachia	August	11,205	1,836	2,519	4,355	4,668	2,182
	September	8,009	1,314	2,103	3,417	3,167	1,425
	October	4,305	752	1,049	1,801	1,796	708
Fort Patrick Henry	August	5,442	1,146	2,519	3,664	1,400	378
	September	5,159	1,771	2,103	3,874	982	303
	October	3,020	1,148	1,049	2,197	614	209
Great Falls	August	29,845	4,063	2,443	6,507	15,626	7,713
	September	21,597	4,088	2,040	6,128	10,430	5,039
	October	12,893	1,602	1,018	2,620	7,162	3,111
Melton Hill	August	25,504	5,573	1,795	7,368	12,656	5,480
	September	24,638	9,713	1,645	11,358	8,877	4,403
	October	16,000	6,868	550	7,417	5,552	3,032
Ocoee #1	August	13,251	1,591	2,519	4,110	6,120	3,021
	September	9,763	1,601	2,103	3,704	4,085	1,973
	October	5,701	628	1,049	1,677	2,805	1,219
Ocoee #2	August	59,619	0	5,614	5,614	54,005	0
	September	30,300	0	3,392	3,392	26,908	0
	October	7,931	0	2,001	2,001	5,930	0
Ocoee #3	August	13,004	0	2,519	2,519	10,485	0
	September	5,606	0	1,467	1,467	4,139	0
	October	1,049	0	1,049	1,049	0	0
Wilbur	August	6,200	280	4,876	5,156	711	332
	September	4,687	200	3,787	3,987	483	217
	October	2,391	115	1,895	2,009	274	108
Run-of-River Projects	**August**	**164,070**	**14,489**	**24,804**	**39,293**	**105,671**	**19,105**
	September	**109,759**	**18,687**	**18,641**	**37,327**	**59,071**	**13,361**
	October	**53,291**	**11,112**	**9,660**	**20,772**	**24,132**	**8,387**
All Projects	**August**	**3,123,864**	**257,151**	**93,296**	**350,447**	**1,916,286**	**857,131**
	September	**2,163,347**	**271,953**	**72,941**	**344,894**	**1,204,538**	**613,915**
	October	**1,282,124**	**141,457**	**37,126**	**178,583**	**723,732**	**379,808**

Table D8-03 Recreation Use (User Days) at Tributary Projects during August, September, and October

Project	Month	Total Recreation Use	Public Access Use			Commercial Use	Private Access Use
			Reservoir	Below Dam	Combined		
Bear Creek	August	11,874	1,761	0	1,761	6,771	3,342
	September	8,475	1,771	0	1,771	4,520	2,183
	October	5,146	694	0	694	3,103	1,348
Blue Ridge	August	26,780	2,826	2,443	5,270	5,983	15,527
	September	21,237	4,025	2,040	6,065	5,313	9,859
	October	12,648	881	1,018	1,899	5,566	5,184
Boone	August	14,381	4,678	2,443	7,122	5,716	1,543
	September	14,521	7,232	2,040	9,272	4,010	1,239
	October	9,068	4,689	1,018	5,707	2,508	853
Cedars	August	18,953	2,810	0	2,810	10,808	5,335
	September	13,527	2,827	0	2,827	7,214	3,485
	October	8,214	1,108	0	1,108	4,954	2,152
Chatuge	August	106,121	7,305	2,443	9,748	54,480	41,893
	September	68,082	5,877	2,040	7,917	34,067	26,098
	October	38,071	919	1,018	1,937	19,519	16,616
Cherokee	August	190,296	4,556	2,519	7,075	143,760	39,461
	September	129,655	10,672	2,103	12,775	88,060	28,820
	October	82,912	1,835	1,049	2,884	60,030	19,998
Douglas	August	136,050	8,645	4,482	13,127	56,966	65,957
	September	75,984	3,551	2,393	5,943	31,881	38,160
	October	54,522	2,788	1,743	4,531	29,652	20,339
Fontana	August	68,015	13,862	2,443	16,306	35,239	16,469
	September	46,625	9,919	2,040	11,959	23,905	10,760
	October	25,596	5,675	1,018	6,693	13,557	5,346
Hiawassee	August	19,951	2,802	0	2,802	8,296	8,853
	September	11,164	2,076	0	2,076	3,079	6,009
	October	6,611	2,184	0	2,184	1,056	3,371
Little Bear Creek	August	10,276	1,524	0	1,524	5,860	2,892
	September	7,334	1,533	0	1,533	3,911	1,890
	October	4,453	601	0	601	2,686	1,167

Table D8-03 Recreation Use (User Days) at Tributary Projects during August, September, and October (continued)

Project	Month	Total Recreation Use	Public Access Use			Commercial Use	Private Access Use
			Reservoir	Below Dam	Combined		
Normandy	August	19,668	2,543	2,519	5,062	9,779	4,827
	September	14,342	2,558	2,103	4,661	6,528	3,153
	October	8,481	1,003	1,049	2,052	4,482	1,947
Norris	August	509,558	8,239	6,007	14,246	430,472	64,840
	September	240,875	8,092	3,692	11,784	184,257	44,834
	October	147,420	2,772	1,472	4,245	112,359	30,816
Nottely	August	25,758	3,457	2,443	5,900	13,295	6,562
	September	18,679	3,478	2,040	5,518	8,874	4,287
	October	11,122	1,363	1,018	2,381	6,094	2,647
South Holston	August	78,293	11,775	6,340	18,115	44,754	15,424
	September	56,667	8,882	4,783	13,665	33,173	9,830
	October	29,523	3,569	1,922	5,490	19,574	4,458
Tims Ford	August	117,694	10,776	2,519	13,295	58,258	46,141
	September	81,975	10,841	2,103	12,944	38,886	30,144
	October	50,613	4,250	1,049	5,299	26,701	18,613
Upper Bear Creek	August	26,496	3,555	2,519	6,074	13,673	6,749
	September	19,215	3,577	2,103	5,680	9,126	4,409
	October	11,440	1,402	1,049	2,451	6,267	2,722
Watauga	August	28,925	6,115	0	6,115	15,545	7,265
	September	19,668	4,376	0	4,376	10,545	4,747
	October	10,842	2,503	0	2,503	5,980	2,358
Tributary Projects	**August**	**1,409,089**	**97,229**	**39,122**	**136,351**	**919,658**	**353,080**
	September	**848,025**	**91,288**	**29,480**	**120,768**	**497,350**	**229,907**
	October	**516,684**	**38,237**	**14,423**	**52,661**	**324,087**	**139,936**
All Projects	**August**	**3,123,864**	**257,151**	**93,296**	**350,447**	**1,916,286**	**857,131**
	September	**2,163,347**	**271,953**	**72,941**	**344,894**	**1,204,538**	**613,915**
	October	**1,282,124**	**141,457**	**37,126**	**178,583**	**723,732**	**379,808**

Table D8-04 Recreation Use (User Days) at Mainstem Projects by Policy Alternative during August, September, and October

Project	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
Mainstem projects	Base	3,468,417	--	399,520	--	67,232	--	1,914,588	--	1,087,077	--
	2A	4,143,877	19.5%	409,028	2.4%	65,903	-2.0%	1,942,506	1.5%	1,726,440	58.8%
	3C	4,250,250	22.5%	414,407	3.7%	66,515	-1.1%	1,956,872	2.2%	1,812,456	66.7%
	4D	2,769,937	-20.1%	389,568	-2.5%	65,048	-3.2%	1,889,978	-1.3%	425,343	-60.9%
	5A	3,532,986	1.9%	398,070	-0.4%	62,500	-7.0%	1,895,678	-1.0%	1,176,737	8.2%
	6A	3,402,367	-1.9%	399,374	0.0%	67,178	-0.1%	1,913,943	0.0%	1,021,873	-6.0%
	7C	4,244,159	22.4%	413,699	3.5%	66,173	-1.6%	1,953,573	2.0%	1,810,714	66.6%
	8A	4,174,356	20.4%	414,304	3.7%	66,175	-1.6%	1,960,142	2.4%	1,733,734	59.5%
	Preferred	4,085,987	17.8%	406,309	1.7%	66,662	-0.8%	1,926,465	0.6%	1,686,551	55.1%
Chickamauga	Base	318,202	--	41,654	--	10,558	--	108,493	--	157,497	--
	2A	439,761	38.2%	43,478	4.4%	9,617	-8.9%	113,244	4.4%	273,423	73.6%
	3C	450,213	41.5%	44,482	6.8%	9,686	-8.3%	115,861	6.8%	280,185	77.9%
	4D	205,749	-35.3%	39,451	-5.3%	9,881	-6.4%	102,756	-5.3%	53,662	-65.9%
	5A	208,990	-34.3%	39,307	-5.6%	7,907	-25.1%	102,380	-5.6%	59,396	-62.3%
	6A	296,786	-6.7%	41,532	-0.3%	10,526	-0.3%	108,176	-0.3%	136,553	-13.3%
	7C	447,318	40.6%	43,993	5.6%	9,496	-10.1%	114,587	5.6%	279,243	77.3%
	8A	450,356	41.5%	44,555	7.0%	9,604	-9.0%	116,049	7.0%	280,149	77.9%
	Preferred	414,995	30.4%	42,526	2.1%	9,879	-6.4%	110,766	2.1%	251,823	59.9%
Fort Loudoun	Base	154,135	--	20,101	--	5,671	--	52,357	--	76,006	--
	2A	221,091	43.4%	21,963	9.3%	6,052	6.7%	57,206	9.3%	135,869	78.8%
	3C	218,486	41.7%	23,103	14.9%	6,348	11.9%	60,175	14.9%	128,860	69.5%
	4D	95,938	-37.8%	18,791	-6.5%	5,346	-5.7%	48,943	-6.5%	22,858	-69.9%
	5A	178,726	16.0%	21,582	7.4%	5,884	3.7%	56,215	7.4%	95,046	25.1%
	6A	147,096	-4.6%	20,194	0.5%	5,687	0.3%	52,598	0.5%	68,617	-9.7%
	7C	219,678	42.5%	23,268	15.8%	6,384	12.6%	60,604	15.8%	129,422	70.3%
	8A	218,462	41.7%	23,282	15.8%	6,400	12.8%	60,641	15.8%	128,140	68.6%
	Preferred	218,144	-31.4%	21,410	6.5%	5,932	4.6%	55,764	6.5%	135,039	77.7%

Table D8-04 Recreation Use (User Days) at Mainstem Projects by Policy Alternative during August, September, and October (continued)

Project	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
Guntersville	Base	656,803	--	54,905	--	4,159	--	457,504	--	140,236	--
	2A	722,100	9.9%	55,449	1.0%	4,230	1.7%	462,040	1.0%	200,381	42.9%
	3C	745,326	13.5%	55,800	1.6%	4,287	3.1%	464,966	1.6%	220,272	57.1%
	4D	566,337	-13.8%	53,802	-2.0%	4,020	-3.3%	448,315	-2.0%	60,199	-57.1%
	5A	748,648	14.0%	56,154	2.3%	4,309	3.6%	467,916	2.3%	220,268	57.1%
	6A	656,723	0.0%	54,896	0.0%	4,158	0.0%	457,433	0.0%	140,236	0.0%
	7C	746,318	13.6%	55,907	1.8%	4,289	3.1%	465,854	1.8%	220,268	57.1%
	8A	721,010	9.8%	55,333	0.8%	4,222	1.5%	461,073	0.8%	200,381	42.9%
	Preferred	748,977	14.0%	56,189	2.3%	4,314	3.7%	468,206	2.3%	220,268	57.1%
Kentucky	Base	853,031	--	73,442	--	10,558	--	674,800	--	94,231	--
	2A	891,972	4.6%	72,465	-1.3%	10,290	-2.5%	665,823	-1.3%	143,395	52.2%
	3C	893,925	4.8%	71,669	-2.4%	10,062	-4.7%	658,510	-2.4%	153,684	63.1%
	4D	830,339	-2.7%	75,593	2.9%	11,069	4.8%	694,565	2.9%	49,113	-47.9%
	5A	881,862	3.4%	71,263	-3.0%	10,014	-5.2%	654,784	-3.0%	145,801	54.7%
	6A	853,172	0.0%	73,456	0.0%	10,559	0.0%	674,926	0.0%	94,231	0.0%
	7C	893,144	4.7%	71,593	-2.5%	10,055	-4.8%	657,814	-2.5%	153,682	63.1%
	8A	891,988	4.6%	72,466	-1.3%	10,291	-2.5%	665,836	-1.3%	143,395	52.2%
	Preferred	828,914	-2.8%	71,126	-3.2%	10,032	-5.0%	653,524	-3.2%	94,231	0.0%
Nickajack	Base	75,650	--	9,498	--	5,501	--	24,739	--	35,913	--
	2A	103,093	36.3%	9,914	4.4%	5,011	-8.9%	25,822	4.4%	62,346	73.6%
	3C	105,496	39.5%	10,143	6.8%	5,046	-8.3%	26,419	6.8%	63,888	77.9%
	4D	49,810	-34.2%	8,996	-5.3%	5,148	-6.4%	23,430	-5.3%	12,236	-65.9%
	5A	49,971	-33.9%	8,963	-5.6%	4,120	-25.1%	23,345	-5.6%	13,543	-62.3%
	6A	70,758	-6.5%	9,470	-0.3%	5,485	-0.3%	24,666	-0.3%	31,137	-13.3%
	7C	104,780	38.5%	10,031	5.6%	4,947	-10.1%	26,128	5.6%	63,673	77.3%
	8A	105,505	39.5%	10,159	7.0%	5,004	-9.0%	26,462	7.0%	63,880	77.9%
	Preferred	97,522	28.9%	9,697	2.1%	5,148	-6.4%	25,257	2.1%	57,421	59.9%

Table D8-04 Recreation Use (User Days) at Mainstem Projects by Policy Alternative during August, September, and October (continued)

Project	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
Pickwick	Base	227,878	--	54,155	--	8,884	--	69,984	--	94,855	--
	2A	269,942	18.5%	54,692	1.0%	9,035	1.7%	70,678	1.0%	135,537	42.9%
	3C	284,312	24.8%	55,039	1.6%	9,157	3.1%	71,125	1.6%	148,992	57.1%
	4D	170,952	-25.0%	53,068	-2.0%	8,588	-3.3%	68,578	-2.0%	40,718	-57.1%
	5A	285,158	25.1%	55,388	2.3%	9,205	3.6%	71,577	2.3%	148,989	57.1%
	6A	227,857	0.0%	54,147	0.0%	8,882	0.0%	69,973	0.0%	94,855	0.0%
	7C	284,556	24.9%	55,144	1.8%	9,162	3.1%	71,261	1.8%	148,989	57.1%
	8A	269,665	18.3%	54,578	0.8%	9,019	1.5%	70,530	0.8%	135,537	42.9%
	Preferred	285,247	25.2%	55,422	2.3%	9,215	3.7%	71,621	2.3%	148,989	57.1%
Tellico	Base	120,474	--	21,864	--	0	--	71,965	--	26,645	--
	2A	150,151	24.6%	23,889	9.3%	0	--	78,631	9.3%	47,631	78.8%
	3C	153,015	27.0%	25,129	14.9%	0	--	82,712	14.9%	45,174	69.5%
	4D	95,725	-20.5%	20,438	-6.5%	0	--	67,273	-6.5%	8,013	-69.9%
	5A	134,062	11.3%	23,475	7.4%	0	--	77,268	7.4%	33,320	25.1%
	6A	118,317	-1.8%	21,965	0.5%	0	--	72,298	0.5%	24,055	-9.7%
	7C	153,980	27.8%	25,308	15.8%	0	--	83,301	15.8%	45,371	70.3%
	8A	153,596	27.5%	25,323	15.8%	0	--	83,352	15.8%	44,921	68.6%
	Preferred	147,276	22.2%	23,287	6.5%	0	--	76,649	6.5%	47,340	77.7%
Watts Bar	Base	577,541	--	60,472	--	5,671	--	289,536	--	221,861	--
	2A	755,662	30.8%	63,120	4.4%	5,166	-8.9%	302,214	4.4%	385,162	73.6%
	3C	773,666	34.0%	64,579	6.8%	5,203	-8.3%	309,198	6.8%	394,687	77.9%
	4D	412,398	-28.6%	57,274	-5.3%	5,308	-6.4%	274,225	-5.3%	75,591	-65.9%
	5A	418,204	-27.6%	57,065	-5.6%	4,247	-25.1%	273,223	-5.6%	83,668	-62.3%
	6A	546,995	-5.3%	60,295	-0.3%	5,654	-0.3%	288,689	-0.3%	192,357	-13.3%
	7C	768,127	33.0%	63,869	5.6%	5,101	-10.1%	305,798	5.6%	393,360	77.3%
	8A	774,179	34.0%	64,684	7.0%	5,159	-9.0%	309,701	7.0%	394,636	77.9%
	Preferred	717,383	24.2%	61,739	2.1%	5,307	-6.4%	295,603	2.1%	354,734	59.9%

Table D8-04 Recreation Use (User Days) at Mainstem Projects by Policy Alternative during August, September, and October (continued)

Project	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
Wheeler	Base	408,902	--	54,596	--	5,671	--	142,202	--	206,433	--
	2A	499,486	22.2%	55,137	1.0%	5,767	1.7%	143,612	1.0%	294,970	42.9%
	3C	530,104	29.6%	55,486	1.6%	5,845	3.1%	144,522	1.6%	324,251	57.1%
	4D	286,943	-29.8%	53,499	-2.0%	5,482	-3.3%	139,346	-2.0%	88,615	-57.1%
	5A	531,397	30.0%	55,838	2.3%	5,876	3.6%	145,439	2.3%	324,244	57.1%
	6A	408,870	0.0%	54,587	0.0%	5,670	0.0%	142,180	0.0%	206,433	0.0%
	7C	530,483	29.7%	55,592	1.8%	5,849	3.1%	144,798	1.8%	324,244	57.1%
	8A	499,061	22.0%	55,022	0.8%	5,758	1.5%	143,312	0.8%	294,970	42.9%
	Preferred	531,528	30.0%	55,873	2.3%	5,883	3.7%	145,529	2.3%	324,244	57.1%
Wilson	Base	75,800	--	8,834	--	10,558	--	23,008	--	33,401	--
	2A	90,620	19.6%	8,921	1.0%	10,737	1.7%	23,236	1.0%	47,726	42.9%
	3C	95,706	26.3%	8,978	1.6%	10,882	3.1%	23,383	1.6%	52,463	57.1%
	4D	55,746	-26.5%	8,656	-2.0%	10,206	-3.3%	22,546	-2.0%	14,338	-57.1%
	5A	95,968	26.6%	9,035	2.3%	10,939	3.6%	23,532	2.3%	52,462	57.1%
	6A	75,793	0.0%	8,832	0.0%	10,556	0.0%	23,005	0.0%	33,401	0.0%
	7C	95,774	26.4%	8,995	1.8%	10,889	3.1%	23,428	1.8%	52,462	57.1%
	8A	90,535	19.4%	8,902	0.8%	10,719	1.5%	23,188	0.8%	47,726	42.9%
	Preferred	96,001	26.6%	9,040	2.3%	10,952	3.7%	23,546	2.3%	52,462	57.1%

Note: Base = Base Case

[1] Alt. = Alternative. The chart to the right shows the relationship of the former codes used for policy alternatives and the names used in the main document.

[2] Percentages calculated relative to the August through October use numbers for the Base Case. Use numbers consider both internal and external recreation users.

Alternative Name	Former Number Code
Reservoir Recreation A	2A
Reservoir Recreation B	3C
Summer Hydropower	4D
Equalized Summer/Winter Flood Risk	5A
Commercial Navigation	6A
Tailwater Recreation	7C
Tailwater Habitat	8A

Table D8-05 Recreation Use (User Days) at Run-of-River Projects by Policy Alternative during August, September, and October

Project	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
Run-of-river projects	Base	327,120	--	44,288	--	53,105	--	188,874	--	40,853	--
	2A	361,268	10.4%	46,941	6.0%	53,178	0.1%	192,845	2.1%	68,304	67.2%
	3C	365,263	11.7%	48,177	8.8%	52,907	-0.4%	194,923	3.2%	69,257	69.5%
	4D	278,848	-14.8%	42,754	-3.5%	47,978	-9.7%	171,595	-9.1%	16,522	-59.6%
	5A	335,404	2.5%	45,960	3.8%	51,609	-2.8%	190,346	0.8%	47,490	16.2%
	6A	324,532	-0.8%	44,349	0.1%	53,021	-0.2%	188,965	0.0%	38,197	-6.5%
	7C	364,526	11.4%	48,130	8.7%	52,374	-1.4%	194,765	3.1%	69,257	69.5%
	8A	342,995	4.9%	48,159	8.7%	47,507	-10.5%	179,935	-4.7%	67,393	65.0%
	Preferred	347,234	6.1%	45,734	3.3%	52,615	-0.9%	190,429	0.8%	58,456	43.1%
Apalachia	Base	23,519	--	3,902	--	5,671	--	9,630	--	4,315	--
	2A	26,782	13.9%	4,073	4.4%	5,166	-8.9%	10,052	4.4%	7,491	73.6%
	3C	27,330	16.2%	4,167	6.8%	5,203	-8.3%	10,284	6.8%	7,677	77.9%
	4D	19,595	-16.7%	3,696	-5.3%	5,308	-6.4%	9,121	-5.3%	1,470	-65.9%
	5A	18,644	-20.7%	3,682	-5.6%	4,247	-25.1%	9,088	-5.6%	1,627	-62.3%
	6A	22,888	-2.7%	3,891	-0.3%	5,654	-0.3%	9,602	-0.3%	3,741	-13.3%
	7C	27,044	15.0%	4,121	5.6%	5,101	-10.1%	10,171	5.6%	7,651	77.3%
	8A	27,309	16.1%	4,174	7.0%	5,159	-9.0%	10,301	7.0%	7,676	77.9%
	Preferred	26,022	10.6%	3,984	2.1%	5,307	-6.4%	9,832	2.1%	6,899	59.9%
Fort Patrick Henry	Base	13,622	--	4,065	--	5,671	--	2,996	--	890	--
	2A	14,909	9.5%	4,216	3.7%	5,975	5.4%	3,107	3.7%	1,612	81.1%
	3C	14,243	4.6%	3,967	-2.4%	5,764	1.6%	2,924	-2.4%	1,588	78.4%
	4D	13,916	2.2%	4,342	6.8%	5,923	4.4%	3,200	6.8%	451	-49.4%
	5A	15,319	12.5%	4,374	7.6%	6,097	7.5%	3,223	7.6%	1,625	82.6%
	6A	13,533	-0.7%	4,030	-0.8%	5,642	-0.5%	2,970	-0.8%	890	0.0%
	7C	13,879	1.9%	3,840	-5.5%	5,638	-0.6%	2,830	-5.5%	1,570	76.4%
	8A	14,112	3.6%	3,920	-3.6%	5,718	0.8%	2,889	-3.6%	1,585	78.0%
	Preferred	14,601	7.2%	4,117	1.3%	5,832	2.8%	3,034	1.3%	1,619	81.9%

Table D8-05 Recreation Use (User Days) at Run-of-River Projects by Policy Alternative during August, September, and October (continued)

Project	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
Great Falls	Base	64,335	--	9,753	--	5,501	--	33,218	--	15,863	--
	2A	72,953	13.4%	9,843	0.9%	5,448	-1.0%	33,524	0.9%	24,139	52.2%
	3C	75,084	16.7%	9,922	1.7%	5,500	0.0%	33,791	1.7%	25,871	63.1%
	4D	56,888	-11.6%	9,754	0.0%	5,645	2.6%	33,221	0.0%	8,267	-47.9%
	5A	73,533	14.3%	9,874	1.2%	5,484	-0.3%	33,631	1.2%	24,544	54.7%
	6A	64,448	0.2%	9,774	0.2%	5,523	0.4%	33,288	0.2%	15,863	0.0%
	7C	75,121	16.8%	9,929	1.8%	5,504	0.1%	33,817	1.8%	25,870	63.1%
	8A	72,403	12.5%	9,748	-0.1%	5,316	-3.4%	33,200	-0.1%	24,139	52.2%
	Preferred	62,976	-2.1%	9,536	-2.2%	5,098	-7.3%	32,479	-2.2%	15,863	0.0%
Melton Hill	Base	66,142	--	22,153	--	3,990	--	27,085	--	12,915	--
	2A	81,143	22.7%	24,205	9.3%	4,258	6.7%	29,594	9.3%	23,086	78.8%
	3C	82,952	25.4%	25,461	14.9%	4,465	11.9%	31,130	14.9%	21,895	69.5%
	4D	53,672	-18.9%	20,709	-6.5%	3,761	-5.7%	25,319	-6.5%	3,884	-69.9%
	5A	73,155	10.6%	23,785	7.4%	4,139	3.7%	29,081	7.4%	16,150	25.1%
	6A	65,125	-1.5%	22,255	0.5%	4,001	0.3%	27,210	0.5%	11,659	-9.7%
	7C	83,476	26.2%	25,643	15.8%	4,491	12.6%	31,351	15.8%	21,991	70.3%
	8A	83,304	25.9%	25,658	15.8%	4,502	12.8%	31,370	15.8%	21,773	68.6%
	Preferred	79,561	20.3%	23,595	6.5%	4,173	4.6%	28,848	6.5%	22,945	77.7%
Ocoee #1	Base	28,715	--	3,820	--	5,671	--	13,010	--	6,213	--
	2A	33,519	16.7%	3,987	4.4%	5,166	-8.9%	13,580	4.4%	10,786	73.6%
	3C	34,229	19.2%	4,079	6.8%	5,203	-8.3%	13,894	6.8%	11,053	77.9%
	4D	23,365	-18.6%	3,618	-5.3%	5,308	-6.4%	12,322	-5.3%	2,117	-65.9%
	5A	22,472	-21.7%	3,605	-5.6%	4,247	-25.1%	12,277	-5.6%	2,343	-62.3%
	6A	27,822	-3.1%	3,809	-0.3%	5,654	-0.3%	12,972	-0.3%	5,387	-13.3%
	7C	33,892	18.0%	4,035	5.6%	5,101	-10.1%	13,741	5.6%	11,015	77.3%
	8A	34,212	19.1%	4,086	7.0%	5,159	-9.0%	13,917	7.0%	11,051	77.9%
	Preferred	32,424	12.9%	3,900	2.1%	5,307	-6.4%	13,283	2.1%	9,934	59.9%

Table D8-05 Recreation Use (User Days) at Run-of-River Projects by Policy Alternative during August, September, and October (continued)

Project	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
Ocoee #2	Base	97,850	--	0	--	11,007	--	86,843	--	0	--
	2A	97,850	0.0%	0	--	11,007	0.0%	86,843	0.0%	0	--
	3C	97,850	0.0%	0	--	11,007	0.0%	86,843	0.0%	0	--
	4D	97,850	0.0%	0	--	11,007	0.0%	86,843	0.0%	0	--
	5A	97,850	0.0%	0	--	11,007	0.0%	86,843	0.0%	0	--
	6A	97,850	0.0%	0	--	11,007	0.0%	86,843	0.0%	0	--
	7C	97,850	0.0%	0	--	11,007	0.0%	86,843	0.0%	0	--
	8A	97,850	0.0%	0	--	11,007	0.0%	86,843	0.0%	0	--
	Preferred	97,850	0.0%	0	--	11,007	0.0%	86,843	0.0%	0	--
Ocoee #3	Base	19,659	--	0	--	5,035	--	14,624	--	0	--
	2A	19,659	0.0%	0	--	5,035	0.0%	14,624	0.0%	0	--
	3C	19,659	0.0%	0	--	5,035	0.0%	14,624	0.0%	0	--
	4D	0	-100.0%	0	--	0	-100.0%	0	-100.0%	0	--
	5A	19,659	0.0%	0	--	5,035	0.0%	14,624	0.0%	0	--
	6A	19,659	0.0%	0	--	5,035	0.0%	14,624	0.0%	0	--
	7C	19,659	0.0%	0	--	5,035	0.0%	14,624	0.0%	0	--
	8A	0	-100.0%	0	--	0	-100.0%	0	-100.0%	0	--
	Preferred	19,659	0.0%	0	--	5,035	0.0%	14,624	0.0%	0	--
Wilbur	Base	13,278	--	595	--	10,558	--	1,467	--	658	--
	2A	14,453	8.8%	617	3.7%	11,123	5.4%	1,522	3.7%	1,191	81.1%
	3C	13,916	4.8%	580	-2.4%	10,730	1.6%	1,432	-2.4%	1,173	78.4%
	4D	13,563	2.1%	635	6.8%	11,027	4.4%	1,568	6.8%	333	-49.4%
	5A	14,771	11.2%	640	7.6%	11,351	7.5%	1,579	7.6%	1,201	82.6%
	6A	13,206	-0.5%	590	-0.8%	10,504	-0.5%	1,455	-0.8%	658	0.0%
	7C	13,605	2.5%	562	-5.5%	10,497	-0.6%	1,386	-5.5%	1,160	76.4%
	8A	13,805	4.0%	573	-3.6%	10,646	0.8%	1,415	-3.6%	1,170	78.0%
	Preferred	14,141	6.5%	602	1.3%	10,857	2.8%	1,486	1.3%	1,196	81.9%

Table D8-05 Recreation Use (User Days) at Run-of-River Projects by Policy Alternative during August, September, and October (continued)

Note: Base = Base Case.

[1] Alt. = Alternative. The chart to the right shows the relationship of the former codes used for policy alternatives and the names used in the main document.

[2] Percentages calculated relative to the August through October use numbers for the Base Case. Use numbers consider both internal and external recreation users.

Alternative Name	Former Number Code
Reservoir Recreation A	2A
Reservoir Recreation B	3C
Summer Hydropower	4D
Equalized Summer/Winter Flood Risk	5A
Commercial Navigation	6A
Tailwater Recreation	7C
Tailwater Habitat	8A

Table D8-06 Recreation Use (User Days) at Tributary Projects by Policy Alternative during August, September, and October

Project	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
Tributary projects	Base	2,773,798	--	226,754	--	83,025	--	1,741,095	--	722,924	--
	2A	3,402,655	22.7%	236,192	4.2%	85,243	2.7%	1,862,435	7.0%	1,218,785	68.6%
	3C	3,498,529	26.1%	248,539	9.6%	89,777	8.1%	1,952,155	12.1%	1,208,058	67.1%
	4D	2,251,311	-18.8%	223,598	-1.4%	80,239	-3.4%	1,663,652	-4.4%	283,822	-60.7%
	5A	2,945,333	6.2%	223,503	-1.4%	78,240	-5.8%	1,805,413	3.7%	838,177	15.9%
	6A	2,722,470	-1.9%	226,222	-0.2%	82,905	-0.1%	1,744,294	0.2%	669,049	-7.5%
	7C	3,506,354	26.4%	248,533	9.6%	89,642	8.0%	1,959,364	12.5%	1,208,815	67.2%
	8A	3,492,120	25.9%	250,298	10.4%	89,987	8.4%	1,964,151	12.8%	1,187,684	64.3%
	Preferred	3,302,700	19.1%	237,481	4.7%	85,309	2.8%	1,834,088	5.3%	1,145,822	58.5%
Bear Creek	Base	25,495	--	4,226	--	0	--	14,395	--	6,874	--
	2A	28,628	12.3%	4,268	1.0%	0	--	14,537	1.0%	9,822	42.9%
	3C	29,722	16.6%	4,295	1.6%	0	--	14,629	1.6%	10,797	57.1%
	4D	21,198	-16.9%	4,142	-2.0%	0	--	14,105	-2.0%	2,951	-57.1%
	5A	29,841	17.0%	4,323	2.3%	0	--	14,722	2.3%	10,797	57.1%
	6A	25,492	0.0%	4,226	0.0%	0	--	14,392	0.0%	6,874	0.0%
	7C	29,758	16.7%	4,304	1.8%	0	--	14,657	1.8%	10,797	57.1%
	8A	28,588	12.1%	4,259	0.8%	0	--	14,507	0.8%	9,822	42.9%
	Preferred	29,853	17.1%	4,325	2.3%	0	--	14,731	2.3%	10,797	57.1%
Blue Ridge	Base	60,665	--	7,732	--	5,501	--	16,862	--	30,570	--
	2A	83,753	38.1%	8,071	4.4%	5,011	-8.9%	17,600	4.4%	53,072	73.6%
	3C	85,695	41.3%	8,257	6.8%	5,046	-8.3%	18,007	6.8%	54,384	77.9%
	4D	38,858	-35.9%	7,323	-5.3%	5,148	-6.4%	15,970	-5.3%	10,416	-65.9%
	5A	38,857	-35.9%	7,297	-5.6%	4,120	-25.1%	15,912	-5.6%	11,529	-62.3%
	6A	56,512	-6.8%	7,710	-0.3%	5,485	-0.3%	16,812	-0.3%	26,505	-13.3%
	7C	85,124	40.3%	8,167	5.6%	4,947	-10.1%	17,809	5.6%	54,201	77.3%
	8A	85,688	41.2%	8,271	7.0%	5,004	-9.0%	18,036	7.0%	54,377	77.9%
	Preferred	79,136	30.4%	7,894	2.1%	5,148	-6.4%	17,215	2.1%	48,879	59.9%

Table D8-06 Recreation Use (User Days) at Tributary Projects by Policy Alternative during August, September, and October (continued)

Project	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
Boone	Base	37,970	--	16,600	--	5,501	--	12,234	--	3,635	--
	2A	42,283	11.4%	17,217	3.7%	5,796	5.4%	12,689	3.7%	6,582	81.1%
	3C	40,220	5.9%	16,202	-2.4%	5,591	1.6%	11,941	-2.4%	6,486	78.4%
	4D	38,389	1.1%	17,734	6.8%	5,745	4.4%	13,069	6.8%	1,840	-49.4%
	5A	43,577	14.8%	17,862	7.6%	5,914	7.5%	13,164	7.6%	6,637	82.6%
	6A	37,697	-0.7%	16,459	-0.8%	5,473	-0.5%	12,130	-0.8%	3,635	0.0%
	7C	39,123	3.0%	15,683	-5.5%	5,469	-0.6%	11,558	-5.5%	6,412	76.4%
	8A	39,825	4.9%	16,009	-3.6%	5,547	0.8%	11,798	-3.6%	6,471	78.0%
	Preferred	41,470	9.2%	16,812	1.3%	5,657	2.8%	12,390	1.3%	6,611	81.9%
Cedar Creek	Base	40,694	--	6,746	--	0	--	22,976	--	10,972	--
	2A	45,694	12.3%	6,813	1.0%	0	--	23,204	1.0%	15,677	42.9%
	3C	47,440	16.6%	6,856	1.6%	0	--	23,351	1.6%	17,233	57.1%
	4D	33,835	-16.9%	6,611	-2.0%	0	--	22,514	-2.0%	4,710	-57.1%
	5A	47,632	17.0%	6,900	2.3%	0	--	23,499	2.3%	17,233	57.1%
	6A	40,689	0.0%	6,745	0.0%	0	--	22,972	0.0%	10,972	0.0%
	7C	47,498	16.7%	6,869	1.8%	0	--	23,395	1.8%	17,233	57.1%
	8A	45,631	12.1%	6,799	0.8%	0	--	23,155	0.8%	15,677	42.9%
	Preferred	47,650	17.1%	6,904	2.3%	0	--	23,513	2.3%	17,233	57.1%
Chatuge	Base	212,275	--	14,101	--	5,501	--	108,066	--	84,607	--
	2A	279,409	31.6%	14,718	4.4%	5,011	-8.9%	112,798	4.4%	146,881	73.6%
	3C	286,024	34.7%	15,059	6.8%	5,046	-8.3%	115,405	6.8%	150,514	77.9%
	4D	149,682	-29.5%	13,355	-5.3%	5,148	-6.4%	102,351	-5.3%	28,827	-65.9%
	5A	151,311	-28.7%	13,307	-5.6%	4,120	-25.1%	101,978	-5.6%	31,907	-62.3%
	6A	200,649	-5.5%	14,060	-0.3%	5,485	-0.3%	107,750	-0.3%	73,355	-13.3%
	7C	283,984	33.8%	14,893	5.6%	4,947	-10.1%	114,136	5.6%	150,008	77.3%
	8A	286,174	34.8%	15,083	7.0%	5,004	-9.0%	115,592	7.0%	150,494	77.9%
	Preferred	265,152	24.9%	14,396	2.1%	5,148	-6.4%	110,331	2.1%	135,278	59.9%

Table D8-06 Recreation Use (User Days) at Tributary Projects by Policy Alternative during August, September, and October (continued)

Project	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
Cherokee	Base	402,863	--	17,063	--	5,671	--	291,849	--	88,279	--
	2A	501,387	24.5%	18,644	9.3%	6,052	6.7%	318,881	9.3%	157,809	78.8%
	3C	511,059	26.9%	19,611	14.9%	6,348	11.9%	335,432	14.9%	149,668	69.5%
	4D	320,666	-20.4%	15,951	-6.5%	5,346	-5.7%	272,820	-6.5%	26,550	-69.9%
	5A	447,951	11.2%	18,320	7.4%	5,884	3.7%	313,353	7.4%	110,394	25.1%
	6A	395,722	-1.8%	17,142	0.5%	5,687	0.3%	293,196	0.5%	79,697	-9.7%
	7C	514,278	27.7%	19,751	15.8%	6,384	12.6%	337,821	15.8%	150,322	70.3%
	8A	513,020	27.3%	19,763	15.8%	6,400	12.8%	338,026	15.8%	148,832	68.6%
	Preferred	491,794	22.1%	18,174	6.5%	5,932	4.6%	310,843	6.5%	156,845	77.7%
Douglas	Base	266,556	--	14,983	--	8,619	--	118,499	--	124,455	--
	2A	377,522	41.6%	16,371	9.3%	9,198	6.7%	129,475	9.3%	222,478	78.8%
	3C	374,063	40.3%	17,221	14.9%	9,646	11.9%	136,195	14.9%	211,001	69.5%
	4D	170,332	-36.1%	14,006	-6.5%	8,124	-5.7%	110,773	-6.5%	37,430	-69.9%
	5A	307,891	15.5%	16,087	7.4%	8,941	3.7%	127,230	7.4%	155,632	25.1%
	6A	255,097	-4.3%	15,052	0.5%	8,642	0.3%	119,046	0.5%	112,356	-9.7%
	7C	376,133	41.1%	17,343	15.8%	9,702	12.6%	137,165	15.8%	211,922	70.3%
	8A	374,149	40.4%	17,354	15.8%	9,726	12.8%	137,248	15.8%	209,822	68.6%
	Preferred	372,303	39.7%	15,958	6.5%	9,014	4.6%	126,211	6.5%	221,119	77.7%
Fontana	Base	140,236	--	29,457	--	5,501	--	72,702	--	32,576	--
	2A	143,130	2.1%	30,004	1.9%	6,501	18.2%	74,050	1.9%	32,576	--
	3C	186,390	32.9%	41,437	40.7%	10,106	83.7%	102,270	40.7%	32,576	--
	4D	135,333	-3.5%	28,389	-3.6%	4,305	-21.8%	70,065	-3.6%	32,576	--
	5A	102,606	-26.8%	19,517	-33.7%	2,343	-57.4%	48,170	-33.7%	32,576	--
	6A	139,218	-0.7%	29,189	-0.9%	5,411	-1.6%	72,041	-0.9%	32,576	--
	7C	192,416	37.2%	43,061	46.2%	10,501	90.9%	106,278	46.2%	32,576	--
	8A	196,236	39.9%	44,070	49.6%	10,825	96.8%	108,766	49.6%	32,576	--
	Preferred	163,663	16.7%	35,558	20.7%	7,772	41.3%	87,758	20.7%	32,576	0.0%

Table D8-06 Recreation Use (User Days) at Tributary Projects by Policy Alternative during August, September, and October (continued)

Project	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
Hiwassee	Base	37,726	--	7,062	--	0	--	12,431	--	18,233	--
	2A	52,000	37.8%	7,371	4.4%	0	--	12,976	4.4%	31,653	73.6%
	3C	53,253	41.2%	7,542	6.8%	0	--	13,276	6.8%	32,436	77.9%
	4D	24,675	-34.6%	6,689	-5.3%	0	--	11,774	-5.3%	6,212	-65.9%
	5A	25,271	-33.0%	6,664	-5.6%	0	--	11,731	-5.6%	6,876	-62.3%
	6A	35,245	-6.6%	7,041	-0.3%	0	--	12,395	-0.3%	15,808	-13.3%
	7C	52,915	40.3%	7,459	5.6%	0	--	13,130	5.6%	32,327	77.3%
	8A	53,283	41.2%	7,554	7.0%	0	--	13,297	7.0%	32,432	77.9%
	Preferred	49,054	30.0%	7,210	2.1%	0	--	12,692	2.1%	29,152	59.9%
Little Bear Creek	Base	22,063	--	3,657	--	0	--	12,457	--	5,948	--
	2A	24,774	12.3%	3,694	1.0%	0	--	12,580	1.0%	8,500	42.9%
	3C	25,721	16.6%	3,717	1.6%	0	--	12,660	1.6%	9,343	57.1%
	4D	18,344	-16.9%	3,584	-2.0%	0	--	12,207	-2.0%	2,553	-57.1%
	5A	25,824	17.0%	3,741	2.3%	0	--	12,740	2.3%	9,343	57.1%
	6A	22,060	0.0%	3,657	0.0%	0	--	12,455	0.0%	5,948	0.0%
	7C	25,752	16.7%	3,724	1.8%	0	--	12,684	1.8%	9,343	57.1%
	8A	24,740	12.1%	3,686	0.8%	0	--	12,554	0.8%	8,500	42.9%
	Preferred	25,835	17.1%	3,743	2.3%	0	--	12,748	2.3%	9,343	57.1%
Normandy	Base	42,492	--	6,104	--	5,671	--	20,789	--	9,927	--
	2A	47,863	12.6%	6,160	0.9%	5,616	-1.0%	20,980	0.9%	15,107	52.2%
	3C	49,218	15.8%	6,209	1.7%	5,670	0.0%	21,148	1.7%	16,191	63.1%
	4D	37,889	-10.8%	6,105	0.0%	5,820	2.6%	20,791	0.0%	5,174	-47.9%
	5A	48,241	13.5%	6,180	1.2%	5,654	-0.3%	21,047	1.2%	15,360	54.7%
	6A	42,571	0.2%	6,117	0.2%	5,694	0.4%	20,833	0.2%	9,927	0.0%
	7C	49,243	15.9%	6,214	1.8%	5,675	0.1%	21,164	1.8%	16,191	63.1%
	8A	47,465	11.7%	6,101	-0.1%	5,480	-3.4%	20,778	-0.1%	15,107	52.2%
	Preferred	41,478	-2.4%	5,968	-2.2%	5,256	-7.3%	20,327	-2.2%	9,927	0.0%

Table D8-06 Recreation Use (User Days) at Tributary Projects by Policy Alternative during August, September, and October (continued)

Project	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
Norris	Base	897,853	--	19,103	--	11,172	--	727,088	--	140,490	--
	2A	1,078,372	20.1%	20,872	9.3%	11,922	6.7%	794,434	9.3%	251,144	78.8%
	3C	1,108,314	23.4%	21,955	14.9%	12,504	11.9%	835,668	14.9%	238,187	69.5%
	4D	750,320	-16.4%	17,857	-6.5%	10,530	-5.7%	679,680	-6.5%	42,252	-69.9%
	5A	988,447	10.1%	20,510	7.4%	11,590	3.7%	780,662	7.4%	175,685	25.1%
	6A	887,670	-1.1%	19,191	0.5%	11,202	0.3%	730,444	0.5%	126,833	-9.7%
	7C	1,115,534	24.2%	22,112	15.8%	12,576	12.6%	841,619	15.8%	239,227	70.3%
	8A	1,113,717	24.0%	22,125	15.8%	12,607	12.8%	842,129	15.8%	236,856	68.6%
	Preferred	1,056,048	17.6%	20,346	6.5%	11,685	4.6%	774,409	6.5%	249,609	77.7%
Nottely	Base	55,559	--	8,298	--	5,501	--	28,263	--	13,496	--
	2A	66,604	19.9%	8,662	4.4%	5,011	-8.9%	29,501	4.4%	23,430	73.6%
	3C	68,101	22.6%	8,862	6.8%	5,046	-8.3%	30,182	6.8%	24,010	77.9%
	4D	44,375	-20.1%	7,860	-5.3%	5,148	-6.4%	26,769	-5.3%	4,598	-65.9%
	5A	43,711	-21.3%	7,831	-5.6%	4,120	-25.1%	26,671	-5.6%	5,090	-62.3%
	6A	53,641	-3.5%	8,274	-0.3%	5,485	-0.3%	28,180	-0.3%	11,702	-13.3%
	7C	67,492	21.5%	8,765	5.6%	4,947	-10.1%	29,851	5.6%	23,929	77.3%
	8A	68,119	22.6%	8,876	7.0%	5,004	-9.0%	30,232	7.0%	24,007	77.9%
	Preferred	64,055	15.3%	8,472	2.1%	5,148	-6.4%	28,855	2.1%	21,579	59.9%
South Holston	Base	164,484	--	24,226	--	13,045	--	97,502	--	29,712	--
	2A	193,791	17.8%	25,127	3.7%	13,743	5.4%	101,128	3.7%	53,794	81.1%
	3C	185,085	12.5%	23,645	-2.4%	13,257	1.6%	95,166	-2.4%	53,016	78.4%
	4D	158,707	-3.5%	25,881	6.8%	13,624	4.4%	104,162	6.8%	15,040	-49.4%
	5A	199,253	21.1%	26,067	7.6%	14,024	7.5%	104,914	7.6%	54,247	82.6%
	6A	163,387	-0.7%	24,021	-0.8%	12,978	-0.5%	96,677	-0.8%	29,712	0.0%
	7C	180,386	9.7%	22,889	-5.5%	12,969	-0.6%	92,120	-5.5%	52,408	76.4%
	8A	183,439	11.5%	23,364	-3.6%	13,153	0.8%	94,033	-3.6%	52,889	78.0%
	Preferred	190,733	16.0%	24,535	1.3%	13,413	2.8%	98,747	1.3%	54,037	81.9%

Table D8-06 Recreation Use (User Days) at Tributary Projects by Policy Alternative during August, September, and October (continued)

Project	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
Tims Ford	Base	250,283	--	25,866	--	5,671	--	123,846	--	94,899	--
	2A	301,115	20.3%	26,104	0.9%	5,616	-1.0%	124,985	0.9%	144,410	52.2%
	3C	312,739	25.0%	26,313	1.7%	5,670	0.0%	125,983	1.7%	154,773	63.1%
	4D	205,006	-18.1%	25,869	0.0%	5,820	2.6%	123,857	0.0%	49,461	-47.9%
	5A	304,059	21.5%	26,188	1.2%	5,654	-0.3%	125,384	1.2%	146,834	54.7%
	6A	250,622	0.1%	25,921	0.2%	5,694	0.4%	124,108	0.2%	94,899	0.0%
	7C	312,859	25.0%	26,333	1.8%	5,675	0.1%	126,080	1.8%	154,771	63.1%
	8A	299,521	19.7%	25,852	-0.1%	5,480	-3.4%	123,778	-0.1%	144,410	52.2%
	Preferred	246,537	-1.5%	25,291	-2.2%	5,256	-7.3%	121,091	-2.2%	94,899	0.0%
Upper Bear Creek	Base	57,151	--	8,534	--	5,671	--	29,066	--	13,880	--
	2A	63,573	11.2%	8,619	1.0%	5,767	1.7%	29,354	1.0%	19,833	42.9%
	3C	65,860	15.2%	8,673	1.6%	5,845	3.1%	29,540	1.6%	21,801	57.1%
	4D	48,285	-15.5%	8,363	-2.0%	5,482	-3.3%	28,482	-2.0%	5,958	-57.1%
	5A	66,133	15.7%	8,728	2.3%	5,876	3.6%	29,727	2.3%	21,801	57.1%
	6A	57,144	0.0%	8,533	0.0%	5,670	0.0%	29,061	0.0%	13,880	0.0%
	7C	65,936	15.4%	8,690	1.8%	5,849	3.1%	29,596	1.8%	21,801	57.1%
	8A	63,484	11.1%	8,601	0.8%	5,758	1.5%	29,293	0.8%	19,833	42.9%
	Preferred	66,163	15.8%	8,734	2.3%	5,883	3.7%	29,746	2.3%	21,801	57.1%
Watauga	Base	59,435	--	12,994	--	0	--	32,071	--	14,370	--
	2A	72,758	22.4%	13,478	3.7%	0	--	33,263	3.7%	26,018	81.1%
	3C	69,627	17.1%	12,683	-2.4%	0	--	31,302	-2.4%	25,641	78.4%
	4D	55,418	-6.8%	13,882	6.8%	0	--	34,261	6.8%	7,274	-49.4%
	5A	74,727	25.7%	13,982	7.6%	0	--	34,509	7.6%	26,236	82.6%
	6A	59,054	-0.6%	12,884	-0.8%	0	--	31,799	-0.8%	14,370	0.0%
	7C	67,925	14.3%	12,277	-5.5%	0	--	30,300	-5.5%	25,347	76.4%
	8A	69,041	16.2%	12,532	-3.6%	0	--	30,930	-3.6%	25,580	78.0%
	Preferred	71,775	20.8%	13,160	1.3%	0	--	32,480	1.3%	26,135	81.9%

Table D8-06 Recreation Use (User Days) at Tributary Projects by Policy Alternative during August, September, and October (continued)

Note: Base = Base Case.

[1] Alt. = Alternative. The chart to the right shows the relationship of the former codes used for policy alternatives and the names used in the main document.

[2] Percentages calculated relative to the August through October use numbers for the Base Case. Use numbers consider both internal and external recreation users.

Alternative Name	Former Number Code
Reservoir Recreation A	2A
Reservoir Recreation B	3C
Summer Hydropower	4D
Equalized Summer/Winter Flood Risk	5A
Commercial Navigation	6A
Tailwater Recreation	7C
Tailwater Habitat	8A

Table D8-07 Recreation Use (User Days) by Policy Alternatives during August through October

Projects	Alt.[1]	Total Recreation Use	(%) to Base[2]	Public Reservoir Use	(%) to Base[2]	Public Use below Dam	(%) to Base[2]	Commercial Use	(%) to Base[2]	Private Access Use	(%) to Base[2]
All projects	Base	6,569,334	--	670,561	--	203,363	--	3,844,556	--	1,850,854	--
	2A	7,907,800	20.37%	692,160	3.22%	204,324	0.47%	3,997,786	3.99%	3,013,530	62.82%
	3C	8,114,041	23.51%	711,123	6.05%	209,198	2.87%	4,103,949	6.75%	3,089,770	66.94%
	4D	5,300,096	-19.32%	655,920	-2.18%	193,265	-4.97%	3,725,224	-3.10%	725,687	-60.79%
	5A	6,813,723	3.72%	667,534	-0.45%	192,349	-5.42%	3,891,437	1.22%	2,062,403	11.43%
	6A	6,449,369	-1.83%	669,945	-0.09%	203,104	-0.13%	3,847,202	0.07%	1,729,119	-6.58%
	7C	8,115,039	23.53%	710,362	5.94%	208,189	2.37%	4,107,702	6.84%	3,088,786	66.88%
	8A	8,009,471	21.92%	712,761	6.29%	203,669	0.15%	4,104,229	6.75%	2,988,812	61.48%
	Preferred	7,735,922	17.8%	689,524	2.8%	204,586	0.6%	3,950,983	2.8%	2,890,828	56.2%

Note: Base = Base Case.

1 Alt. = Alternative. The chart to the right shows the relationship of the former codes used for policy alternatives and the names used in the main document.

2 Percentages calculated relative to the August through October use numbers for the Base Case. Use numbers consider both internal and external recreation users.

Alternative Name	Former Number Code
Reservoir Recreation A	2A
Reservoir Recreation B	3C
Summer Hydropower	4D
Equalized Summer/Winter Flood Risk	5A
Commercial Navigation	6A
Tailwater Recreation	7C
Tailwater Habitat	8A

Table D8-08 Changes in Recreation Use (User Days) at Mainstem Project by Policy Alternative during August, September, and October, Compared to the Base Case

Project	Alt.[1]	Total Recreation Use	Public Reservoir Use	Public Use below Dam	Commercial Use	Private Access Use
Mainstem projects	2A	675,460	9,508	-1,329	27,918	639,363
	3C	781,833	14,888	-718	42,284	725,379
	4D	-698,480	-9,952	-2,184	-24,610	-661,734
	5A	64,569	-1,450	-4,732	-18,909	89,660
	6A	-66,050	-146	-55	-644	-65,204
	7C	775,742	14,179	-1,060	38,985	723,637
	8A	705,939	14,784	-1,057	45,555	646,657
	Preferred	617,571	6,790	-571	11,878	599,474
Chickamauga	2A	121,559	1,824	-941	4,751	115,926
	3C	132,011	2,829	-873	7,368	122,688
	4D	-112,453	-2,203	-677	-5,737	-103,836
	5A	-109,212	-2,347	-2,651	-6,113	-98,102
	6A	-21,416	-122	-32	-317	-20,945
	7C	129,116	2,340	-1,063	6,094	121,746
	8A	132,154	2,901	-954	7,556	122,651
	Preferred	96,793	873	-679	2,273	94,325
Fort Loudoun	2A	66,956	1,862	381	4,849	59,863
	3C	64,351	3,002	676	7,819	52,854
	4D	-58,197	-1,311	-326	-3,414	-53,147
	5A	24,591	1,481	212	3,858	19,040
	6A	-7,039	93	16	242	-7,389
	7C	65,543	3,166	713	8,247	53,417
	8A	64,327	3,180	729	8,284	52,134
	Preferred	64,010	1,308	260	3,407	59,034
Guntersville	2A	65,297	544	70	4,536	60,146
	3C	88,523	896	128	7,463	80,037
	4D	-90,466	-1,103	-139	-9,188	-80,037
	5A	91,845	1,250	150	10,413	80,032
	6A	-80	-9	-1	-71	0
	7C	89,515	1,002	130	8,350	80,032
	8A	64,207	428	63	3,569	60,146
	Preferred	92,174	1,284	155	10,702	80,032
Kentucky	2A	38,941	-977	-268	-8,977	49,163
	3C	40,894	-1,773	-496	-16,290	59,453
	4D	-22,692	2,151	511	19,764	-45,119
	5A	28,830	-2,178	-544	-20,016	51,570
	6A	141	14	1	126	0
	7C	40,113	-1,849	-503	-16,986	59,451
	8A	38,957	-976	-267	-8,964	49,163
	Preferred	-24,117	-2,316	-526	-21,276	0

Table D8-08 Changes in Recreation Use (User Days) at Mainstem Project by Policy Alternative during August, September, and October, Compared to the Base Case (continued)

Project	Alt.[1]	Total Recreation Use	Public Reservoir Use	Public Use below Dam	Commercial Use	Private Access Use
Nickajack	2A	27,442	416	-490	1,083	26,433
	3C	29,846	645	-455	1,680	27,975
	4D	-25,840	-502	-353	-1,308	-23,677
	5A	-25,680	-535	-1,381	-1,394	-22,369
	6A	-4,893	-28	-16	-72	-4,776
	7C	29,130	533	-554	1,389	27,761
	8A	29,854	661	-497	1,723	27,967
	Preferred	21,872	199	-354	518	21,508
Pickwick	2A	42,064	537	150	694	40,682
	3C	56,434	883	272	1,142	54,137
	4D	-56,926	-1,088	-296	-1,406	-54,137
	5A	57,280	1,233	321	1,593	54,134
	6A	-21	-8	-2	-11	0
	7C	56,678	988	278	1,277	54,134
	8A	41,786	423	135	546	40,682
	Preferred	57,369	1,267	331	1,637	54,134
Tellico	2A	29,677	2,025	0	6,666	20,986
	3C	32,541	3,265	0	10,747	18,529
	4D	-24,749	-1,426	0	-4,692	-18,632
	5A	13,588	1,611	0	5,303	6,675
	6A	-2,157	101	0	332	-2,590
	7C	33,506	3,444	0	11,336	18,726
	8A	33,122	3,459	0	11,386	18,276
	Preferred	26,802	1,423	0	4,684	20,695
Watts Bar	2A	178,121	2,648	-506	12,678	163,300
	3C	196,126	4,107	-469	19,662	172,826
	4D	-165,142	-3,198	-364	-15,311	-146,270
	5A	-159,336	-3,407	-1,424	-16,313	-138,193
	6A	-30,545	-177	-17	-847	-29,504
	7C	190,587	3,397	-571	16,262	171,499
	8A	196,639	4,212	-513	20,165	172,775
	Preferred	139,842	1,267	-365	6,067	132,873
Wheeler	2A	90,584	541	96	1,410	88,537
	3C	121,202	891	174	2,320	117,818
	4D	-121,959	-1,096	-189	-2,856	-117,818
	5A	122,495	1,243	205	3,236	117,811
	6A	-32	-8	-1	-22	0
	7C	121,581	996	178	2,595	117,811
	8A	90,159	426	86	1,109	88,537
	Preferred	122,626	1,277	211	3,326	117,811

Table D8-08 Changes in Recreation Use (User Days) at Mainstem Project by Policy Alternative during August, September, and October, Compared to the Base Case (continued)

Project	Alt.[1]	Total Recreation Use	Public Reservoir Use	Public Use below Dam	Commercial Use	Private Access Use
Wilson	2A	14,820	88	179	228	14,325
	3C	19,906	144	324	375	19,063
	4D	-20,054	-177	-352	-462	-19,063
	5A	20,168	201	381	524	19,062
	6A	-7	-1	-2	-4	0
	7C	19,974	161	331	420	19,062
	8A	14,734	69	161	180	14,325
	Preferred	20,200	207	394	538	19,062

[1] Alt. = Alternative. The chart to the right shows the relationship of the former codes used for policy alternatives and the names used in the main document.

Alternative Name	Former Number Code
Reservoir Recreation A	2A
Reservoir Recreation B	3C
Summer Hydropower	4D
Equalized Summer/Winter Flood Risk	5A
Commercial Navigation	6A
Tailwater Recreation	7C
Tailwater Habitat	8A

Table D8-09 Changes in Recreation Use (User Days) at Run-of-River Projects by Policy Alternative during August, September, and October, Compared to the Base Case

Project	Alt.[1]	Total Recreation Use	Public Reservoir Use	Public Use below Dam	Commercial Use	Private Access Use
Run-of-river projects	2A	34,148	2,653	72	3,971	27,451
	3C	38,143	3,889	-199	6,049	28,404
	4D	-48,271	-1,534	-5,127	-17,279	-24,331
	5A	8,285	1,673	-1,497	1,472	6,637
	6A	-2,588	61	-84	91	-2,656
	7C	37,407	3,842	-731	5,891	28,404
	8A	15,875	3,872	-5,599	-8,939	26,540
	Preferred	20,115	1,446	-490	1,555	17,603
Apalachia	2A	3,263	171	-506	422	3,176
	3C	3,812	265	-469	654	3,361
	4D	-3,924	-206	-364	-509	-2,845
	5A	-4,874	-220	-1,424	-543	-2,688
	6A	-630	-11	-17	-28	-574
	7C	3,525	219	-571	541	3,336
	8A	3,790	272	-513	671	3,360
	Preferred	2,503	82	-365	202	2,584
Fort Patrick Henry	2A	1,288	151	304	111	721
	3C	621	-97	92	-72	698
	4D	295	278	252	205	-440
	5A	1,698	309	426	228	735
	6A	-89	-34	-29	-25	0
	7C	257	-224	-33	-165	680
	8A	490	-145	47	-107	694
	Preferred	979	52	160	38	729
Great Falls	2A	8,618	90	-53	305	8,276
	3C	10,749	168	-1	573	10,008
	4D	-7,447	1	144	3	-7,595
	5A	9,198	121	-17	412	8,681
	6A	113	21	22	70	0
	7C	10,786	176	3	599	10,008
	8A	8,067	-5	-185	-18	8,276
	Preferred	-1,359	-217	-403	-739	0
Melton Hill	2A	15,000	2,052	268	2,509	10,172
	3C	16,809	3,308	476	4,045	8,981
	4D	-12,470	-1,444	-229	-1,766	-9,031
	5A	7,013	1,632	149	1,996	3,235
	6A	-1,017	102	11	125	-1,255
	7C	17,334	3,490	502	4,266	9,076
	8A	17,161	3,505	513	4,285	8,858
	Preferred	13,418	1,442	183	1,763	10,031

Table D8-09 Changes in Recreation Use (User Days) at Run-of-River Projects by Policy Alternative during August, September, and October, Compared to the Base Case (continued)

Project	Alt.[1]	Total Recreation Use	Public Reservoir Use	Public Use below Dam	Commercial Use	Private Access Use
Ocoee #1	2A	4,804	167	-506	570	4,573
	3C	5,514	259	-469	884	4,840
	4D	-5,350	-202	-364	-688	-4,096
	5A	-6,242	-215	-1,424	-733	-3,870
	6A	-892	-11	-17	-38	-826
	7C	5,177	215	-571	731	4,803
	8A	5,498	266	-513	906	4,838
	Preferred	3,709	80	-365	273	3,721
Ocoee #2	2A	0	0	0	0	0
	3C	0	0	0	0	0
	4D	0	0	0	0	0
	5A	0	0	0	0	0
	6A	0	0	0	0	0
	7C	0	0	0	0	0
	8A	0	0	0	0	0
	Preferred	0	0	0	0	0
Ocoee #3	2A	0	0	0	0	0
	3C	0	0	0	0	0
	4D	-19,659	0	-5,035	-14,624	0
	5A	0	0	0	0	0
	6A	0	0	0	0	0
	7C	0	0	0	0	0
	8A	-19,659	0	-5,035	-14,624	0
	Preferred	0	0	0	0	0
Wilbur	2A	1,175	22	565	55	533
	3C	638	-14	172	-35	516
	4D	285	41	469	100	-325
	5A	1,493	45	793	112	543
	6A	-72	-5	-54	-12	0
	7C	327	-33	-61	-81	502
	8A	527	-21	88	-52	513
	Preferred	863	8	299	19	538

[1] Alt. = Alternative. The chart to the right shows the relationship of the former codes used for policy alternatives and the names used in the main document.

Alternative Name	Former Number Code
Reservoir Recreation A	2A
Reservoir Recreation B	3C
Summer Hydropower	4D
Equalized Summer/Winter Flood Risk	5A
Commercial Navigation	6A
Tailwater Recreation	7C
Tailwater Habitat	8A

Table D8-10 Change in Recreation Use (User Days) at Tributary Projects by Policy Alternative during August, September, and October, Compared to the Base Case

Project	Alt.[1]	Total Recreation Use	Public Reservoir Use	Public Use below Dam	Commercial Use	Private Access Use
Tributary projects	2A	628,858	9,438	2,218	121,340	495,862
	3C	724,731	21,785	6,751	211,061	485,134
	4D	-522,487	-3,156	-2,786	-77,443	-439,102
	5A	171,535	-3,251	-4,785	64,318	115,253
	6A	-51,328	-532	-120	3,199	-53,875
	7C	732,557	21,779	6,617	218,270	485,891
	8A	718,323	23,544	6,961	223,057	464,761
	Preferred	528,902	10,727	2,284	92,994	422,898
Bear Creek	2A	3,133	42	0	143	2,948
	3C	4,227	69	0	235	3,923
	4D	-4,297	-85	0	-289	-3,923
	5A	4,347	96	0	328	3,923
	6A	-3	-1	0	-2	0
	7C	4,263	77	0	263	3,923
	8A	3,093	33	0	112	2,948
	Preferred	4,358	99	0	337	3,923
Blue Ridge	2A	23,088	339	-490	738	22,501
	3C	25,029	525	-455	1,145	23,814
	4D	-21,808	-409	-353	-892	-20,155
	5A	-21,809	-436	-1,381	-950	-19,042
	6A	-4,154	-23	-16	-49	-4,065
	7C	24,459	434	-554	947	23,631
	8A	25,022	539	-497	1,174	23,807
	Preferred	18,470	162	-354	353	18,309
Boone	2A	4,313	617	295	455	2,946
	3C	2,250	-398	90	-293	2,851
	4D	419	1,134	244	836	-1,795
	5A	5,607	1,262	413	930	3,002
	6A	-272	-140	-28	-103	0
	7C	1,154	-916	-32	-675	2,777
	8A	1,856	-591	46	-435	2,836
	Preferred	3,500	212	156	156	2,976
Cedar Creek	2A	5,000	67	0	228	4,706
	3C	6,747	110	0	375	6,262
	4D	-6,859	-135	0	-461	-6,262
	5A	6,938	154	0	523	6,262
	6A	-5	-1	0	-4	0
	7C	6,804	123	0	419	6,262
	8A	4,938	53	0	179	4,706
	Preferred	6,957	158	0	537	6,262

Table D8-10 Change in Recreation Use (User Days) at Tributary Projects by Policy Alternative during August, September, and October, Compared to the Base Case (continued)

Project	Alt.[1]	Total Recreation Use	Public Reservoir Use	Public Use below Dam	Commercial Use	Private Access Use
Chatuge	2A	67,134	617	-490	4,732	62,275
	3C	73,749	958	-455	7,339	65,907
	4D	-62,593	-746	-353	-5,715	-55,780
	5A	-60,964	-794	-1,381	-6,088	-52,700
	6A	-11,625	-41	-16	-316	-11,251
	7C	71,709	792	-554	6,070	65,401
	8A	73,899	982	-497	7,526	65,888
	Preferred	52,877	295	-354	2,264	50,671
Cherokee	2A	98,524	1,580	381	27,032	69,530
	3C	108,197	2,548	676	43,583	61,389
	4D	-82,197	-1,113	-326	-19,029	-61,729
	5A	45,088	1,257	212	21,504	22,115
	6A	-7,140	79	16	1,347	-8,582
	7C	111,415	2,688	713	45,972	62,043
	8A	110,157	2,700	729	46,177	60,553
	Preferred	88,931	1,110	260	18,994	68,566
Douglas	2A	110,966	1,388	579	10,976	98,023
	3C	107,507	2,238	1,028	17,696	86,546
	4D	-96,224	-977	-495	-7,726	-87,026
	5A	41,335	1,104	323	8,731	31,177
	6A	-11,459	69	24	547	-12,099
	7C	109,577	2,360	1,083	18,666	87,467
	8A	107,593	2,371	1,107	18,749	85,367
	Preferred	105,747	975	396	7,712	96,664
Fontana	2A	2,895	546	999	1,349	0
	3C	46,154	11,980	4,605	29,568	0
	4D	-4,902	-1,068	-1,197	-2,637	0
	5A	-37,629	-9,940	-3,158	-24,532	0
	6A	-1,018	-268	-90	-661	0
	7C	52,181	13,604	5,000	33,576	0
	8A	56,001	14,613	5,324	36,065	0
	Preferred	23,428	6,101	2,270	15,057	0
Hiwassee	2A	14,274	309	0	544	13,420
	3C	15,527	480	0	844	14,203
	4D	-13,051	-373	0	-657	-12,021
	5A	-12,455	-398	0	-700	-11,357
	6A	-2,482	-21	0	-36	-2,425
	7C	15,189	397	0	698	14,094
	8A	15,556	492	0	866	14,199
	Preferred	11,328	148	0	260	10,920

Table D8-10 Change in Recreation Use (User Days) at Tributary Projects by Policy Alternative during August, September, and October, Compared to the Base Case (continued)

Project	Alt.[1]	Total Recreation Use	Public Reservoir Use	Public Use below Dam	Commercial Use	Private Access Use
Little Bear Creek	2A	2,711	36	0	124	2,551
	3C	3,658	60	0	203	3,395
	4D	-3,719	-73	0	-250	-3,395
	5A	3,762	83	0	284	3,395
	6A	-2	-1	0	-2	0
	7C	3,689	67	0	227	3,395
	8A	2,677	29	0	97	2,551
	Preferred	3,772	86	0	291	3,395
Normandy	2A	5,372	56	-55	191	5,179
	3C	6,726	105	-1	359	6,263
	4D	-4,603	1	148	2	-4,753
	5A	5,750	76	-17	258	5,433
	6A	80	13	23	44	0
	7C	6,752	110	3	375	6,263
	8A	4,974	-3	-191	-11	5,179
	Preferred	-1,014	-136	-415	-462	0
Norris	2A	180,519	1,769	751	67,346	110,653
	3C	210,461	2,853	1,332	108,579	97,697
	4D	-147,533	-1,246	-642	-47,408	-98,238
	5A	90,593	1,408	418	53,573	35,194
	6A	-10,183	88	31	3,356	-13,658
	7C	217,681	3,009	1,404	114,531	98,737
	8A	215,864	3,022	1,435	115,040	96,366
	Preferred	158,195	1,243	513	47,320	109,119
Nottely	2A	11,045	363	-490	1,238	9,934
	3C	12,542	564	-455	1,919	10,513
	4D	-11,184	-439	-353	-1,495	-8,898
	5A	-11,848	-468	-1,381	-1,592	-8,407
	6A	-1,918	-24	-16	-83	-1,795
	7C	11,933	466	-554	1,587	10,433
	8A	12,560	578	-497	1,968	10,510
	Preferred	8,496	174	-354	592	8,083
South Holston	2A	29,308	901	698	3,626	24,082
	3C	20,601	-580	212	-2,335	23,304
	4D	-5,777	1,655	579	6,661	-14,672
	5A	34,769	1,842	980	7,413	24,535
	6A	-1,097	-205	-67	-825	0
	7C	15,902	-1,337	-76	-5,382	22,697
	8A	18,955	-862	108	-3,469	23,178
	Preferred	26,249	310	369	1,246	24,325

Table D8-10 Change in Recreation Use (User Days) at Tributary Projects by Policy Alternative during August, September, and October, Compared to the Base Case (continued)

Project	Alt.[1]	Total Recreation Use	Public Reservoir Use	Public Use below Dam	Commercial Use	Private Access Use
Tims Ford	2A	50,833	238	-55	1,139	49,512
	3C	62,456	446	-1	2,137	59,874
	4D	-45,276	2	148	11	-45,438
	5A	53,777	321	-17	1,538	51,935
	6A	339	55	23	262	0
	7C	62,576	467	3	2,234	59,872
	8A	49,239	-14	-191	-68	49,512
	Preferred	-3,746	-575	-415	-2,755	0
Upper Bear Creek	2A	6,422	85	96	288	5,953
	3C	8,709	139	174	474	7,922
	4D	-8,866	-171	-189	-584	-7,922
	5A	8,982	194	205	662	7,921
	6A	-7	-1	-1	-5	0
	7C	8,785	156	178	530	7,921
	8A	6,333	67	86	227	5,953
	Preferred	9,012	200	211	680	7,921
Watauga	2A	13,323	483	0	1,193	11,647
	3C	10,192	-311	0	-768	11,271
	4D	-4,017	888	0	2,191	-7,096
	5A	15,292	988	0	2,438	11,866
	6A	-381	-110	0	-271	0
	7C	8,490	-717	0	-1,770	10,977
	8A	9,607	-462	0	-1,141	11,210
	Preferred	12,341	166	0	410	11,765

[1] Alt. = Alternative. The chart to the right shows the relationship of the former codes used for policy alternatives and the names used in the main document.

Alternative Name	Former Number Code
Reservoir Recreation A	2A
Reservoir Recreation B	3C
Summer Hydropower	4D
Equalized Summer/Winter Flood Risk	5A
Commercial Navigation	6A
Tailwater Recreation	7C
Tailwater Habitat	8A

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Appendix D9

Inter-Basin Transfers—A Sensitivity Analysis

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An inter-basin transfer (IBT) occurs when water is moved from one watershed to another watershed. In 2000, the 13 IBTs from the Tennessee River watershed diverted 5.61 million gallons per day (mgd). These IBTs have been included as part of the Base Case, and the impacts of these withdrawals were considered in the impact assessments for the relevant resource areas. In addition, for this analysis, it was assumed that operation of the locks through the Tennessee–Tombigbee Waterway would eventually reach the level projected when the waterway was authorized. This additional IBT, which would divert an additional 600 mgd from the TVA reservoir system and the Tennessee River watershed, was also included in the impact assessments. This assumption is conservative and may result in overstated related impacts.

There are increasing demands on available water supplies in the Southeast. Alabama, Georgia, Mississippi, and Florida are already involved in disputes over water supply use. Inquiries that have been made about the availability of water from the Tennessee River system to meet demands outside the watershed could result in additional IBTs from the TVA reservoir system. Because TVA does not know the location, timing or magnitude of potential IBTs, TVA decided not to speculate about potential additional IBTs in its primary ROS analyses. When requests to approve additional IBTs under Section 26a of the TVA Act are received, TVA would analyze the environmental, economic, and operational effects of these requests both individually and in the aggregate. TVA would also work closely with potentially affected states and communities in these assessments.

Although specific IBTs are too speculative to address in the ROS, TVA conducted an initial sensitivity analysis to investigate whether the policy alternatives allowed for the potential of large IBTs from the TVA system occurring in the future. The results of that analysis are reported in this appendix.

Bohac (2003) discussed the possibility that water-short areas external to the Tennessee River watershed could look to the Tennessee River for water supply in the future. Based on a review of water needs in areas outside the watershed, requests for IBT withdrawals were assumed to be received from the Blount County/Birmingham, Alabama, area; the 18- to 20-county area comprising the Atlanta Metropolitan Area; North Georgia; and Northeast Mississippi. The point of withdrawal for these areas would likely be Chickamauga, Guntersville, and Pickwick Reservoirs, which all are mainstem storage reservoirs. Table D9-01 shows the potential amount of withdrawals for those areas for 2030. These amounts were used to determine the sensitivity of the Base Case and the policy alternatives to large transfers of water from the Tennessee River.

Table D9-01 Potential Inter-Basin Transfers by 2030

Assumed Water Transfer Destination	Point of Withdrawal	Assumed Transfer (2030) (mgd)
North Georgia and Atlanta	Chickamauga	264
Blount County–Birmingham, Alabama	Guntersville	180
Northeast Mississippi	Pickwick	17

TVA used the Weekly Scheduling Model (WSM) to conduct the sensitivity analysis for IBT withdrawals (see Appendix C for a brief description of the WSM). Reservoir levels from the model results for the Base Case were compared to reservoir levels for the policy alternatives to identify the policy alternative that showed the greatest change in median reservoir elevations. Reservoir Recreation Alternative B showed the greatest change in median reservoir elevations.

Water withdrawals for the IBTs were added as an input to the WSM, and a second-iteration model run was completed. Table D9-02 shows the effect of withdrawals from Chickamauga, Guntersville, and Pickwick Reservoirs at upstream tributary storage reservoirs. The results shown are based on analysis of the 90th and 10th percentile ranges of reservoir elevations—that is, the reservoir elevation that would be exceeded at least 10 percent of the time but not exceeded 90 percent of the time. Reservoir elevations outside this range would occur infrequently due to drought or extremely wet weather conditions. The general seasonality of these effects is also shown. The analysis found that, for both the Base Case and Reservoir Recreation Alternative B, no change in median reservoir elevations would be likely should the IBTs be implemented.

Table D9-02 Weekly Scheduling Model Results That Include Potential Inter-Basin Transfers under the Base Case and Reservoir Recreation Alternative B

Reservoir	Base Case		Reservoir Recreation Alternative B	
	Elevation Difference – 90th Percentile (feet)	Elevation Difference – 10th Percentile (feet)	Elevation Difference – 90th Percentile (feet)	Elevation Difference – 10th Percentile (feet)
Watauga	0 to 1 (August-October)	0	0	Less than 0.5 (July)
South Holston	0 to 1 (August-October)	0	0	Less than 0.5 (October)
Cherokee	0 to 0.5 (October)	0	0	0 to 1 (July-September)
Douglas	0 to 0.5 (October)	0 to 2 (June-July)	0	0 to 1 (July-September)
Norris	0 to 0.5 (October)	0 to 0.5 (June)	0	0 to 1 (July-November)
Fontana	Less than 0.5	0	0	0
Chatuge	Less than 0.5	0	0	0
Nottely	0 to 1 (November)	0	0	Less than 0.5 (August)
Blue Ridge	0	0 to 0.5 (June-July)	0	0 to 2 (March - September)
Chickamauga	0	Less than 0.5 (April)	0	0

Table D9-02 shows that the effect of the IBTs would be to reduce some tributary reservoir levels by a small amount under infrequent conditions. Under the Base Case, during unusually wet conditions in which reservoir levels were above normal (90^{th} percentile or no more than 10 percent of the time), IBTs would cause some tributary reservoirs to fall from 0 to 1 foot below their elevations without the transfers for a period of 1 to 3 months. This would likely occur in the late summer and fall periods. Similarly, during unusually dry conditions (10^{th} percentile, or no more than 10 percent of the time) in which reservoir elevations were already below normal, IBTs could cause some tributary reservoirs elevations to fall an additional 0.0 to 0.5 foot for 1 to 2 months during summer. One reservoir (Douglas) was up to 2 feet below where it would have been without the transfers for 1 to 2 months. Under the Base Case, no impacts on mainstem reservoirs were noted except on Chickamauga Reservoir. In approximately 1 year in 10, Chickamauga Reservoir would be delayed in being filled by about 1 week. Otherwise, no effect was observed for mainstem reservoirs.

Under Reservoir Recreation Alternative B, IBTs would not affect reservoir elevations in unusually wet years. During dry conditions, when reservoir elevations were below normal, IBTs would cause some tributary reservoirs to drop up to 1 foot below their levels without the transfers for one to several months during summer. One reservoir (Blue Ridge) was as much as 2 feet below its level without a transfer for 1 to 2 months. No impacts on mainstem reservoirs were noted.

This sensitivity analysis shows that IBTs are not likely to substantially affect future reservoir elevations, under either the Base Case or the most conservative assumptions for the policy alternatives under most hydrologic conditions. However, this conclusion is only valid for the assumptions used. IBTs with other withdrawal points or withdrawal quantities might result in different outcomes. It must also be recognized that the reservoir elevation differences discussed above would occur about 1 year in 10. Under very dry conditions, which would occur less often than 1 year in 10, IBTs might cause more significant elevation differences than discussed above.

Literature Cited

Bohac, C. E. 2003. Water Supply Inventory and Needs Analysis. Tennessee Valley Authority, Navigation and Hydraulic Engineering. Draft. Chattanooga, TN. December.

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Appendix D10

Social and Economic Resources

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Table D10-01 List of Counties Constituting Each Sub-Region in the TVA ROS Area

Sub-Region	State	County	Sub-Region	State	County
Alabama	AL	Cherokee	Knoxville	TN	Blount
Alabama	AL	Colbert	Knoxville	TN	Campbell
Alabama	AL	Cullman	Knoxville	TN	Claiborne
Alabama	AL	DeKalb	Knoxville	TN	Cocke
Alabama	AL	Franklin	Knoxville	TN	Cumberland
Alabama	AL	Jackson	Knoxville	TN	Fentress
Alabama	AL	Lauderdale	Knoxville	TN	Grainger
Alabama	AL	Lawrence	Knoxville	TN	Hamblen
Alabama	AL	Limestone	Knoxville	TN	Jefferson
Alabama	AL	Madison	Knoxville	TN	Knox
Alabama	AL	Marshall	Knoxville	TN	Loudon
Alabama	AL	Morgan	Knoxville	TN	Morgan
Chattanooga	GA	Catoosa	Knoxville	TN	Pickett
Chattanooga	GA	Chattooga	Knoxville	TN	Roane
Chattanooga	GA	Fannin	Knoxville	TN	Scott
Chattanooga	GA	Gordon	Knoxville	TN	Sevier
Chattanooga	GA	Murray	Knoxville	TN	Union
Chattanooga	GA	Towns	Mississippi	MS	Alcorn
Chattanooga	GA	Union	Mississippi	MS	Attala
Chattanooga	GA	Walker	Mississippi	MS	Benton
Chattanooga	GA	Whitfield	Mississippi	MS	Calhoun
Chattanooga	NC	Cherokee	Mississippi	MS	Chickasaw
Chattanooga	NC	Clay	Mississippi	MS	Choctaw
Chattanooga	TN	Bledsoe	Mississippi	MS	Clay
Chattanooga	TN	Bradley	Mississippi	MS	Itawamba
Chattanooga	TN	Grundy	Mississippi	MS	Kemper
Chattanooga	TN	Hamilton	Mississippi	MS	Lafayette
Chattanooga	TN	Marion	Mississippi	MS	Leake
Chattanooga	TN	McMinn	Mississippi	MS	Lee
Chattanooga	TN	Meigs	Mississippi	MS	Lowndes
Chattanooga	TN	Monroe	Mississippi	MS	Marshall
Chattanooga	TN	Polk	Mississippi	MS	Monroe
Chattanooga	TN	Rhea	Mississippi	MS	Neshoba
Chattanooga	TN	Sequatchie	Mississippi	MS	Noxubee
Knoxville	TN	Anderson	Mississippi	MS	Oktibbeha

Table D10-01 List of Counties Constituting Each Sub-Region in the TVA ROS Area (continued)

Sub-Region	State	County	Sub-Region	State	County
Mississippi	MS	Panola	Nashville	TN	Hickman
Mississippi	MS	Pontotoc	Nashville	TN	Houston
Mississippi	MS	Prentiss	Nashville	TN	Humphreys
Mississippi	MS	Scott	Nashville	TN	Jackson
Mississippi	MS	Tallahatchie	Nashville	TN	Lawrence
Mississippi	MS	Tate	Nashville	TN	Lewis
Mississippi	MS	Tippah	Nashville	TN	Lincoln
Mississippi	MS	Tishomingo	Nashville	TN	Macon
Mississippi	MS	Union	Nashville	TN	Marshall
Mississippi	MS	Webster	Nashville	TN	Maury
Mississippi	MS	Winston	Nashville	TN	Montgomery
Mississippi	MS	Yalobusha	Nashville	TN	Moore
Nashville	KY	Allen	Nashville	TN	Overton
Nashville	KY	Butler	Nashville	TN	Perry
Nashville	KY	Christian	Nashville	TN	Putnam
Nashville	KY	Cumberland	Nashville	TN	Robertson
Nashville	KY	Edmonson	Nashville	TN	Rutherford
Nashville	KY	Grayson	Nashville	TN	Smith
Nashville	KY	Logan	Nashville	TN	Stewart
Nashville	KY	Lyon	Nashville	TN	Sumner
Nashville	KY	Monroe	Nashville	TN	Trousdale
Nashville	KY	Simpson	Nashville	TN	Van Buren
Nashville	KY	Todd	Nashville	TN	Warren
Nashville	KY	Trigg	Nashville	TN	Wayne
Nashville	KY	Warren	Nashville	TN	White
Nashville	TN	Bedford	Nashville	TN	Williamson
Nashville	TN	Cannon	Nashville	TN	Wilson
Nashville	TN	Cheatham	NC non-PSA	NC	Buncombe
Nashville	TN	Clay	NC non-PSA	NC	Graham
Nashville	TN	Coffee	NC non-PSA	NC	Haywood
Nashville	TN	Davidson	NC non-PSA	NC	Henderson
Nashville	TN	Dekalb	NC non-PSA	NC	Jackson
Nashville	TN	Dickson	NC non-PSA	NC	Macon
Nashville	TN	Franklin	NC non-PSA	NC	Madison
Nashville	TN	Giles	NC non-PSA	NC	Mitchell
Nashville	TN	Hardin	NC non-PSA	NC	Swain

Table D10-01 List of Counties Constituting Each Sub-Region in the TVA ROS Area (continued)

Sub-Region	State	County	Sub-Region	State	County
NC non-PSA	NC	Transylvania	Western	KY	Marshall
NC non-PSA	NC	Watauga	Western	TN	Benton
NC non-PSA	NC	Yancey	Western	TN	Carroll
Tri-Cities	NC	Avery	Western	TN	Chester
Tri-Cities	TN	Carter	Western	TN	Crockett
Tri-Cities	TN	Greene	Western	TN	Decatur
Tri-Cities	TN	Hancock	Western	TN	Dyer
Tri-Cities	TN	Hawkins	Western	TN	Fayette
Tri-Cities	TN	Johnson	Western	TN	Gibson
Tri-Cities	TN	Sullivan	Western	TN	Hardeman
Tri-Cities	TN	Unicoi	Western	TN	Haywood
Tri-Cities	TN	Washington	Western	TN	Henderson
Tri-Cities	VA	Lee	Western	TN	Henry
Tri-Cities	VA	Washington	Western	TN	Lake
VA non-PSA	VA	Bland	Western	TN	Lauderdale
VA non-PSA	VA	Dickenson	Western	TN	Madison
VA non-PSA	VA	Grayson	Western	TN	McNairy
VA non-PSA	VA	Russell	Western	TN	Obion
VA non-PSA	VA	Scott	Western	TN	Shelby
VA non-PSA	VA	Smyth	Western	TN	Tipton
VA non-PSA	VA	Tazewell	Western	TN	Weakley
VA non-PSA	VA	Wise			
VA non-PSA	VA	Wythe			
Western	KY	Calloway			
Western	KY	Carlisle			
Western	KY	Fulton			
Western	KY	Graves			
Western	KY	Hickman			

Note: Non-PSA = Not in the Power Service Area.

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Appendix E

Prime Farmland Technical Report

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TECHNICAL REPORT FOR PRIME FARMLAND

SEPTEMBER 2003

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Technical Report for Prime Farmland

Prepared for
TENNESSEE VALLEY AUTHORITY

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R-19301.008

September 2003

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Executive Summary

The soils within the TVA region are a valuable resource for agriculture and forest production. The TVA, as a federal agency, is mandated by the Farmland Protection and Policy Act (FPPA) to complete a prime farmland review prior to initiating a program. The FPPA is intended to minimize the impact of Federal programs on the unnecessary and irreversible conversion of farmland to nonagricultural uses. Farmland conversion and soil erosion are considered the major issues that could potentially impact prime farmland as a result of TVA actions. In addition, soil erosion was considered a by-product of land use change.

An overview is provided of the soils within the TVA region by physiographic region. Soils are influenced by topography, slope and aspect with prime farmland soils occurring primarily in valleys where the soils are deep, fertile and nearly level. The rate of farmland conversion to non-farm use was variable across the region. Based on a review of Census of Agriculture data for the period 1987 to 1997, the twenty counties within the TVA region that have experienced 10 percent and higher rates of conversion to non-farm use are within commuting distance of large population centers. Farmland conversion is anticipated to result in an increase in erosion due to the removal of vegetation and exposure of soils. The erosion of this resource impacts the quality and extent of productive soils as well degrades downstream water resources and associated uses. Soil erosion along the shoreline, which is discussed in more detail in Section 4.16, Shoreline Erosion, initially was thought to affect prime farmland. After preliminary investigation, erosion along the shoreline was considered an insignificant impact on prime farmland and not considered further in this report.

The extent of prime farmland within the counties of the TVA region was based on data provided by the Natural Resources Conservation Service (NRCS). The highest acreage occurs within the Highland Rim, Coastal Plain, and Valley and Ridge Regions. An analysis of the acreage of prime farmland within 0.25 mile of seven representative reservoirs determined that the majority of the prime farmland is in forestland. Agricultural land (pasture/hay and cropland) is the second largest use and non-farm use is a small percentage of the total.

A comparison of the Base Case with the policy alternatives assumed that reservoir operation activities that increase the rate of development along the shoreline of the reservoirs and rivers would result in a loss of prime farmland due to a combination of conversion and erosion. Farmland conversion and soil erosion under the Base Case were considered to be insignificant within 0.25 mile of the TVA shoreline. One alternative (the Commercial Navigation Alternative was anticipated to have similar impacts as the Base Case while five alternatives (the Preferred Alternative, Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative) would result in an increase in rates of conversion and erosion. Two alternatives (the Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative) would result in slower rates of conversion compared to the Base Case.

List of Abbreviations and Acronyms

FPPA	Farmland Protection Policy Act
NRCS	Natural Resources Conservation Service
ROS	Reservoir Operations System
SMI	Shoreline Management Initiative
STATSGO	State Soil Geographic Database
TVA	Tennessee Valley Authority
TVA Region	Counties bordering the TVA system

List of Figures

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1 Introduction

1.1 Key Issues

The key issues for soils are (1) the identification of the soil resources within the Tennessee Valley Authority (TVA) system having high agricultural value (classified as prime farmland) and (2) soils that are susceptible to erosion. Farmland conversion and soil erosion are the key issues for this resource and were used to determine potential impacts associated with the policy alternatives. The following report provides a regional overview of the soils within the six physiographic regions encompassing the TVA system. A discussion is provided on soils designated as prime farmland by the USDA Natural Resources Conservation Service (NRCS), based on criteria of the Farmland Protection and Policy Act (FPPA; 7CFR 658.1 et seq.). A comparison is provided of cropland conversion by physiographic region during the period 1987 to 1997 and discussion of potential trends. An overview is also provided of the erosion potential of soils within the region. Representative reservoirs were selected for a more detailed review of soil and land use characteristics and the effect reservoir operation changes may have on land use and soil erosion. Soil erosion was considered a secondary impact, as a result of farmland conversion to development. Shoreline erosion, which is discussed in Section 4.16, Shoreline Erosion, was determined not to be a key factor in loss of prime farmland.

Farmland is considered prime or unique as determined by the appropriate state or local unit of government. Prime farmland is defined as:

“Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion. Prime farmland includes land that possesses the above characteristics but are being used currently to produce livestock and timber” (7 U.S.C. 4201 et seq.).

1.2 Metrics to be Used as Indices of Impact

Farmland conversion involves the conversion of cropland to non-farm uses such as residential housing. Floods also affect farmland; however, the impact of flooding was considered to be an economic impact as it pertains to loss of use and crop loss. Flooding therefore is discussed in Section 4.25, Social and Economic Resources.

Soil erosion affects the quality and extent of productive soils as well as degrades downstream water resources and associated uses. In addition, the transport and deposition of sediment reduces the water storage capacity of reservoirs. A more detailed analysis of shoreline susceptibility to erosion is provided in Section 4.16, Shoreline Erosion.

Soil erosion was considered as both a direct and indirect impact due to changes in reservoir operations. The direct impact on prime farmland and soils would result from erosion along the shoreline, which is discussed in Section 4.16. Indirect effects would result from land use activities occurring in the "backlands" (lands extending 0.25 mile from the shoreline and generally in private ownership) that would either influence farmland conversion or increase soil erosion.

1.3 Highlight of Impact Methodology

The lands extending 0.25 mile from the shoreline were assumed to be the area indirectly influenced by TVA reservoir operations (TVA 1998). A secondary region (TVA region) consists of those counties bordering the reservoirs of the TVA system. The data for this resource are summarized by physiographic region as well as by grouping reservoirs by location (relative eastern and western) and by type (tributary and mainstem). Summary data tables are provided in Appendix A.

Data on the acres of prime farmlands and total extent of soils within a county have been provided by the county NRCS offices within the TVA region. The NRCS indicated that updates to a number of county soil surveys are in progress and that the acreage data will be revised in the near future. Acreage of prime farmland soils by county are provided in Appendix B. Information on erodible soils is from published resources and the NRCS.

As data were not available on conversion of prime farmland, trends in farmland conversion were based on total cropland data by county from the Census of Agriculture. The Census defines cropland as "land from which crops were harvested or hay was cut; land in orchards, citrus groves, vineyards, nurseries, and greenhouses; cropland used only for pasture or grazing; land in cover crops, legumes, and soil-improvement grasses; land on which all crops failed; land in cultivated summer fallow; and idle cropland".

An assessment of the general extent of prime farmland within the TVA region was conducted using data provided by county offices of the Natural Resources Conservation Service (NRCS). The prime farmland and erosion data were obtained from the State Soil Geographic (STATSGO) database (USDA, NRCS 1994) for the states within the TVA region. STATSGO is at a scale of 1:250,000, having a minimum area of detail of 625 hectares (1,544 acres) and thus is suitable for a general characterization. The soil erosion assessment used the STATSGO database (NRCS 1994a-d) to provide an estimate of the erosion potential of soils within 0.25 mile of the TVA system shoreline. The potential for an increase in soil erosion was based on changes in land use resulting in vegetation cover type changes increasing soil exposure.

Seven representative reservoirs were selected for a more detailed review of farmland conversion and soil erosion in the backlands. The representative tributary reservoirs (and their respective physiographic region) included Chatuge (Blue Ridge), Cherokee (Valley and Ridge), Tims Ford (Highland Rim), and Normandy (Highland Rim). The representative mainstem reservoirs included: Ft. Loudoun (Valley and Ridge), Nickajack (Cumberland Plateau), and Kentucky (Coastal Plain and Highland Rim). These reservoirs represent five of the six physiographic regions and were selected to provide a range of characteristics, including land that is available for residential development (from 15 to 84 percent), varying acreage of farmland, and varying rates of development (Table 1-1).

Table 1-1 Characteristics of Representative Reservoirs

Physiographic Region	Reservoir	County/State	Mainstem/ Tributary	Miles of shoreline[1]	Shoreline Available for Development [1]		1997 Acres of Farmland[2]	Rate of Development[3]
					(%)	(miles)		
Blue Ridge	Chatuge	Towns, GA; Clay, NC.	Tributary	128	62	79.6	26,996	High
Valley and Ridge	Cherokee	Grainger, Hamblen, Hawkins, Jefferson, TN	Tributary	394	44	172.3	393,793	Medium
Valley and Ridge	Ft. Loudoun	Knox, Blount, Loudon TN	Mainstem	378	84	317.2	254,994	High
Coastal Plain/Highland Rim (50:50)	Kentucky	Hardin, TN	Mainstem	2,064	45	936.9	115,598	Medium
Cumberland Plateau	Nickajack	Marion, Hamilton, TN	Mainstem	178	55	98	107,882	Low
Highland Rim	Normandy	Bedford, Coffee, TN	Tributary	75	15	11.2	271,230	Low
Highland Rim	Tims Ford	Franklin, Moore, TN	Tributary	308	15	47.7	184,041	High

[1] Sum of flowage easement and TVA-owned residential shoreland (TVA 1998).
[2] Sum of acres in counties that contain reservoir. Source: Oregon State University Libraries, Corvallis, Oregon. GovStats. Available at http://govinfo.library.orst.edu/php/agri/index.php.
[3] TVA 1990.

1.4 Regulatory and TVA Management Activities

1.4.1 Regulatory

The TVA, as a federal agency, is mandated by the FPPA to complete a prime farmland review prior to initiating a program. Congress passed the Agriculture and Food Act of 1981 (Public Law 97-98) containing the FPPA—Subtitle I of Title XV, Section 1539-1549. The final rules and regulations were published in the Federal Register on June 17, 1994. The review should (1) identify and take into account adverse effects that may occur due to TVA activities on the preservation of farmland; (2) consider alternative actions, as appropriate, that could lessen the adverse effects; and (3) ensure that TVA programs, to the extent practicable, are compatible with State and units of local government and private programs and policies to protect farmland. The FPPA does not authorize the Federal Government to regulate the use of private or nonfederal land or, in any way, affect the property rights of owners. This programmatic EIS provides an overview of the prime farmland resource in the TVA region and evaluates potential effects on prime farmland that could result from reservoir operations policy alternatives.

Parcels allocated by TVA for development prior to the passage of the FPPA would be excluded and the remaining parcels with 10 or more acres of soils classified as prime farmland would be required to complete the FPPA process prior to development. The FPPA defines farmland as not including land already in or committed to urban development or water storage. Farmland "already in" urban development or water storage includes:

- All lands with a density of 30 structures per 40-acre area.
- Lands identified as "urbanized area" on the Census Bureau Map, or as urban areas mapped with a "tint overprint" on the USGS topographical maps, or as "urban built-up" on the USDA Important Farmland Maps (7CFR 658.2).

Section 26A of The TVA Act (U.S. Congress, 1933, as amended) established standards to minimize soil erosion by requiring soil stabilization measures and vegetation management, which reduce the erosion potential from development activities. These activities are required for all development projects on lands under the jurisdiction of the TVA.

1.4.2 TVA Management Activities

TVA initiated a comprehensive reservoir management planning process in 1979. Since that time, land management plans have been completed and approved by the TVA board of directors for seven mainstem reservoirs. The land planning process identifies and evaluates the most suitable use of the land and then allocates the land into clearly defined zones. TVA considers leases for agricultural land as a short-term use with renewable leases, which can be compatible with TVA Land Use Zones. It was anticipated that Zone 3 (Sensitive Resource Management) and Zone 4 (Natural Resource Conservation) inherently protect prime farmland, whether it was currently cropped or in forest. Prime farmland allocated to Zone 2 (TVA Project Operations), Zone 5 (Industrial/Commercial Development), and Zone 7 (Residential Access or Residential Development) would be allocated for a use that would convert prime farmland to non-farm use. Zone 6 (Recreation and State Park Expansion) may result in limited impacts to prime farmland.

The land planning process identifies and evaluates the most suitable use of the land and then allocates the land into clearly defined zones. TVA considers leases for agricultural land as a short-term use with renewable leases, which are compatible with TVA land use zones. It is assumed that the same zones will protect prime farmland based on allowable uses.

More detailed assessments using FPPA criteria will be conducted as land management plans for specific reservoirs are written and updated. Subsequent assessments will complete Form AD 1006, Farmland Conversion Impact Rating when appropriate (with assistance from the NRCS), which includes summarizing total acres of prime farmland to be converted directly and indirectly by the proposed program and assigning a total score for the rating process. Sites receiving a score greater than 160 must be given further consideration for prime farmland protection.

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2 Affected Environment

2.1 Soils

The TVA system encompasses six physiographic regions (Fenneman 1938) that range from the mountainous Blue Ridge Region in the east to the nearly level Coastal Plain Region in the west (Figure 2-1). The soils within the region vary as a result of climate, parent material, and topography.

The climate within the TVA region is generally temperate, averaging 62°F, with the coolest temperatures occurring within the Cumberland and Unaka Mountains with an average of 45°F. The soils rarely freeze and then generally only to a depth of approximately 4 inches (Springer and Elder 1980). The majority of the TVA region receives between 51 and 55 inches of rain annually (DeSelm and Schmidt 2001). The Blue Ridge Region, which includes the Unaka range, receives between 43 and 79 inches of rainfall compared to 43 and 55 inches for the Valley and Ridge Region, which lies within the rain shadow of the Cumberland Plateau. The Cumberland Plateau receives over 59 inches of precipitation annually.

2.1.1 Physiographic Regions

The following review of soils within the physiographic regions is from Springer and Elder (1980). Over 50 percent of the TVA region is within two regions, 35 percent in the Highland Rim and 32 percent in the Valley and Ridge (Table 2-1).

Soils of the Blue Ridge

The Blue Ridge Region is mountainous, including the Great Smoky Mountain in the Unaka Range, with elevations ranging from 1,000 feet to over 6,000 feet. The soils of the Blue Ridge Region are derived from highly metamorphosed parent material. Bedrock in the southern portion of the region is predominately phyllite, slate, sandstone and quartzite while granite and gneiss dominate the northern portion. The soils consist of highly weatherable material and the depth varies from 1 to 3 feet at higher elevations and side slopes from 3 to 7 feet on the lower slopes. The valleys contain a variety of soils and are generally productive. The major uses are pasture, hay, burley tobacco, and vegetables.

Soils of the Valley and Ridge

The Valley and Ridge Region is bounded to the east by the Unaka Mountain Range and to the west by the Cumberland Plateau and Mountains. This region is also referred to as the “Great Valley of East Tennessee.” The topography is variable ranging from wooded parallel ridges and narrow, cleared valleys to broad expanses of rolling to hilly pasture and cropland. Streams and rivers generally follow the strike of the rock formations, although occasional gaps have formed at right angles through the ridges. The parent material of the valleys generally consist of soft shales and clayey limestones while the ridges are mostly sandstones and hard shale with some cherty, dolomitic limestone. Soil depths range from shallow over shales and sandstones to very deep over the dolomitic limestone. The upland soils are primarily highly leached, strongly acid with low fertility. Because of the variable landscape, soils properties vary over short distances resulting in small patches of productive land intermixed with average land or large tracts of rough land. The region is used primarily for pasture, hay, forest, and burley tobacco.

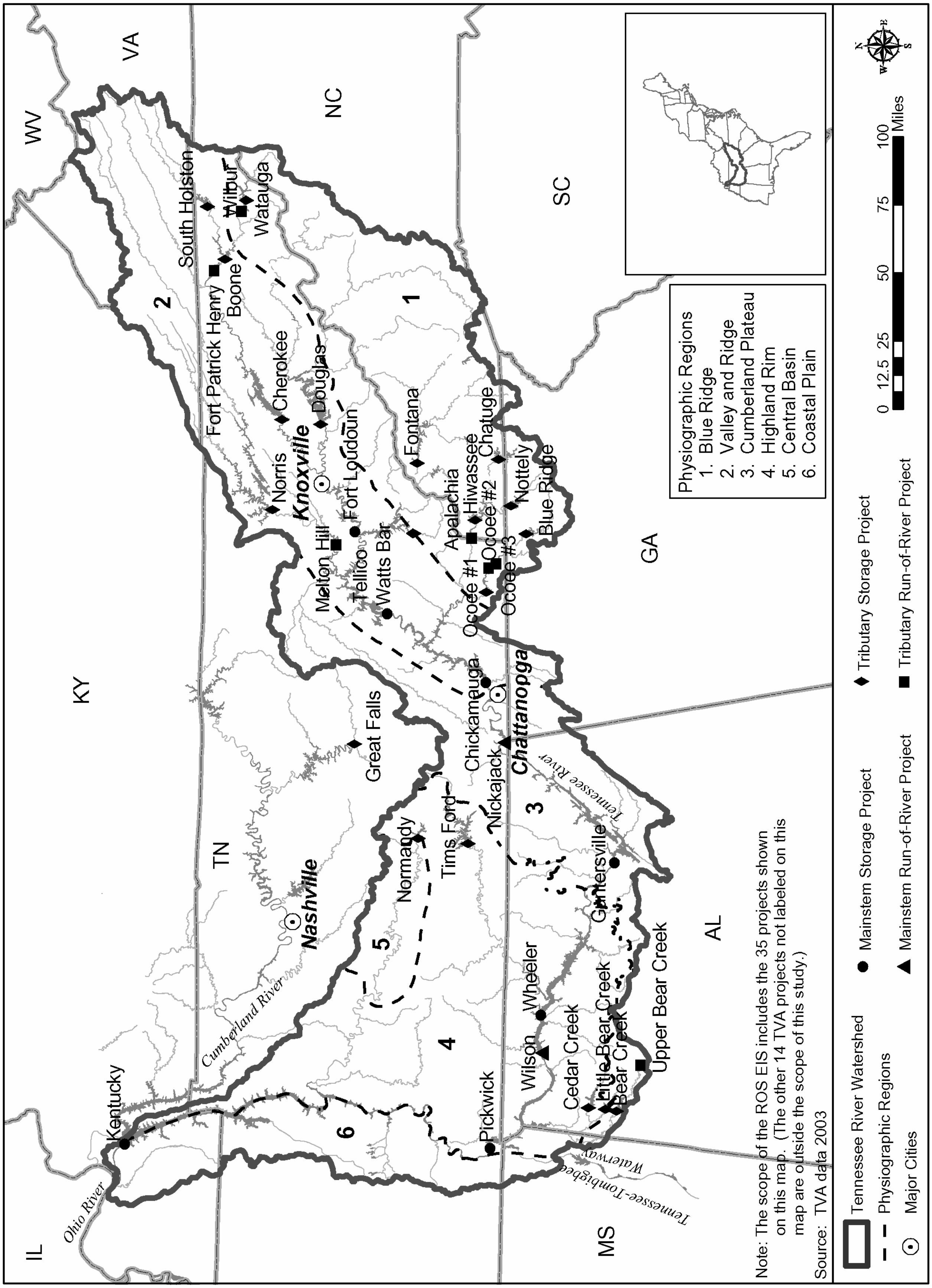


Figure 2.1 Physiographic Regions within the Tennessee River Watershed

Table 2-1 Acreage of Farmland by Physiographic Region

Physiographic Region	Land Area of TVA region		1987 Farmland (Acres)[2]	1997 Farmland (Acres)[2]	Farmland Conversion 1987 to 1997 (%)[2]	Percent 1997 Farmland in Region (%)
	Acres[1]	Percent				
Blue Ridge	1,358,904	8	169,900	155,283	-9.4	18
Coastal Plain	2,756,088	15	1,133,281	1,103,998	-2.7	40
Cumberland Plateau	1,805,350	10	400,790	418,355	4.2	23
Highland Rim	6,235,935	35	2,435,068	2,462,078	1.1	39
Valley and Ridge	5,757,232	32	2,204,114	2,025,877	-8.8	35
Total	**18,296,866**		**6,343,153**	**6,165,591**	**-2.9**	**34**

1 NRCS county soil surveys.
2 Source: Oregon State University Libraries, Corvallis, Oregon. GovStats. Available at http://govinfo.kerr.orst. edu/php/agri/index.php.

Soils of the Cumberland Plateau

The Cumberland Plateau is bounded to the west and east by escarpments. The terrain is gently rolling to hilly highland with deeply cut gorges. The plateau elevation is approximately 1,700 to 1,900 feet with a few mountain peaks in the northeastern part that range to 3,000 feet. The parent material consists of sandstones and shales resulting in soils 2 to 4 feet deep that are well drained, loamy, strongly acid and low in natural fertility. Coal mining is important in this region. Much of the area is forested, with cleared areas used primarily for pasture and hay and small crops such as corn, vegetables, small grain, soybeans, and tobacco.

Soils of the Central Basin

The Central Basin formed as a result of weathering of a limestone dome. The present basin is 60 miles wide and 120 miles long (including the Elk River basin) (Fenneman 1938). Limestone underlies the majority of the basin with thin layers of shale, siltstone, and sandstone in small inclusions. Soil depths range from several inches in large tracts of “cedar glades” to 6 to 8 feet near rivers where alluvium has been deposited. Productive cropland tends to be in small tracts, mostly on narrow river bottoms and old terraces due to the prevalence of shallow soils. The soils tend to be redder and of lower phosphorus content than the soils in the outer part of the basin. The outer part of the basin is dominated by rocks high in phosphorus compared to the inner part of the basin where phosphorus content is lower. The terrain is hilly and steep with scattered parcels of undulating and rolling land. Soils are highly productive.

Soils of the Highland Rim

The Highland Rim is the largest region within the TVA region. The terrain is predominately undulating to hilly except in the western part, which is more dissected and ranges from hilly to steep. Limestone, much of it cherty, underlies most of the region with limestone sinks a common feature in the eastern and northern parts of the region. The hill slope soils were formed from limestone and have clayey and cherty subsoils. The more level areas and hill caps have soils formed from thin loess (wind blown material) and limestone residuum. The soils are highly leached, strongly acid with low fertility except near the Kentucky-Tennessee border. Forest, hay and pasture are the main uses of the soils.

Soils of the Coastal Plain

This region is hilly with fairly wide tracts of stream bottoms and broad expanses of level and undulating terraces adjacent to and only a few feet higher than the bottoms. The parent material is predominately sands and clays deposited in ancient seas. Generally the soils are highly leached, low in fertility, and strongly acid. Quality cropland is found mainly on the bottoms and terraces, which are intensively cultivated for soybeans, corn, cotton, and hay. Control of erosion is of major concern as evidenced by deep gullies that are common on some hillsides.

2.1.2 Representative Reservoirs

The following is a brief overview of the soils bordering the representative reservoirs based on the General Soil Map of Tennessee (scale of 1:750,000) and associated text (Springer and Elder 1980), which provides an overview of soil units consisting of soil series commonly found within a region. Chatuge Reservoir is in the hilly Blue Ridge Region. The bedrock contains highly weatherable minerals including arkosic sandstone, graywacke, and feldspathic quartzite. The soils tend to be deep, ranging from 7 to 8 feet, in the coves and lower slopes. Ditney and Jeffrey soils are on the upper slopes of mountains. Brookshire and Spivey soils are in the coves and lower parts of the slopes where colluvium has collected.

The Cherokee and Fort Loudoun Reservoirs are within the Valley and Ridge Region. The topography is predominantly hilly and steep with scattered tracks of level to rolling land on the narrow bottoms, terraces and broad hilltops. The ridges are underlain primarily by sandstones and hard shale with some areas of cherty, dolomitic limestone. Soft shales and clayey limestones generally form the valleys. The hills and ridges include the Fullerton-Dewey units, which are deep, well drained, with cherty and clayey soils formed from dolomitic limestone.

The Nickajack reservoir is in the Cumberland Plateau. The Waynesboro-Etowah-Sequatchie - Allen unit is undulating to hilly, deep, well drained, clayey and loamy soils from alluvium and colluvium. Clayey limestone underlies several feet of alluvium and colluvium within this unit. The potential for farming is high with the main limitations being slope, flooding in bottomlands, and poor drainage along the edge of floodplains.

The Tims Ford and Normandy Reservoirs are within the Highland Rim Region, which is distinctive for its red soils. The soils generally are strongly acid, permeable, well drained, and very deep over limestone bedrock. The Waynesboro-Decatur-Bewleyville-Curtistown unit is undulating and rolling, red and dark-red well-drained clayey and loamy soils from alluvium and thin loess. Red or dark red clayey subsoils formed from either alluvium or limestone residuum or both. The upper portion of the soils differs based on color and texture. Soils with fragipans are also noted in this unit. The potential for farming is high in this unit with the major limitations being susceptibility to erosion and slope.

Kentucky Reservoir is on the boundary between the Coastal Plain Region to the west and Highland Rim Region to the east. The Bodine-Mountview-Dickson unit is hilly and steep, excessively drained, cherty soils from limestone, and undulating, well-drained and moderately well drained silty soils from thin loess and limestone. The soils on the foot slopes commonly are deep and cherty; some have fragipans

2.2 Farmland Conversion

2.2.1 Existing Trends

The total land area within the TVA region is 18,296,866, of which 1,791,351 acres (or 10 percent) is within 0.25 mile of the TVA system shoreline. Of the total acreage in the TVA region, 6,165,591 acres are farmland, representing 34 percent of the total land area (Table 2-1). The smallest amount of land in the TVA region is located in the Blue Ridge Region (8 percent), of which 18 percent was farmland compared to the Valley and Ridge and Highland Rim Regions—which make up a combined 67 percent of the region and account for 74 percent of farmland in the region. The Coastal Plain Region has the largest percentage of farmland, 40 percent, or 1,103,998 acres. The Highland Rim Region has 2,462, 078 acres of farmland for 39 percent of its total land area and the Valley and Ridge Region has 35 percent farmland, or 2,025,877 acres. The Cumberland Plateau Region has 418, 355 acres of farmland representing 23 percent of its total land area.

Prime Farmland

During the decade 1987 to 1997, the Census of Agriculture indicated that over 50 percent of the counties within the TVA region experienced conversion of farmland to non-farm use, with 20 counties experiencing 10 percent and higher conversion (Figure 2-2, Appendix Tables A-1 and A-2). The reduction in farmland was assumed to reflect a number of factors, including population growth and viability of agriculture in the region due to competition and economies of scale. The converted areas generally were located within a reasonable commute of large population centers in Tennessee: Kingsport and Knoxville in the Valley and Ridge Region, and Chattanooga in the Coastal Plain. The large population centers in Alabama included Florence and Huntsville in the Highland Rim Region.

The Census of Agriculture indicated that 22 counties experienced an increase in farmland, the majority occurring in Alabama (Highland Rim) and along the northern portion of Kentucky Reservoir (Coastal Plain and Highland Rim) (Appendix A, Table A-3). These numbers reflect a strong farm economy within those regions.

A review of farmland conversion by physiographic region finds that the Valley and Ridge and Blue Ridge Regions have seen the largest conversion of farmland in the last decade, with an 8.8 percent and 9.4 percent decline, respectively (Table 2-1). Overall, the TVA region experienced a 2.9-percent or 177,562-acre decline in farmland.

The total acreage of prime farmland in the TVA region is 3,849,358 acres, representing 62 percent of the total farmland acreage and 21 percent of the land area in the TVA region (Table 2-2). Over 50 percent of the farmland reported in 1997 by the Census of Agriculture in the Coastal Plain, Cumberland Plateau, and Highland Rim Regions had been categorized by NRCS as prime farmland (Figure 2-3). Counties with over 31 percent of the total acreage in prime farmland are found primarily in the Coastal Plain and Highland Rim Regions; counties with over 45 percent of the total acreage in prime farmland include Calloway County in Kentucky; Limestone and Madison Counties in Alabama, and Coffee County in Tennessee (Appendix Table A-4).

Table 2-3 summarizes the estimated acreage of prime farmland within 0.25 mile of the representative reservoirs. The extent of prime farmland by land use was based on the STATSGO (NRCS 1994) data layer overlaid with Landsat TM imagery, with a resolution of 30 meters (ca. 1992) to which U.S. Geological Survey land use classifications had been applied. Prime farmland ranges from none bordering Chatuge Reservoir to an estimated 37 percent (or 30,163 acres) of the land area within 0.25 mile of Kentucky Reservoir and 17,443 acres (or 71 percent) of the land bordering Tims Ford Reservoir.

An analysis was conducted on the type of land use (agricultural or forest) of prime farmland bordering the representative reservoirs (Table 2-3). Over 50 percent of the prime farmland is in forestland for all six reservoirs. Over 30 percent of the acreage of prime farmland for Tims Ford, Ft. Loudoun, and Nickajack Reservoirs are in agricultural use (pasture/hay and cropland). Kentucky, Tims Ford, and Nickajack Reservoirs have the highest percent of prime farmland in non-farm use—16, 11, and 11 percent, respectively.

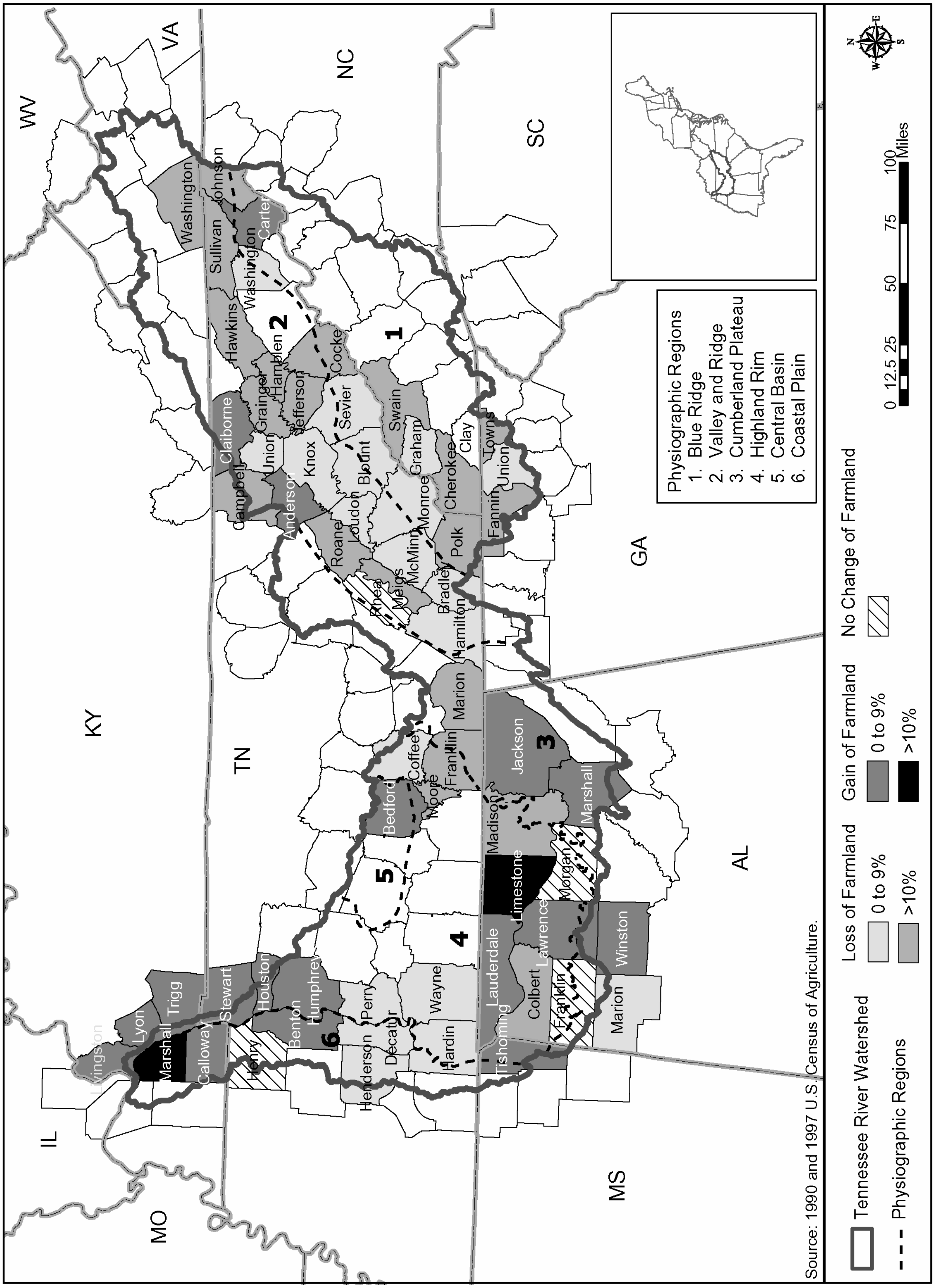


Figure 2.2 Farmland Conversion within Counties in the Tennessee River Watershed (1987 to 1997)

Table 2-2 Acreage of Prime Farmland in the TVA Region by Physiographic Region

Physiographic Region	1997 Farmland[1]	Prime Farmland[2]	
	Acres	Acres	Percent
Blue Ridge	155,283	36,460	23
Coastal Plain	1,103,998	766,741	69
Cumberland Plateau[3]	418,355	485,122	116
Highland Rim	2,462,078	1,826,591	74
Valley and Ridge	2,025,877	614,480	30
Total	**6,165,591**	**3,849,358**	**62**

[1] Source: Oregon State University Libraries, Corvallis, Oregon. GovStats. Available at http://govinfo.library.orst.edu/php/agri/index.php.
[2] Data provided by Natural Resources Conservation Service county offices.
[3] Cumberland Plateau farmland data provided by the Agricultural Census does not appear to be accurate based on the prime farmland data, which are based on actual NRCS field analysis.

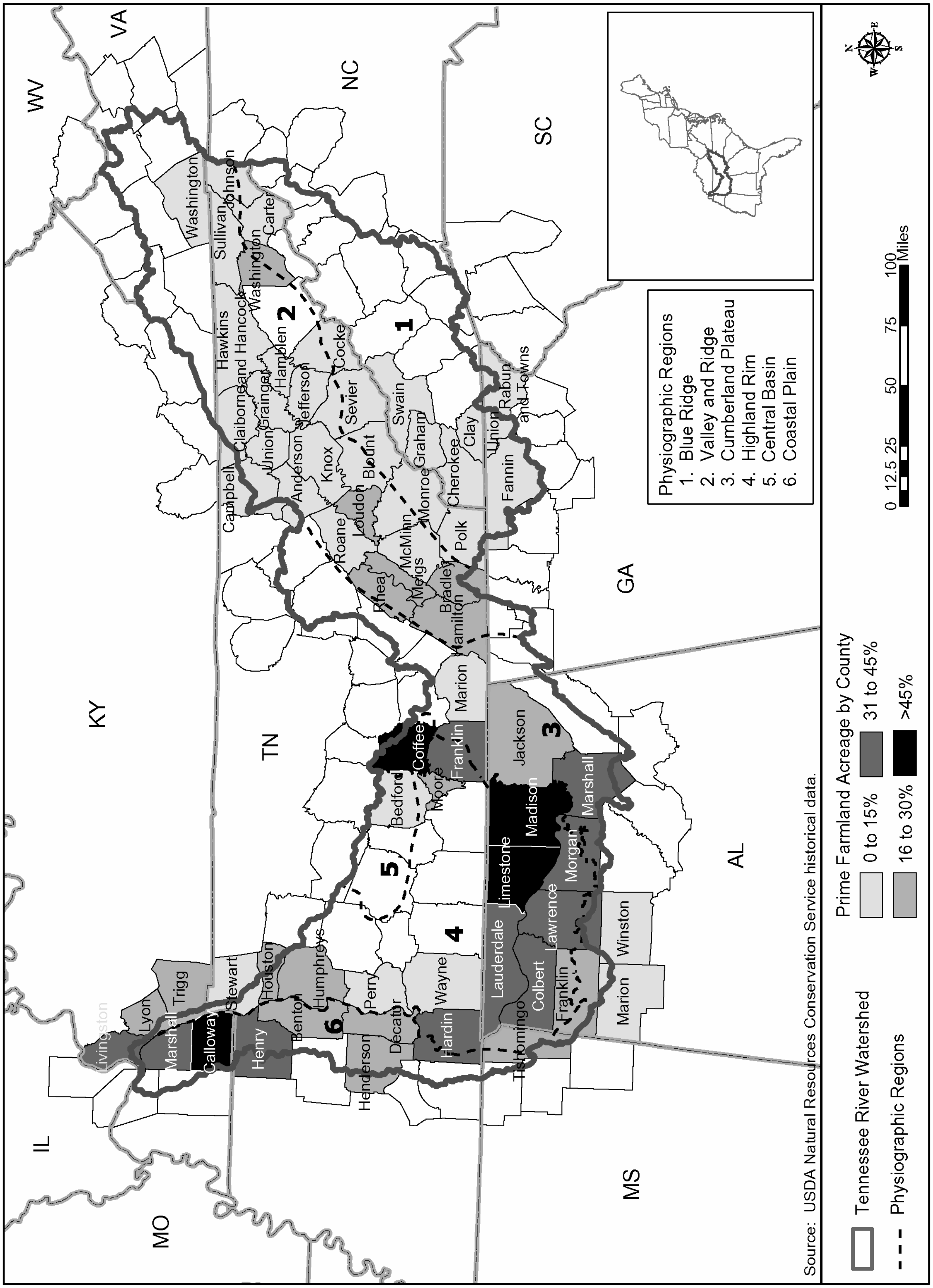


Figure 2.3 Prime Farmland Acreage by County in the Tennessee River Watershed

Table 2-3 Land Use of Prime Farmland within 0.25 Mile of Representative Reservoirs

Reservoir	Total Land within 0.25 Mile (acres)[1]	Prime Farmland		Forest-land (acres)[3]	Pasture/ Hay (acres)[3]	Row Crops (acres)[3]	Non-Farm (acres)[3]	Prime Farmland Land Use			
		(acres)[2]	%					Forest-land	Pasture/ Hay	Row Crops	Non-Farm
Chatuge	11,047	none									
Cherokee	32,088	4,059	13%	2,802	818	164	275	69%	20%	4%	7%
Ft. Loudoun	27,914	4,454	16%	2,415	1,676	250	113	54%	38%	6%	3%
Kentucky	81,779	30,163	37%	20,203	2,482	2,550	4928	67%	8%	8%	16%
Nickajack	9,085	369	4%	210	75	44	40	57%	20%	12%	11%
Normandy	9,831	319	3%	238	51	14	16	75%	16%	4%	5%
Tims Ford	24,491	17,443	71%	9,653	3,161	2,730	1899	55%	18%	16%	11%

1 Landsat TM imagery (ca. 1992).
2 STATSGO (USDA NRCS 1994).
3 Data generated by overlaying STATSGO data layer with Landsat TM imagery to which U.S. Geological Survey land use classification was applied.

A comparison of the reservoir groupings in the SMI found that the eastern tributary reservoirs have the highest average decline in farmland (11 percent) and the lowest prime farmland acreage (average 6.1 percent) in the TVA system (Table 2-4). The western commercially navigable reservoirs have the highest acreage of prime farmland, with an increase in farmland acreage of 2.3 percent during the last decade. The eastern commercially navigable and western tributary reservoirs have moderate acreage in prime farmland (average 16.5 and 25.4 percent, respectively) with declining farmland acreage of 6.3 and 5.2 percent, respectively.

2.2.2 Future Trends

Population trend data indicate that the population will continue to grow within the TVA region with the eastern portion experiencing the highest increases. Census data indicate that the population in the TVA region has shown moderate increases throughout the system from 1990 to 1997 ranging from 7.8 to 8.6 percent within the reservoir groupings (Table 2-5). Individual counties experienced higher rates including Jefferson, Loudon and Sevier Counties in Tennessee, and Towns and Union Counties in Georgia, which experienced over 18 percent increases in population during the period 1990 to 1997 (Figure 2-4, Appendix Table A-5).

It was anticipated that the decline in farmland within the majority of counties bordering the TVA region would continue based on anticipated land use pressures from development and recreation as outlined in Section 4.15, Shoreline Development and Land Use, and Section 4.24, Recreation. The highest rate of conversion is expected to continue to occur in the eastern portion of the region based on past trends. The conversion of farmland was projected to the year 2030 based on the assumption of a fixed rate of conversion, using the average conversion rate for counties bordering the representative reservoirs during the decade 1987 to 1997 (Table 2-6). A further assumption was made that farmland conversion would occur at a faster rate than forestland conversion, as farmland has the characteristics considered ideal for development, and all the farmland would be prime farmland. The SMI established a maximum residential buildout of 38 percent for the entire TVA system, projected to occur by 2023.

Based on these assumptions, farmland conversion would be less than the SMI maximum buildout of 38 percent by the Year 2023. Kentucky and Normandy Reservoirs would actually experience an increase in prime farmland if current conversion rates continue (Table 2-6). The majority of these impacts would occur on private backlands, where erosion control and stabilization measures vary by county. Overall, it is anticipated that prime farmland conversion would occur at very low rates under the Base Case, of which the majority would occur on backlands due to activities not directly related to the ROS.

Table 2-4 Acreage of Farmland by Reservoir Grouping

Reservoir	Total Prime Farmland in County[1] (acres)	Total Land in County[1] (acres)	% Prime Farmland	Farmland Conversion Rate[2]
Eastern Commercially Navigable Waterway Reservoirs				
Chickamauga	254,688	1,183,360	21.5%	-5.2%
Ft. Loudoun	123,638	843,794	14.7%	-7.1%
Melton Hill	120,143	938,523	12.8%	-6.2%
Nickajack	157,503	827,870	19.0%	-6.14%
Tellico	116,670	936,594	12.5%	-7.1%
Watts Bar	125,964	731,163	17.2%	-6.6%
Total	898,606	5,461,304	16.5%	-6.3%
Eastern Tributary Reservoirs				
Apalachia	NA[3]	NA		
Blue Ridge	8,345	461,000	1.8%	-29.0%
Boone	49,500	484,890	10.2%	-4.5%
Chatuge	10,859	482,886	2.2%	-22.0%
Cherokee	73,456	961,000	7.6%	-12.8%
Douglas	98,494	840,860	11.7%	-13.0%
Fontana	3,114	193,018	1.6%	-7.0%
Ft. Patrick Henry	49,500	484,890	10.2%	-7.5%
Hiwassee	NA	NA		
Norris	43,492	1,162,068	3.7%	-4.0%
Nottely	8,345	461,000	1.8%	-4.5%
Ocoee Project	19,715	282,900	7.0%	-15.9%
South Holston	27,153	624,100	4.4%	-13.0%
Wautaga	23,130	413,360	5.6%	-13.0%
Wilbur	14,142	222,000	6.4%	3.4%
Total	429,245	7,073,972	6.1%	-11.0%
Western Commercially Navigable Waterway Reservoirs				
Guntersville	391,730	1,595,720	24.5%	3.3%
Kentucky	1,000,013	3,836,740	26.1%	2.2%
Pickwick	507,882	1,514,520	33.5%	-4.5%
Wheeler	1,168,253	2,610,690	44.7%	3.6%
Wilson	482,196	1,318,570	36.6%	6.8%
Total	3,550,074	10,876,240	32.6%	2.3%
Western Tributary Reservoirs				
Bear Creek Project	54,405	475,870	11.4%	-2.0%
Beech River Project	119,288	540,800	22.1%	-6.2%
Normandy	206,922	582,200	35.5%	1.6%
Tims Ford	138,120	442,100	31.2%	-14.2%
Total	518,735	2,040,970	25.4%	-5.2%

[1] NRCS county data. Farmland data available only for Graham County, North Carolina. Census of Agriculture, 1987 to 1997.

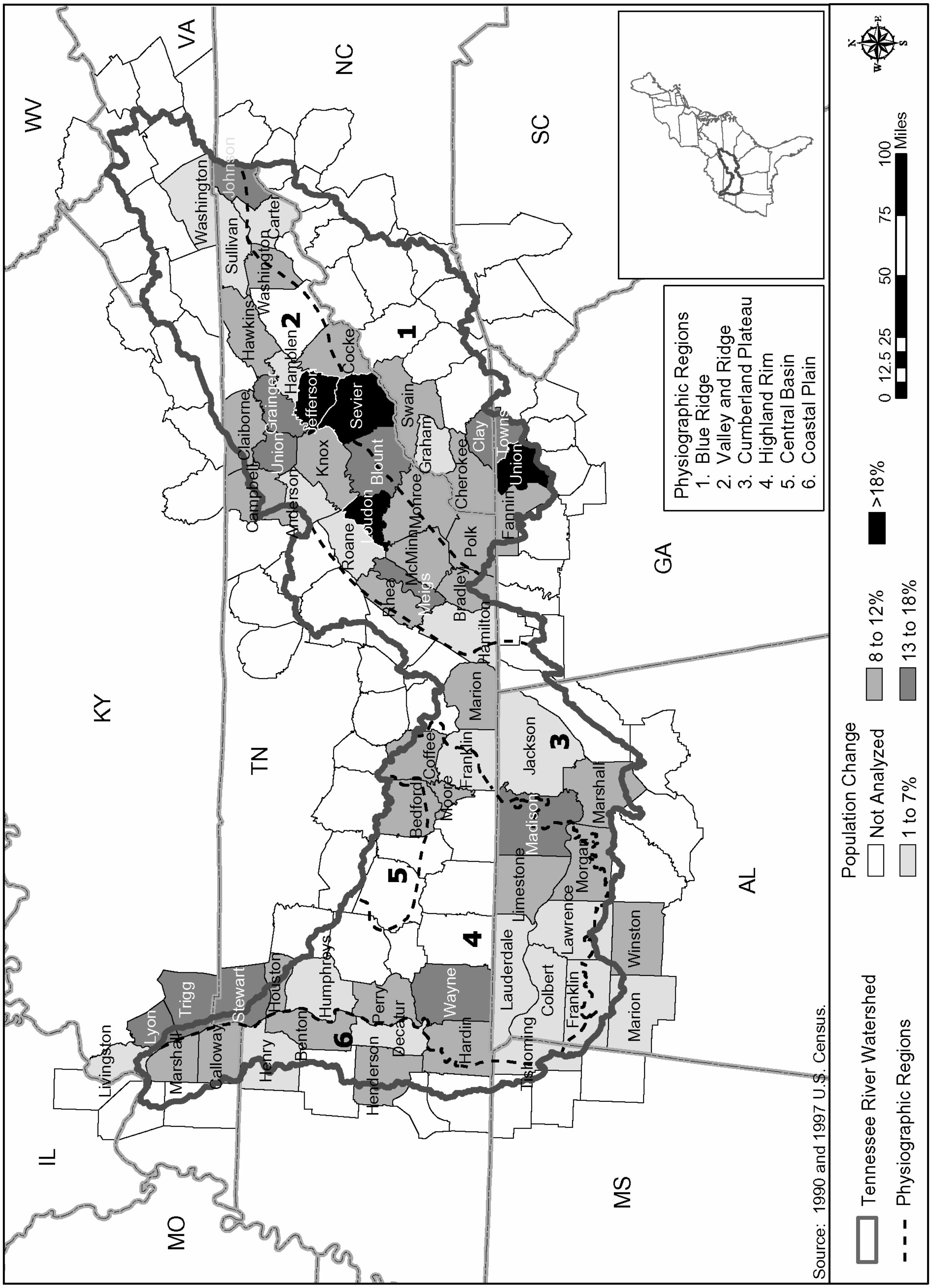
[2] Percent change from 1987 to 1997.

[3] NA = Data not available.

Table 2-5 Population Change by Reservoir Group

Reservoir Group	Population			Percent Increase	
	1980	1990	1997	1980-1990	1990-1997
Eastern Commercially Navigable	1,938,482	1,942,305	2,106,918	0.2%	7.8%
Eastern Tributary	1,379,939	1,361,513	1,489,709	-1.4%	8.6%
Western Commercially Navigable	1,265,428	1,265,428	1,383,283	0.0%	8.5%
Western Tributary	222,209	222,209	241,158	0.0%	7.9%
Total	4,808,038	4,793,445	5,223,065	-0.3%	8.2%

[1] US Census, source: http://govinfo.kerr.orst.edu.



Source: 1990 and 1997 U.S. Census.

Figure 2.4 Percent Population Change in the Tennessee River Watershed (1990 to 1997)

Table 2-6 Projection of Prime Farmland Conversion within 0.25 Mile of Representative Reservoirs

Reservoir	Total Prime Farmland in Cropland[1] (acres)	Farmland Conversion Rate[2]	Projected Prime Farmland Conversion (acres)				
			Year 2010	Year 2020	Year 2030	Total Converted (Acres)	SMI Buildout Cap[3]
Chatuge	--[4]	--					
Cherokee	982	-12.8%	-125	-109	-95	-330	373
Ft. Loudoun	1,926	-7%	-136	-127	-118	-380	732
Kentucky	5,032	+2.2%	+110	+113	+115	+338	1,912
Nickajack	119	-6.1%	-7	-7	-6	-21	45
Normandy	65	+1.6%	+1	+1	+1	+3	25
Tims Ford	5,891	-14.2%		-719	-616	-2,173	2,239

1 Sum of pasture/hay and row crops from Landsat TM imagery (ca. 1992) (NRCS 1994).
2 Rate based on 1987 and 1998 farmland conversion data, Oregon State University Libraries, Corvallis Oregon. GovStats. Available at http://govinfo.kerr.orst.edu/php/commerce/state/show.php.
3 SMI maximum buildout of 38 percent.
4 Chatuge Reservoir had no cropland within 0.5 mile.

2.3 Soil Erosion

2.3.1 Existing Trends

An overview of the extent of erodible soils in the TVA region was based on average K factors for soil associations. The K factor is a relative index of susceptibility of bare, cultivated soil to particle detachment and transport by rainfall (USDA Soil Survey Staff 1993). Soil erodibility depends on slope and soil physical characteristics, as well as vegetative cover. A more detailed analysis of shoreline erosion is provided in Section 4.16, Shoreline Erosion.

Soil erodibility is variable within the TVA region. Of the six physiographic regions, the regions with the highest estimated area of erodible soils are the Coastal Plain, Blue Ridge, and Highland Rim (NRCS 1997).

The potential for erosion for the majority of the soils within 0.25 mile of the representative reservoirs is considered moderate (Table 2-7). Kentucky Reservoir has the highest acreage of highly erodible soils (24,608 acres) and Tims Ford the second highest (5,299 acres).

2.3.2 Future Trends

The future trends discussed for farmland conversion also apply to soil erosion, as erosion is directly influenced by changes in land use. Soil erosion is anticipated to continue as land is converted from forestland, although the degree of erosion would be lessened through practices such as those required by Section 26A regulations. Activities in the backlands that are not under TVA jurisdiction come under the jurisdiction of county regulations, which may not specify minimum standards for erosion control.

Table 2-7 Erosion Potential of Soils within 0.25 Mile of Representative Reservoirs

Reservoir	Erodibility Potential (acres)[1]		
	Low	Moderate	High
Cherokee	32,783	29,489	287
Normandy		9,445	386
Nickajack	3,956	5,128	
Tims Ford		19,192	5,299
Ft. Loudoun		27,914	
Kentucky		27,453	24,608
Total	36,739	118,621	30,580

[1] The following ranges were used in assessing erodibility:
K = <0.2 are considered low as water infiltrates readily.
K = 0.2 to 0.3 are considered moderate, with moderate structural stability and infiltration.
K = >0.3 are considered high, with low infiltration rates (Brady 1990).

Source: STATSGO (NRCS 1994).

3 Environmental Consequences

3.1 Introduction and Assessment Methodology

The impact analysis focuses on the backlands—the land extending from the shoreline out 0.25 mile, which would be indirectly affected by farmland conversion and soil erosion due to land use changes brought about by changes in reservoir operations.

The majority of prime farmland bordering the reservoirs is forestland, with cropland the second most common cover type. It was assumed that conversion of prime farmland to residential/industrial/commercial use is an irretrievable loss due to the expense to restore land to agricultural use. The following analysis also assumed that reservoir operation activities that increase the rate of development along the shoreline of the reservoirs and rivers would result in a loss of prime farmland.

The factors influencing erosion include changes in land use that result in the removal of vegetation and exposure of soil. Land in forest was considered to be the least susceptible to erosion while herbaceous cover, such as lawns and cropland (particularly row crops), were considered more vulnerable to erosion (Brady 1990). In addition, the anticipated increase in foot and vehicle traffic with associated roads and trails was assumed to result in additional areas of exposed soils.

Anticipated impacts by the alternatives were assessed relative to the Base Case, which includes ongoing impacts as a result of current operations as well as indirect impacts resulting from adjacent land uses related to commercial/industrial business, farming, and residential activities outside the control of TVA. The SMI established a total residential buildout of 38 percent for the entire TVA system shoreline, which was projected to occur by 2023. The proposed alternatives also would be required to comply with the SMI, and therefore would differ from the Base Case by influencing the rate of development (see Section 4.15, Shoreline Development and Land Use). Table 3-1 provides a summary of the alternatives.

3.2 Alternatives Analysis

3.2.1 Base Case

The Base Case would continue the current reservoir pool level and tailwater release policies for the integrated operation of dams and reservoirs. Reservoir operations influence shoreline development by the duration of high water levels during the summer recreation season; the timing of water releases for recreation use; and overall reservoir fluctuations, which affect shoreline exposure and resultant visual quality.

Based on farmland conversion data, the loss of farmland would be expected to continue, particularly within the eastern tributary reservoirs, which have the highest rate of farmland conversion in the TVA system. The loss would be attributed to factors unrelated to TVA's reservoir operations policy, including proximity of reservoirs to large urban populations. Most likely, development would focus initially on existing cropland due to the low cost of site preparation. The total loss of prime farmland under the Base Case is considered very low compared to the prime farmland resource within the counties bordering the TVA system..

Table 3-1. Summary of Impacts on Prime Farmland and Soils by Policy Alternative.

Alternative								
Base Case	**Reservoir Recreation Alternative A**	**Reservoir Recreation Alternative B**	**Summer Hydropower**	**Equalized Summer/ Winter Flood Risk**	**Commercial Navigation**	**Tailwater Recreation**	**Tailwater Habitat**	**Preferred Alternative**
Farmland conversion is considered minimal compared to overall resources of counties bordering the TVA system. Section 26A standards would minimize erosion on land bordering shoreline. Erosion controls in backlands depend on county regulations, which are variable.	Farmland conversion and resultant soil erosion are projected to increase at a slightly faster rate than under the Base Case, but the total amount of farmland conversion through 2030 is expected to be similar to the Base Case.	Farmland conversion and resultant soil erosion are projected to increase at a faster rate than under Reservoir Recreation Alternative A, but the total amount of farmland conversion through 2030 is expected to be similar to the Base Case.	Farmland conversion and soil erosion are projected to be slower than under the Base Case. The total amount of farmland conversion through 2030 may be less than under the Base Case.	Farmland conversion and soil erosion are projected to be slower than under the Base Case. The total amount of farmland conversion, however, may be less than under the Base Case.	Farmland conversion and soil erosion are projected to be at a similar rate to the Base Case, but the total amount of farmland conversion through 2030 is expected to be similar to the Base Case.	Farmland conversion and soil erosion are projected to increase at a faster rate than under Reservoir Recreation Alternative B, but the total amount of farmland conversion through 2030 is expected to be similar to the Base Case.	Farmland conversion and soil erosion are projected to increase at a slightly faster rate than under Reservoir Recreation Alternative B, but the total amount of farmland conversion through 2030 is expected to be similar to the Base Case.	Farmland conversion and soil erosion are projected to increase at a higher rate than under the Base Case, but the total amount of farmland conversion through 2030 is expected to be similar to the Base Case.

The erosion potential of soils in the backlands was estimated to be moderate based on a review of six representative reservoirs. Current TVA standards for soil stabilization and vegetation management under Permit 26A result in minimizing the impact of erosion. The major difference between the Base Case and the policy alternatives will be the effect increased rates of development would have on soil erosion within the backlands, where county soil erosion and stabilization regulations are variable to non-existent.

Farmland conversion at the county level is projected based on conversion rates (Census of Agriculture, 1987 to 1997) for the reservoir groupings. The farmland conversion rate for the western commercially navigable reservoirs was ranked as low; the eastern commercially navigable and western tributary reservoirs as moderate; and the eastern tributary reservoirs as high (low = <4 percent; moderate = 4.1 to 9 percent, and high - >10 percent) (see Table 2-4). Overall, farmland conversion projections estimated insignificant loss of prime farmland within 0.25 mile of the TVA shoreline under the Base Case; most of the conversion would occur due to factors unrelated to TVA's reservoir operations. Erosion controls within the backland would continue to depend on county-specific regulations.

3.2.2 Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Tailwater Recreation Alternative, Tailwater Habitat Alternative, and the Preferred Alternative

The rate of farmland conversion and soil erosion under Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative was considered higher than that under the Base Case for all the eastern tributary and eastern commercially navigable reservoirs and four of the western commercially navigable reservoirs. Under these alternatives, the rate of conversion for the western tributary reservoirs would not change. The Tailwater Recreation Alternative would result in the highest rate of conversion compared to Reservoir Recreation Alternative B. Conversion under both the Tailwater Recreation Alternative and Reservoir Recreation Alternative B would be higher than under Reservoir Recreation Alternative A. Conversion under the Tailwater Habitat Alternative would increase at a slightly higher rate than under the Base Case.

The Preferred Alternative would result in a higher rate of farmland conversion and soil erosion for a majority of the eastern tributaries and four mainstem reservoirs. There would be no change to the western tributaries compared to the Base Case.

3.2.3 Summer Hydropower Alternative and Equalized Summer/Winter Flood Risk Alternative

The rate of farmland conversion and soil erosion under the Summer Hydropower Alternative and Equalized Summer/Winter Flood Risk Alternative was considered slower than under the Base Case for all reservoirs.

3.2.4 Commercial Navigation Alternative

The Commercial Navigation Alternative would result in similar impacts on prime farmland and soil erosion as the Base Case.

3.3 Conclusions

The land use buildout rate, as described in the SMI, would continue to occur under all alternatives, including the Base Case. Therefore, the conversion of prime farmland out to 2030 would be similar under all alternatives. However, development may be accelerated under certain alternatives, resulting in an accelerated rate of prime farmland conversion. Erosion controls in the backlands would continue to depend on county-specific regulations, which govern land development and minimizing erosion from construction sites.

Table 3-1 provides a summary of impacts on prime farmland and soils by policy alternative. Under the Base Case, farmland conversion and soil erosion were considered to be minimal within 0.25 mile of the TVA shoreline. Impacts under the Commercial Navigation Alternative would be similar to those for the Base Case. Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative would increase the rates of farmland conversion and soil erosion. The highest rates would result under the Tailwater Recreation Alternative, and the rates under the Tailwater Habitat Alternative would increase only slightly from those under the Base Case. The Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative would result in slower rates of farmland conversion and therefore slower impacts on prime farmland and soils compared to the Base Case.

4 Supporting Information

4.1 Glossary

Backlands –Lands extending 0.25 mile from the shoreline and generally in private ownership.

Prime farmland – Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion. Prime farmland includes land that possesses the above characteristics but are being used currently to produce livestock and timber" (7 U.S.C.: 4201 et seq.).

Section 26A – Section 26a of the TVA Act.

TVA Region – Counties bordering the TVA system.

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Appendix A

Tables

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Table A-1 Counties with Farmland Conversion Exceeding 10% (1987 to 1997)

Physiographic Region	Reservoir	County	State	1987 (Acres)	1997 (Acres)	Percent Change
Blue Ridge	Blue Ridge	Fannin	GA	19,413	15,052	-28.97%
Blue Ridge	Chatuge	Towns	GA	10,638	8,708	-22.16%
Blue Ridge	Ocoee Project	Polk	TN	37,228	32,122	-15.90%
Blue Ridge	Apalachia, Hiwassee	Cherokee	NC	27,100	24,533	-10.46%
Coastal Plain	Pickwick	Colbert	AL	145,104	115,542	-25.59%
Cumberland Plateau	Nickajack	Marion	TN	56,177	51,060	-10.02%
Highland Rim	Tims Ford	Franklin	TN	152,578	131,976	-15.61%
Highland Rim	Wheeler	Madison	AL	235,478	210,455	-11.89%
Highland Rim	Tims Ford	Moore	TN	57,642	52,065	-10.71%
Valley and Ridge	Watauga	Johnson	TN	62,446	49,475	-26.22%
Valley and Ridge	Douglas	Cocke	TN	89,277	75,222	-18.68%
Valley and Ridge	Cherokee	Hawkins	TN	167,866	146,888	-14.28%
Valley and Ridge	Norris	Campbell	TN	34,850	30,683	-13.58%
Valley and Ridge	S. Holston	Washington	VA	202,709	178,496	-13.57%
Valley and Ridge	S. Holston, Ft. Patrick Henry, Boone	Sullivan	TN	97,537	86,402	-12.89%
Valley and Ridge	Cherokee, Douglas	Hamblen	TN	58,434	51,996	-12.38%
Valley and Ridge	Watts Bar, Chickamauga	Meigs	TN	54,949	48,977	-12.19%
Valley and Ridge	Cherokee, Douglas	Jefferson	TN	109,592	98,067	-11.75%
Valley and Ridge	Norris, Cherokee	Grainger	TN	108,212	96,842	-11.74%
Valley and Ridge	Melton Hill, Watts Bar	Roane	TN	58,739	53,110	-10.60%

Source: Oregon State University Libraries, Corvallis, Oregon. GovStats. Available at http://govinfo.library.orst.edu/php/agri/index.php.

Table A-2 Conversion of Farmland (1987 to 1997)

Physiographic Region	Reservoir	County	State	1987 (Acres)	1997 (Acres)	Percent Change
Blue Ridge	Blue Ridge	Fannin	GA	19,413	15,052	-28.97%
Blue Ridge	Chatuge	Towns	GA	10,638	8,708	-22.16%
Blue Ridge	Ocoee Project	Polk	TN	37,228	32,122	-15.90%
Blue Ridge	Apalachia, Hiwassee	Cherokee	NC	27,100	24,533	-10.46%
Blue Ridge	Fontana	Swain	NC	7,258	6,624	-9.57%
Blue Ridge	Fontana	Graham	NC	7,533	7,194	-4.71%
Blue Ridge	Nottely	Union	GA	23,141	22,156	-4.45%
Blue Ridge	Wilbur, Watauga	Carter	TN	37,589	38,894	3.36%
Blue Ridge	Chatuge	Clay	NC	withheld	18,288	
Total				**169,900**	**155,283**	**-9.41%**
Coastal Plain	Pickwick	Colbert	AL	145,104	115,542	-25.59%
Coastal Plain	Beech River Project	Henderson	TN	163,685	152,034	-7.66%
Coastal Plain	Guntersville, Bear Creek Project	Marion	AL	105,586	98,078	-7.66%
Coastal Plain	Pickwick, Kentucky	Hardin	TN	121,098	115,598	-4.76%
Coastal Plain	Kentucky, Beech River Project	Decatur	TN	91,591	88,399	-3.61%
Coastal Plain	Kentucky	Henry	TN	186,659	185,304	-0.73%
Coastal Plain	Pickwick	Tishomingo	MS	43,216	44,866	3.68%
Coastal Plain	Kentucky	Calloway	KY	137,781	145,909	5.57%
Coastal Plain	Kentucky	Benton	TN	64,560	68,931	6.34%
Coastal Plain	Kentucky	Marshall	KY	74,001	89,337	17.17%
Total				**1,133,281**	**1,103,998**	**-2.65%**
Cumberland Plateau	Nickajack	Marion	TN	56,177	51,060	-10.02%
Cumberland Plateau	Guntersville	Jackson	AL	208,014	221,166	5.95%
Cumberland Plateau	Guntersville, Wheeler	Marshall	AL	136,599	146,129	6.52%
Total				**400,790**	**418,355**	**4.20%**
Highland Rim	Tims Ford	Franklin	TN	152,578	131,976	-15.61%
Highland Rim	Wheeler	Madison	AL	235,478	210,455	-11.89%
Highland Rim	Tims Ford	Moore	TN	57,642	52,065	-10.71%
Highland Rim	Kentucky	Perry	TN	58,327	54,390	-7.24%
Highland Rim	Normandy	Coffee	TN	143,496	135,615	-5.81%
Highland Rim	Kentucky	Wayne	TN	135,209	130,012	-4.00%
Highland Rim	Wheeler	Morgan	AL	159,757	158,711	-0.66%
Highland Rim	Bear Creek Project	Franklin	AL	127,653	128,437	0.61%
Highland Rim	Kentucky	Humphreys	TN	120,570	121,983	1.16%
Highland Rim	Kentucky	Stewart	TN	55,703	56,517	1.44%
Highland Rim	Bear Creek Project	Winston	AL	57,923	59,090	1.97%
Highland Rim	Kentucky	Trigg	KY	111,362	116,966	4.79%
Highland Rim	Wheeler, Wilson, Pickwick	Lauderdale	AL	199,960	211,586	5.49%

Table A-2 Conversion of Farmland (1987 to 1997) (Continued)

Physiographic Region	Reservoir	County	State	1987 (Acres)	1997 (Acres)	Percent Change
Highland Rim	Normandy	Bedford	TN	207,434	221,058	6.16%
Highland Rim	Kentucky	Livingston	KY	110,028	117,279	6.18%
Highland Rim	Kentucky	Houston	TN	45,691	48,735	6.25%
Highland Rim	Kentucky	Lyon	KY	44,702	48,344	7.53%
Highland Rim	Wheeler, Wilson	Lawrence	AL	188,365	204,970	8.10%
Highland Rim	Wheeler	Limestone	AL	223,190	253,889	12.09%
Total				**2,435,068**	**2,462,078**	**1.10%**
Valley and Ridge	Watauga	Johnson	TN	62,446	49,475	-26.22%
Valley and Ridge	Douglas	Cocke	TN	89,277	75,222	-18.68%
Valley and Ridge	Cherokee	Hawkins	TN	167,866	146,888	-14.28%
Valley and Ridge	Norris	Campbell	TN	34,850	30,683	-13.58%
Valley and Ridge	S. Holston	Washington	VA	202,709	178,496	-13.57%
Valley and Ridge	S. Holston, Ft. Patrick Henry, Boone	Sullivan	TN	97,537	86,402	-12.89%
Valley and Ridge	Cherokee, Douglas	Hamblen	TN	58,434	51,996	-12.38%
Valley and Ridge	Watts Bar, Chickamauga	Meigs	TN	54,949	48,977	-12.19%
Valley and Ridge	Cherokee, Douglas	Jefferson	TN	109,592	98,067	-11.75%
Valley and Ridge	Norris, Cherokee	Grainger	TN	108,212	96,842	-11.74%
Valley and Ridge	Melton Hill, Watts Bar	Roane	TN	58,739	53,110	-10.60%
Valley and Ridge	Douglas	Sevier	TN	78,192	71,677	-9.09%
Valley and Ridge	Tellico	Blount	TN	101,397	93,209	-8.78%
Valley and Ridge	Chickamauga	McMinn	TN	137,843	127,322	-8.26%
Valley and Ridge	Ft. Loudoun	Monroe	TN	104,646	96,929	-7.96%
Valley and Ridge	Melton Hill, Ft. Loudoun	Knox	TN	94,701	87,809	-7.85%
Valley and Ridge	Melton Hill, Ft. Loudoun, Tellico, Watts Bar	Loudon	TN	77,665	73,976	-4.99%
Valley and Ridge	Norris	Union	TN	53,305	51,290	-3.93%
Valley and Ridge	Ft. Patrick Henry, Boone	Washington	TN	123,904	119,670	-3.54%
Valley and Ridge	Chickamauga	Bradley	TN	92,127	90,067	-2.29%
Valley and Ridge	Chickamauga, Nickajack	Hamilton	TN	57,708	56,822	-1.56%
Valley and Ridge	Watts Bar, Chickamauga	Rhea	TN	55,956	56,049	0.17%
Valley and Ridge	Melton Hill, Norris	Anderson	TN	40,472	40,928	1.11%
Valley and Ridge	Norris	Claiborne	TN	141,587	143,971	1.66%
Total Valley and Ridge				**2,204,114**	**2,025,877**	**-8.80%**
Total Farmland				**6,343,153**	**6,165,591**	**-2.88%**

Source: Oregon State University Libraries, Corvallis, Oregon. GovStats. Available at http://govinfo.library.orst.edu/php/agri/index.php.

Table A-3 Counties with Increasing Farmland Acreage (1987 to 1997)

Physiographic Region	Reservoir	County	State	1987 (Acres)	1997 (Acres)	Percent Change
Blue Ridge	Wilbur, Watauga	Carter	TN	37,589	38,894	3.36%
Coastal Plain	Kentucky	Marshall	KY	74,001	89,337	17.17%
Coastal Plain	Kentucky	Benton	TN	64,560	68,931	6.34%
Coastal Plain	Kentucky	Calloway	KY	137,781	145,909	5.57%
Coastal Plain	Pickwick	Tishomingo	MS	43,216	44,866	3.68%
Cumberland Plateau	Guntersville, Wheeler	Marshall	AL	136,599	146,129	6.52%
Cumberland Plateau	Guntersville	Jackson	AL	208,014	221,166	5.95%
Highland Rim	Wheeler	Limestone	AL	223,190	253,889	12.09%
Highland Rim	Wheeler, Wilson	Lawrence	AL	188,365	204,970	8.10%
Highland Rim	Kentucky	Lyon	KY	44,702	48,344	7.53%
Highland Rim	Kentucky	Houston	TN	45,691	48,735	6.25%
Highland Rim	Kentucky	Livingston	KY	110,028	117,279	6.18%
Highland Rim	Normandy	Bedford	TN	207,434	221,058	6.16%
Highland Rim	Wheeler, Wilson, Pickwick	Lauderdale	AL	199,960	211,586	5.49%
Highland Rim	Kentucky	Trigg	KY	111,362	116,966	4.79%
Highland Rim	Bear Creek Project	Winston	AL	57,923	59,090	1.97%
Highland Rim	Kentucky	Stewart	TN	55,703	56,517	1.44%
Highland Rim	Kentucky	Humphreys	TN	120,570	121,983	1.16%
Highland Rim	Bear Creek Project	Franklin	AL	127,653	128,437	0.61%
Valley and Ridge	Norris	Claiborne	TN	141,587	143,971	1.66%
Valley and Ridge	Melton Hill, Norris	Anderson	TN	40,472	40,928	1.11%
Valley and Ridge	Watts Bar, Chickamauga	Rhea	TN	55,956	56,049	0.17%

Source: Oregon State University Libraries, Corvallis, Oregon. GovStats. Available at http://govinfo.library.orst.edu/php/agri/index.php.

Table A-4 Prime Farmland Acreage by County and Physiographic Region[1]

Physiographic Region	County	State	Total Prime Farmland (Acres)	Total Land in County (Acres)	Prime Farmland in County (%)
Blue Ridge	Fannin and Union	GA	8,345	461,000	1.81%
Blue Ridge	Rabun and Towns	GA	3,430	341,760	1.00%
Blue Ridge	Cherokee	NC	NA[2]	NA[2]	
Blue Ridge	Clay	NC	7,429	141,126	5.26%
Blue Ridge	Graham	NC	3,114	193,018	1.61%
Blue Ridge	Swain	NC	NA[2]	339,200	
Blue Ridge	Carter	TN	14,142	222,000	6.37%
Total Land[3]			**36,460**	**1,358,904**	**2.68%**
Coastal Plain	Colbert	AL	133,794	399,170	33.52%
Coastal Plain	Marion	AL	54,405	475,870	11.43%
Coastal Plain	Tishomingo	MS	50,702	279,640	18.13%
Coastal Plain	Benton	TN	66,230	245,248	27.01%
Coastal Plain	Decatur	TN	58,070	211,200	27.50%
Coastal Plain	Hardin	TN	131,832	375,680	35.09%
Coastal Plain	Henderson	TN	61,218	329,600	18.57%
Coastal Plain	Henry	TN			
Coastal Plain	Calloway	KY	124,410	245,760	50.62%
Coastal Plain	Marshall	KY	86,080	193,920	44.39%
Total Land			**766,741**	**2,756,088**	**27.82%**
Cumberland Plateau	Jackson	AL	172,069	721,100	23.86%
Cumberland Plateau	Marshall	AL	165,256	398,750	41.44%
Cumberland Plateau	Hamilton	TN	103,098	352,000	29.29%
Cumberland Plateau	Marion	TN	44,699	333,500	13.40%
Total Land			**485,122**	**1,805,350**	**26.87%**
Highland Rim	Franklin	AL	65,125	413,830	15.74%
Highland Rim	Lauderdale	AL	191,554	460,030	41.64%
Highland Rim	Lawrence	AL	156,848	459,370	34.14%
Highland Rim	Limestone	AL	228,552	388,700	58.80%
Highland Rim	Madison	AL	271,929	520,380	52.26%
Highland Rim	Morgan	AL	154,114	383,460	40.19%
Highland Rim	Winston	AL	NA[2]	404,290	
Highland Rim	Livingston	KY	76,402	219,085	34.87%
Highland Rim	Lyon	KY	37,490	142,726	26.27%
Highland Rim	Trigg	KY	80,320	275,320	29.17%
Highland Rim	Bedford	TN	37,340	304,200	12.27%
Highland Rim	Coffee	TN	169,582	278,000	61.00%
Highland Rim	Franklin	TN	123,045	358,400	34.33%
Highland Rim	Houston	TN	29,381	132,500	22.17%
Highland Rim	Humphreys	TN	59,776	352,064	16.98%
Highland Rim	Moore	TN	15,075	83,700	18.01%
Highland Rim	Perry	TN	23,804	271,100	8.78%
Highland Rim	Stewart	TN	48,148	318,080	15.14%
Highland Rim	Wayne	TN	58,106	470,700	12.34%
Total Land			**1,826,591**	**6,235,935**	**29.29%**

Table A-4 Prime Farmland Acreage by County and Physiographic Region[1] (Continued)

Physiographic Region	County	State	Total Prime Farmland (Acres)	Total Land in County (Acres)	Prime Farmland in County (%)
Valley and Ridge	Anderson	TN	16,260	214,400	7.58%
Valley and Ridge	Blount	TN	54,051	362,871	14.90%
Valley and Ridge	Bradley	TN	41,174	216,320	19.03%
Valley and Ridge	Campbell	TN	5,926	317,500	1.87%
Valley and Ridge	Claiborne	TN	6,136	277,963	2.21%
Valley and Ridge	Cocke	TN	33,211	277,760	11.96%
Valley and Ridge	Grainger	TN	7,438	193,700	3.84%
Valley and Ridge	Hamblen	TN	12,032	112,000	10.74%
Valley and Ridge	Hawkins and Hancock	TN	32,915	454,400	7.24%
Valley and Ridge	Jefferson	TN	21,071	200,900	10.49%
Valley and Ridge	Johnson	TN	8,988	191,360	4.70%
Valley and Ridge	Knox	TN	46,128	329,600	14.00%
Valley and Ridge	Loudon	TN	23,459	151,323	15.50%
Valley and Ridge	McMinn	TN	42,207	278,400	15.16%
Valley and Ridge	Meigs	TN	25,905	122,240	21.19%
Valley and Ridge	Monroe	TN	39,160	422,400	9.27%
Valley and Ridge	Polk	TN	19,715	282,900	6.97%
Valley and Ridge	Rhea	TN	42,304	214,400	19.73%
Valley and Ridge	Roane	TN	34,296	243,200	14.10%
Valley and Ridge	Sevier	TN	32,180	250,200	12.86%
Valley and Ridge	Sullivan	TN	14,461	275,100	5.26%
Valley and Ridge	Union	TN	7,732	158,505	4.88%
Valley and Ridge	Washington	TN	35,039	209,790	16.70%
Valley and Ridge	Washington	VA	12692	349,000	3.64%
Total Land			**601,788**	**5,757,232**	**10.45%**
Total in TVA region			**3,716,702**	**17,913,509**	**20.75%**

[1] Data provided by Natural Resources Conservation Service county offices.
[2] NA = Not available.
[3] Totals only include counties in which both total prime farmland and total land in county are provided.

Table A-5 Population Change by Reservoir[1]

Physiographic Region	Reservoir	County	State	1990	1997	Percent Change
Eastern Commercially Navigable Waterway Reservoirs						
Valley and Ridge	Chickamauga	Bradley	TN	73,712	80,250	8.15%
Valley and Ridge	Chickamauga	Hamilton	TN	285,536	294,676	3.10%
Valley and Ridge	Chickamauga	McMinn	TN	42,383	45,890	7.64%
Valley and Ridge	Chickamauga	Meigs	TN	8,033	9,697	17.16%
Valley and Ridge	Chickamauga	Rhea	TN	24,344	27,588	11.76%
Subtotal				**434,008**	**458,101**	**5.26%**
Valley and Ridge	Ft. Loudoun	Knox	TN	335,749	365,626	8.17%
Valley and Ridge	Ft. Loudoun	Loudon	TN	31,255	38,234	18.25%
Valley and Ridge	Ft. Loudoun	Blount	TN	85,969	100,377	14.35%
Subtotal				**452,973**	**504,237**	**10.17%**
Valley and Ridge	Melton Hill	Anderson	TN	68,250	71,429	4.45%
Valley and Ridge	Melton Hill	Knox	TN	335,749	365,626	8.17%
Valley and Ridge	Melton Hill	Loudon	TN	31,255	38,234	18.25%
Valley and Ridge	Melton Hill	Roane	TN	47,227	49,909	5.37%
Subtotal				**482,481**	**525,198**	**8.13%**
Valley and Ridge	Nickajack	Hamilton	TN	285,536	294,676	3.10%
Cumberland Plateau	Nickajack	Marion	TN	24,860	26,733	7.01%
Subtotal				**310,396**	**321,409**	**3.43%**
Valley and Ridge	Tellico	Blount	TN	85,969	100,377	14.35%
Valley and Ridge	Tellico	Loudon	TN	31,255	38,234	18.25%
Valley and Ridge	Tellico	Monroe	TN	30,541	33,934	10.00%
Subtotal				**147,765**	**172,545**	**14.36%**
Valley and Ridge	Watts Bar	Loudon	TN	31,255	38,234	18.25%
Valley and Ridge	Watts Bar	Meigs	TN	8,033	9,697	17.16%
Valley and Ridge	Watts Bar	Rhea	TN	24,344	27,588	11.76%
Valley and Ridge	Watts Bar	Roane	TN	47,227	49,909	5.37%
Subtotal				**110,859**	**125,428**	**11.62%**
Eastern Tributary Reservoirs						
Blue Ridge	Apalachia	Cherokee	NC	20,170	22,282	9.48%
Blue Ridge	Blue Ridge	Fannin	GA	15,992	18,090	11.60%
Valley and Ridge	Boone	Sullivan	TN	143,596	150,684	4.70%
Valley and Ridge	Boone	Washington	TN	92,315	101,558	9.10%
Subtotal				**235,911**	**252,242**	**6.47%**
Blue Ridge	Chatuge	Clay	NC	7,155	8,292	13.71%
Blue Ridge	Chatuge	Towns	GA	6,754	8,167	17.30%
Subtotal				**13,909**	**16,459**	**15.49%**
Valley and Ridge	Cherokee	Grainger	TN	17,095	19,462	12.16%
Valley and Ridge	Cherokee	Hamblen	TN	50,480	53,737	6.06%
Valley and Ridge	Cherokee	Hawkins	TN	44,565	48,777	8.64%
Valley and Ridge	Cherokee	Jefferson	TN	33,016	45,054	26.72%
Subtotal				**145,156**	**167,030**	**13.10%**
Valley and Ridge	Douglas	Cocke	TN	29,141	31,597	7.77%
Valley and Ridge	Douglas	Hamblen	TN	50,480	53,737	6.06%
Valley and Ridge	Douglas	Jefferson	TN	33,016	45,054	26.72%
Valley and Ridge	Douglas	Sevier	TN	51,043	62,602	18.46%
Subtotal				**163,680**	**192,990**	**15.19%**

Table A-5 Population Change by Reservoir[1] (Continued)

Physiographic Region	Reservoir	County	State	1990	1997	Percent Change
Blue Ridge	Fontana	Graham	NC	7,196	7,657	6.02%
Blue Ridge	Fontana	Swain	NC	11,268	12,189	7.56%
Subtotal				**18,464**	**19,846**	**6.96%**
Valley and Ridge	Ft. Patrick Henry	Sullivan	TN	143,596	150,684	4.70%
Valley and Ridge	Ft. Patrick Henry	Washington	TN	92,315	101,558	9.10%
Subtotal				**235,911**	**252,242**	**6.47%**
Blue Ridge	Hiwassee	Cherokee	NC	20,170	22,282	9.48%
Subtotal				**20,170**	**22,282**	**9.48%**
Valley and Ridge	Norris	Anderson	TN	68,250	71,429	4.45%
Valley and Ridge	Norris	Campbell	TN	35,079	37,859	7.34%
Valley and Ridge	Norris	Claiborne	TN	26,137	28,999	9.87%
Valley and Ridge	Norris	Grainger	TN	17,095	19,462	12.16%
Valley and Ridge	Norris	Union	TN	13,694	15,913	13.94%
Subtotal				**160,255**	**173,662**	**7.72%**
Blue Ridge	Nottely	Union	GA	11,993	15,675	23.49%
Subtotal				**11,993**	**15,675**	**23.49%**
Blue Ridge	Ocoee Project	Polk	TN	13,643	14,703	7.21%
Subtotal				**13,643**	**14,703**	**7.21%**
Valley and Ridge	S. Holston	Sullivan	TN	143,596	150,684	4.70%
Valley and Ridge	S. Holston	Washington	VA	45,887	48,802	5.97%
Subtotal				**189,483**	**199,486**	**5.01%**
Blue Ridge	Watauga	Carter	TN	51,505	53,082	2.97%
Valley and Ridge	Watauga	Johnson	TN	13,766	16,556	16.85%
Subtotal				**65,271**	**69,638**	**6.27%**
Blue Ridge	Wilbur	Carter	TN	51,505	53,082	2.97%
Subtotal				**51,505**	**53,082**	**2.97%**
Western Commercially Navigable Waterway Reservoirs						
Cumberland Plateau	Guntersville	Jackson	AL	47,796	50,751	5.82%
Coastal Plain	Guntersville	Marion	AL	29,830	30,813	3.19%
Cumberland Plateau	Guntersville	Marshall	AL	70,832	78,893	10.22%
Subtotal				**148,458**	**160,457**	**7.48%**
Coastal Plain	Kentucky	Benton	TN	14,524	16,311	10.96%
Coastal Plain	Kentucky	Calloway	KY	30,735	33,072	7.07%
Coastal Plain	Kentucky	Decatur	TN	10,472	10,766	2.73%
Coastal Plain	Kentucky	Hardin	TN	22,633	24,746	8.54%
Coastal Plain	Kentucky	Henry	TN	27,888	29,702	6.11%
Highland Rim	Kentucky	Houston	TN	7,018	7,801	10.04%
Highland Rim	Kentucky	Humphreys	TN	15,813	16,797	5.86%
Highland Rim	Kentucky	Livingston	KY	9,062	9,330	2.87%
Highland Rim	Kentucky	Lyon	KY	6,624	8,012	17.32%
Coastal Plain	Kentucky	Marshall	KY	27,205	29,832	8.81%
Highland Rim	Kentucky	Perry	TN	6,612	7,487	11.69%
Highland Rim	Kentucky	Stewart	TN	9,479	11,257	15.79%
Highland Rim	Kentucky	Trigg	KY	10,361	12,072	14.17%
Highland Rim	Kentucky	Wayne	TN	13,935	16,553	15.82%
Subtotal				**212,361**	**233,738**	**9.15%**

Table A-5 Population Change by Reservoir[1] (Continued)

Physiographic Region	Reservoir	County	State	1990	1997	Percent Change
Coastal Plain	Pickwick	Colbert	AL	51,666	53,047	2.60%
Coastal Plain	Pickwick	Hardin	TN	22,633	24,746	8.54%
Highland Rim	Pickwick	Lauderdale	AL	79,661	84,241	5.44%
Coastal Plain	Pickwick	Tishomingo	MS	17,683	18,563	4.74%
Subtotal				**171,643**	**180,597**	**4.96%**
Highland Rim	Wheeler	Lauderdale	AL	79,661	84,241	5.44%
Highland Rim	Wheeler	Lawrence	AL	31,513	33,386	5.61%
Highland Rim	Wheeler	Limestone	AL	54,135	60,700	10.82%
Highland Rim	Wheeler	Madison	AL	238,912	272,293	12.26%
Highland Rim	Wheeler	Marshall	AL	70,832	78,893	10.22%
Highland Rim	Wheeler	Morgan	AL	100,043	108,304	7.63%
Subtotal				**575,096**	**637,817**	**9.83%**
Highland Rim	Wilson	Colbert	AL	51,666	53,047	2.60%
Highland Rim	Wilson	Lauderdale	AL	79,661	84,241	5.44%
Highland Rim	Wilson	Lawrence	AL	31,513	33,386	5.61%
Western Tributary Reservoirs						
Highland Rim	Bear Creek Project	Franklin	AL	27,814	29,613	6.08%
Coastal Plain	Bear Creek Project	Marion	AL	29,830	30,813	3.19%
Highland Rim	Bear Creek Project	Winston	AL	22,053	23,913	7.78%
Subtotal				**79,697**	**84,339**	**5.50%**
Coastal Plain	Beech River Project	Decatur	TN	10,472	10,766	2.73%
Coastal Plain	Beech River Project	Henderson	TN	21,844	23,998	8.98%
Subtotal				**32,316**	**34,764**	**7.04%**
Highland Rim	Normandy	Bedford	TN	30,411	34,162	10.98%
Highland Rim	Normandy	Coffee	TN	40,339	45,520	11.38%
Subtotal				**70,750**	**79,682**	**11.21%**
Highland Rim	Tims Ford	Franklin	TN	34,725	37,146	6.52%
Highland Rim	Tims Ford	Moore	TN	4,721	5,227	9.68%
Subtotal				**39,446**	**42,373**	**6.91%**

[1] Source: US Census

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Appendix B
Prime Farmland Soils

Virginia
Tennessee
North Carolina
Mississippi
Kentucky
Georgia
Alabama

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Table B-1 Prime Farmland — Virginia

County	Soil Name	Slope	Acres
Washington County	Allegheny loam	2 to 7 percent slopes	307
	Botetourt loam	2 to 7 percent slopes, rarely flooded	811
	Ebbing loam	2 to 7 percent slopes, rarely flooded	797
	Ernest silt loam	2 to 7 percent slopes	274
	Frederick silt loam	2 to 7 percent slopes	1,227
	Ingledove loam	2 to 7 percent slopes, rarely flooded	644
	Lobdell loam	0 to 3 percent slopes, occasionally flooded	722
	Monongahela silt loam	2 to 7 percent slopes	192
	Shottower loam	2 to 7 percent slopes	208
	Sindion silt loam	0 to 3 percent slopes, occasionally flooded	3,456
	Speedwell loam	0 to 3 percent slopes, occasionally flooded	588
	Tate loam	2 to 7 percent slopes	33
	Tumbling loam	2 to 7 percent slopes	409
	Wheeling loam	2 to 7 percent slopes, rarely flooded	767
	Wolfgap fine sandy loam	0 to 3 percent slopes, occasionally flooded	652
	Wyrick-Marble complex	2 to 7 percent slopes	1,605
Total Farmland			**12,692**
Total Acres in County			**346,000**

Table B-2 Prime Farmland — Tennessee

County	Soil Name	Slope	Acres
Anderson County	Capshaw silt loam	2 to 5 percent slopes	416
	Collegedale silt loam	2 to 5 percent slopes	322
	Emory silt loam	0 to 4 percent slopes	431
	Etowah silt loam	2 to 5 percent slopes	424
	Greendale silt loam	2 to 5 percent slopes	422
	Hamblen silt loam		4,190
	Holston loam	2 to 5 percent slopes	186
	Leadvale silt loam	2 to 7 percent slopes	992
	Lily loam	3 to 10 percent slopes	932
	Monongahela loam	2 to 5 percent slopes	990
	Newark silt loam		1,267
	Newark variant loam	0 to 3 percent slopes	901
	Sequatchie loam	0 to 5 percent slopes	858
	Sewanee-Ealy complex	0 to 3 percent slopes	1,399
	Staser loam		1,347
	Tasso silt loam	2 to 7 percent slopes	701
	Whitwell loam	1 to 3 percent slopes	482
Total Farmland			**16,260**
Total Acres in County			**214,400**
Bedford County	Arrington silt loam	occasionally flooded	
	Braxton silt loam	2 to 5 percent slopes, eroded	4,280
	Bluestocking silt loam	occasionally flooded	
	Capshaw silt loam	0 to 2 percent slopes	3,520
	Capshaw silt loam	2 to 5 percent slopes	12,700
	Dellrose cherty silt loam	5 to 12 percent slopes	
	Eagleville silt clay loam	occasionally flooded	
	Egam silt loam	occasionally flooded	
	Godwin silt loam	occasionally flooded	
	Harpeth silt loam	0 to 2 percent slopes	560
	Harpeth silt loam	2 to 5 percent slopes	8,200
	Lomand silt loam	0 to 2 percent slopes	400
	Lomand silt loam	2 to 5 percent slopes	
	Lynnville silt loam	occasionally flooded	
	Mountview silt loam	2 to 5 percent slopes	1,280
	Nesbitt silt loam	0 to 2 percent slopes	1,120
	Nesbitt silt loam	2 to 5 percent slopes	5,280
	Raus silt loam	0 to 2 percent slopes	
	Raus silt loam	2 to 5 percent slopes	
	Roellen cherty silt loam	5 to 12 percent slopes	
	Tupelo silt loam	occasionally flooded	
Total Farmland			**37,340**
Total Acres in County			**304,200**
Benton County	Alva fine sandy loam	2 to 4 percent slopes	322
	Briensburg silt loam	2 to 4 percent slopes (Collins)	9,961
	Dexter silt loam	eroded undulating phase (Lexington)	264
	Dickson silt loam	eroded undulating phase	3,287

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Benton County (continued)	Dickson silt loam	Undulating phase	1,179
	Dulac silt loam	eroded undulating phase	5,972
	Dulac silt loam	Undulating phase	2,441
	Egam silty clay loam		
	Ennis cherty silt loam		1,819
	Ennis silt loam (Pruition)		2,609
	Eupora fine sandy loam (Mantachie)		2,465
	Freeland silt loam	Undulating phase	2,027
	Freeland silt loam	Undulating phase	603
	Greendale cherty silt loam	undulating phase (Humphreys)	8,087
	Hatchie silt loam	1 to 3 percent slopes	2,268
	Humphreys cherty silt loam		986
	Humphreys silt loam	1 to 5 percent slopes (Pruition)	2,125
	Huntington silt loam (Pruition)		
	Hymon fine sandy loam (Mantachie)		
	Hymon silt loam (Mantachie)		3,912
	Lax silt loam	eroded undulating phase	241
	Lindside silt loam		
	Lindside silty clay loam		
	Lobelville silt loam (Lindside)		13,561
	Paden silt loam	Undulating phase	253
	Providence silt loam	eroded undulating phase	636
	Providence silt loam	Undulating phase	98
	Sequatchie fine sandy loam		
	Shannon fine sandy loam (Ochlockonee)		54
	Shannon silt loam (Ochlockonee)		85
	Taft silt loam		975
	Wolftever silt loam		
	Wolftever silty clay loam	eroded phase	
Total Farmland			**66,230**
Total Acres in County			**245,248**
Blount County	Alcoa loam	eroded gently sloping phase	253
	Barbourville fine sandy loam	gently sloping phase	2304
	Barbourville fine sandy loam	gently sloping phase	3248
	Cumberland silty clay loam	eroded gently sloping phase	409
	Dunmore silty clay loam	eroded gently sloping phase	1406
	Decatur silty clay loam	eroded gently sloping phase	1573
	Dewey silty clay loam	eroded gently sloping phase	2051
	Emory silt loam	level phase	406
	Emory silt loam	gently sloping phase	9978
	Emory silty clay loam	gently sloping phase	1097
	Etowah silt loam	eroded gently sloping phase	497

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Blount County (continued)	Farragut silty clay loam	eroded gently sloping phase	1240
	Greendale silt loam		2379
	Hamblen loam		1124
	Hamblen silt loam		2707
	Hamblen silt loam	local alluvium phase	4036
	Hayter silt loam	gently sloping phase	761
	Hermitage silt loam	gently sloping phase (Etowah)	882
	Hermitage silt loam	eroded gently sloping phase (Etowah)	1679
	Jefferson fine sandy loam	gently sloping phase	384
	Leadvale silt loam	gently sloping phase	709
	Leadvale silt loam	eroded gently sloping phase	483
	Lindside silt loam		2249
	Minvale silt loam	eroded gently sloping phase	356
	Muse silt loam	eroded gently sloping phase	692
	Neubert silt loam		2705
	Pace silt loam	gently sloping phase (Tasso)	724
	Sequatchie fine sandy loam		462
	Sequatchie loam		741
	Sequatchie silt loam		1409
	Staser fine sandy loam		1141
	Staser loam		1104
	Staser silt loam		1115
	Waynesboro loam	eroded gently sloping phase	253
	Whitesburg silt loam	gently sloping phase	838
	Whitwell loam		656
Total Farmland			**54,051**
Total Acres in County			**362,871**
Bradley County	Apison silt loam	eroded undulating phase	
	Apison silt loam	Undulating phase	
	Barbourville loam		
	Barbourville stony loam		
	Capshaw silt loam	Undulating phase	
	Cotaco loam		
	Cotaco silt loam		
	Cumberland silty clay loam	eroded undulating phase	
	Decatur silty clay loam	eroded undulating phase	
	Dewey silty clay loam	eroded undulating phase	
	Emory silt loam		
	Etowah silt loam	eroded rolling phase	
	Etowah silt loam	eroded undulating phase	
	Etowah silt loam	Undulating phase	
	Farragut silty clay loam	eroded undulating phase	
	Fullerton silt loam	eroded undulating phase	
	Greendale cherty silt loam		
	Greendale silt loam		
	Hamblen silt loam		

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Bradley County (continued)	Hermitage silt loam	eroded undulating phase	
	Hermitage silt loam	Undulating phase	
	Holston loam	eroded undulating phase	
	Huntington loam		
	Huntington silt loam		
	Jefferson loam	eroded undulating phase	
	Leadvale silt loam	eroded undulating phase	
	Leadvale silt loam	Undulating phase	
	Lindside silt loam		
	Minvale silt loam	eroded undulating phase	
	Minvale silt loam	Undulating phase	
	Monongahela silt loam	Undulating phase	
	Muse silt loam	eroded undulating phase	
	Muse silt loam	Undulating phase	
	Neubert silt loam		
	Pace silt loam	eroded undulating phase	
	Pace silt loam	Undulating phase	
	Sequatchie loam		
	Staser loam		
	Staser silt loam		
	Tyler silt loam		
	Whitwell loam		
	Wolftever silt loam	Undulating phase	
Total Farmland			**41,174**
Total Acres in County			**216,320**
Campbell County	Collegedale silt loam	2 to 5 percent slopes	379
	Ealy loam	occasionally flooded	1,689
	Etowah silt loam	2 to 5 percent slopes	887
	Hamblen silt loam	occasionally flooded	851
	Sequatchie loam	1 to 5 percent slopes, occasionally flooded	334
	Sewanee silt loam	occasionally flooded	639
	Swafford loam	occasionally flooded	175
	Whitwell loam	occasionally flooded	972
Total Farmland			**5,926**
Total Acres in County			**317,500**
Carter County	Allen loam		104
	Altavista silt loam		220
	Buncombe loamy fine sand		400
	Camp silt loam		217
	Chewacla fine sandy loam		698
	Chewacla gravelly fine sandy loam		633
	Congaree fine sandy loam		1828
	Congaree loam		274
	Emory silt loam		124
	Greendale silt loam		434
	Hamblen loam		1054

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Carter County (continued)	Hayter loam		181
	Jefferson gravelly loam		279
	Lindside silt loam		231
	Masada gravelly silt loam		175
	Masada silt loam		1768
	Ooltewah silt loam		101
	Sequatchie gravelly loam		1269
	Sequatchie loam		3507
	Staser fine sandy loam		181
	State loam		464
Total Farmland			**14,142**
Total Acres in County			**222,000**
Claiborne County	Caylor (Etowah) silt loam	gently sloping phase	84
	Greendale silt loam		1,216
	Holston fine sandy loam		277
	Leadvale silt loam		460
	Lindside silt loam		839
	Monongahela silt loam		151
	Ooltewah (Lindside) silt loam		523
	Philo fine sandy loam (SL)		2,137
	Pope fine sandy loam		607
	Robertsville clay loam (SIL)		107
	Sequatchie fine sandy loam		1,302
Total Farmland			**6,126**
Total Acres in County			**277,963**
Cocke County	Altavista loam		229
	Augusta silt loam		464
	Barbourville fine sandy loam		2,174
	Barbourville silt loam		3,159
	Buncombe loamy fine sand		1,515
	Camp (Shelocta) silt loam		111
	Congaree fine sandy loam		1,272
	Congaree loam		833
	Cotaco fine sandy loam		1,996
	Emory silt loam		1,257
	Greendale silt loam		3,912
	Hamblen fine sandy loam		1,121
	Hamblen silt loam		2,049
	Holston loam	Undulating phase	1,128
	Leadvale silt loam	Undulating phase	478
	Lindside silt loam		952
	Monongahela silt loam		1,312
	Monongahela silt loam	eroded phase	387
	Nolichucky loam	Undulating phase	275
	Ooltewah (Hamblen) silt loam		396
	Sequatchie fine sandy loam		503
	Staser fine sandy loam		
	Staser silt loam		395

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Cocke County (continued)	State loam		2,199
	Waynesboro loam	Undulating phase	187
	Whitesboro silt loam		4,907
Total Farmland			**33,211**
Total Acres in County			**277,760**
Coffee County	Armour silt loam	eroded, gently sloping phase	558
	Baxter cherty silt loam	gently sloping phase	1,284
	Baxter cherty silty clay loam	severely eroded, gently sloping phase	—
	Captina silt loam	level phase (1 to 2%)	47
	Captina silt loam	gently sloping phase	1,450
	Captina silt loam	eroded, gently sloping phase	
	Cookeville silt loam	gently sloping phase (Dewey)	358
	Cookeville silt loam	eroded, gently sloping phase (Dewey)	2,163
	Cumberland silt loam	gently sloping phase	283
	Cumberland silt loam	eroded, gently sloping phase	2,649
	Decatur silty clay loam	eroded, gently sloping phase	301
	Dickson silt loam	gently sloping phase	24,809
	Dickson silt loam	eroded, gently sloping phase	21,859
	Dunning silt loam	drained, overwash phase	375
	Dunning silt loam	silty substratum phase	754
	Dunning silty clay loam	drained phase	358
	Emory silt loam		2,785
	Etowah silt loam	eroded, gently sloping phase	531
	Etowah silt loam	eroded, gently sloping phosphatic phase	24
	Greendale cherty silt loam		584
	Greendale silt loam		4,487
	Hamblen fine sandy loam		2,188
	Hamblen fine sandy loam	local alluvium phase	709
	Hartsells fine sandy loam	gently sloping phase	790
	Hermitage silt loam	gently sloping phase	774
	Hermitage silt loam	eroded, gently sloping phase	879
	Holston loam	gently sloping phase	1,209
	Holston loam	eroded, gently sloping phase	2,444
	Humphreys silt loam	gently sloping phase	836
	Huntington cherty silt loam	local alluvium phosphatic phase	1,938
	Huntington cherty silt loam	phosphatic phase	349
	Huntington silt loam	local alluvium phosphatic phase	187
	Huntington silt loam	phosphatic phase	200
	Lawrence silt loam		15,796
	Lee silt loam	(if drained)	—
	Lindside cherty silt loam	local alluvium phosphatic phase	350

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Coffee County (continued)	Lindside cherty silt loam	phosphatic phase	385
	Lindside silt loam	local alluvium phase	806
	Lindside silt loam	phosphatic phase	356
	Lobelville cherty silt loam	local alluvium phase	461
	Lobelville silt loam		3,622
	Lobelville silt loam	local alluvium phase	8,305
	Monongahela loam	level phase	96
	Monongahela loam	gently sloping phase	2,678
	Monongahela loam	eroded, gently sloping phase	286
	Mountview silt loam	gently sloping	11,595
	Mountview silt loam	eroded, gently sloping phase	19,081
	Mountview silt loam	gently sloping shallow phase	2,184
	Mountview silt loam	eroded, gently sloping shallow phase	5,439
	Mountview silty clay loam	severely eroded, gently sloping phase	249
	Nolichucky loam	gently sloping phase	366
	Nolichucky loam	eroded, gently sloping phase	662
	Pace cherty silt loam	eroded, gently sloping phosphatic phase	412
	Pace cherty silt loam	eroded, gently sloping phase	456
	Pembroke silt loam	eroded gently sloping phase	650
	Prader fine sandy loam	(if drained)	—
	Sango silt loam		7,850
	Sequatchie fine sandy loam	level phase	129
	Sequatchie fine sandy loam	gently sloping phase	301
	Sequatchie fine sandy loam	eroded, gently sloping phase	1,458
	Staser fine sandy loam		604
	Staser fine sandy loam	local alluvium phase	400
	Taft silt loam		786
	Taft silt loam	overwash phase	288
	Tyler loam		2,709
	Tyler loam	overwash phase	346
	Waynesboro clay loam	severely eroded, gently sloping	362
	Waynesboro loam	gently sloping phase	285
	Whitwell loam	level phase	714
	Whitwell loam	gently sloping phase	753
	Whitwell loam	eroded, gently sloping phase	200
Total Farmland			**169,582**
Total Acres in County			**278,000**
Decatur County	Alva find sandy loam (Collins)	0 to 2 percent slopes	423
	Briensburg silt loam (Collins)		6,041
	Dexter silt loam	eroded undulating phase (Lexington)	
	Deanburg		630
	Dickson silt loam	eroded undulating phase	548

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Decatur County (continued)	Dickson silt loam	Undulating phase	860
	Dulac silt loam	eroded undulating phase	2,795
	Dulac slightly eroded undulating phase		699
	Dulac silt loam	Undulating phase	1,334
	Egam silty clay loam		1,096
	Emory silt loam		3,698
	Ennis cherty slit loam		731
	Ennis silt loam (Pruition)		3,107
	Eupora fine sandy loam (Iuka)		3,535
	Freeland silt loam	eroded undulating phase	3,093
	Freeland silt loam		723
	Greendale cherty silt loam	undulating phase (Humphreys)	3,521
	Hatchie fine sandy loam (Loam)		398
	Hatchie silt loam		1,118
	Humphreys cherty silt loam		1,295
	Humphreys silt loam (Pruition silt loam)	0 to 2 percent slopes	226
	Huntington silt loam (Pruition)		248
	Hymon fine sandy loam (Mantachie)		2,494
	Hymon silt loam (Mantachie)		4,408
	Lindside silt loam		4,292
	Lindside silty clay loam		376
	Maury silty clay loam	eroded undulating phase	172
	Paden silt loam	eroded undulating phase	1,427
	Paden silt loam	Undulating phase	537
	Pickwick silt loam	eroded undulating phase	1,268
	Pickwick silt loam	Undulating phase	275
	Savannah loam	eroded undulating phase	604
	Savannah loam	Undulating phase	515
	Sequatchie fine sandy loam		1,010
	Shannon fine sandy loam (Ochlocknee)		1,151
	Shannon silt loam (Ochlocknee)		666
	Taft silt loam		1,032
	Tigrett silt loam (Statler)		344
	Wolftever silt loam		376
	Wolftever silt loam	slightly eroded phase	516
	Wolftever silty clay loam	eroded phase	488
Total Farmland			**58,070**
Total Acres in County			**211,200**

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Franklin County	Barbourville fine sandy loam		135
	Baxter cherty silt loam	Undulating phase	626
	Baxter cherty silt loam	eroded undulating phase	2,006
	Capshaw silt loam		3,230
	Cotaco fine sandy loam		702
	Cumberland and Etowah loams	Undulating phase	317
	Cumberland and Etowah loams	eroded, undulating phase	3,291
	Cumberland and Etowah silt loams	Undulating phase	463
	Cumberland and Etowah silty clay loams	eroded, undulating phase	16,785
	Decatur silt loam, undulating phase		81
	Decatur silty clay loam	eroded, undulating phase	3,890
	Dewey silt loam	Undulating phase	208
	Dewey silty clay loam	eroded, undulating phase	5,495
	Dickson silt loam	Undulating phase	12,016
	Dickson silt loam	eroded, undulating phase	13,102
	Egam silty clay loam		1,696
	Emory cherty silt loam		499
	Emory silt loam		10,185
	Ennis cherty silt loam		1,605
	Greendale cherty silt loam		993
	Greendale silt loam		2,284
	Hermitage silt loam	eroded, undulating phase	1,150
	Holston loam, undulating phase		560
	Holston loam	eroded, undulating phase	1,987
	Humphreys cherty silt loam		573
	Huntington fine sandy loam		2,686
	Huntington silt loam		328
	Lawrence silt loam		4,866
	Lindside fine sandy loam		3,208
	Lindside silty clay loam		553
	Lobelville cherty silt loam		1,790
	Mountview silt loam	Undulating phase	899
	Mountview silt loam	eroded, undulating phase	4,134
	Nolichucky loam	eroded, undulating phase	451
	Nolichucky loam	eroded, rolling phase	147
	Ooltewah silt loam		4,519
	Pace cherty silt loam	eroded, undulating phase	237
	Sequatchie fine sandy loam	Undulating phase	2,960
	Taft silt loam		2,038
	Tyler silt loam		3,060
	Waynesboro loam	Undulating phase	105
	Waynesboro loam	eroded, undulating phase	2,169

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Franklin County (continued)	Whitwell loam		5,016
Total Farmland			**123,045**
Total Acres in County			**358,400**
Grainger County	Dewey silt loam		
	Elk silt loam		
	Etowah silt loam		
	Hamblen silt loam		
	Sewanee loam		
	Shady loam		
Total Farmland			**7,438**
Total Acres in County			**193,700**
Hamblen County	Altavista silt loam		384
	Chewacla loam		128
	Congaree fine sandy loam		704
	Congaree loamy fine sand		320
	Decatur silt loam	undulating, 2 to 5 percent slope	128
	Dewey silt loam	undulating, 2 to 5 percent slope	192
	Dunning silty clay loam		
	Emory silt loam		2,240
	Etowah silt loam	undulating, 2 to 5 percent slope	
	Greendale silt loam		960
	Hamblen silt loam		2,624
	Holston very fine sandy loam	undulating, 2 to 5 percent slope	768
	Huntington silt loam		
	Leadvale silt loam	undulating, 2 to 5 percent slope	
	Lindside silt loam		1,280
	Monongahela very fine sandy loam	undulating, 2 to 5 percent slope	768
	Staser silt loam		512
	State loam		384
	Whitesburg silt loam		640
Total Farmland			**12,032**
Total Acres in County			**112,000**
Hamilton County	Capshaw silt loam	2 to 6 percent slopes	5,229
	Crossville loam	2 to 5 percent slopes	1,792
	Dewey silt loam	2 to 6 percent slopes	4,869
	Emory silt loam		526
	Ennis cherty silt loam		1,554
	Etowah silt loam	2 to 5 percent slopes	8,405
	Fullerton cherty silt loam	3 to 7 percent slopes	18,633
	Hamblen silt loam		3,823

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Hamilton County (continued)	Holston loam	2 to 6 percent slopes	2,060
	Humphreys cherty silt loam	1 to 6 percent slopes	695
	Lily loam	2 to 7 percent slopes	17,874
	Lonewood silt loam	2 to 6 percent slopes	4,757
	Lobelville cherty silt loam		475
	Newark silt loam		4,474
	Nesbitt silt loam	2 to 6 percent slopes	1,780
	Roane cherty silt loam	2 to 6 percent slopes	1,383
	Sequatchie loam	2 to 7 percent slopes	7,325
	Sewanee variant silt loam		5,054
	Staser loam		440
	Tupelo silt loam	0 to 3 percent slopes	2,875
	Waynesboro loam	3 to 8 percent slopes	5,034
	Whitwell loam		3,548
	Woodmont silt loam		493
Total Farmland			**103,098**
Total Acres in County			**352,000**
Hardin County	Beason silt loam		5,993
	Captina silt loam	0 to 2 percent slopes (Paden)	805
	Captina silt loam	2 to 5 percent slopes, eroded	1,699
	Collins fine sandy loam		1,467
	Collins loam	local alluvium	4,936
	Collins silt loam		1,453
	Dexter clay loam	2 to 5 percent slopes, severely eroded	205
	Dexter loam	2 to 5 percent slopes, eroded	318
	Dulac silt loam	2 to 5 percent slopes	1,679
	Dulac silt loam	2 to 5 percent slopes, eroded	684
	Egam silty clay loam		4,282
	Ennis cherty silt loam		2,494
	Ennis cherty silt loam		3,090
	Ennis fine sandy loam (Pruition)		2,527
	Ennis silt loam (Pruition)		6,412
	Ennis silt loam	local alluvium (Pruition)	1,058
	Falaya loam	local alluvium (Enville)	4,164
	Falaya silt loam		3,492
	Freeland loam	2 to 5 percent slopes, eroded	1,917
	Hatchie loam		1,381
	Humphreys cherty silt loam	2 to 5 percent slopes, eroded	544
	Humphreys silt loam	2 to 5 percent slopes, eroded (Sequatchie)	1,382
	Huntington fine sandy loam (Pruition)		1,932
	Huntington silt loam (Pruition)		1,319
	Lindside silt loam		3,009

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Hardin County (continued)	Lindside silty clay loam		1,283
	Lobelville cherty silt loam		858
	Lobelville silt loam		3,070
	Mantachie fine sandy loam		2,490
	Paden silt loam	2 to 5 percent slopes	4,299
	Paden silt loam	2 to 5 percent slopes, eroded	9,266
	Pickwick silt loam	2 to 5 percent slopes	3,551
	Pickwick silt loam	2 to 5 percent slopes, eroded	2,887
	Pickwick silty clay loam	2 to 5 percent slopes, severely eroded	4,630
	Sequatchie fine sandy loam	0 to 2 percent slopes	281
	Sequatchie fine sandy loam	2 to 5 percent slopes, eroded	681
	Sequatchie loam	2 to 8 percent slopes, severely eroded	326
	Silerton silt loam	2 to 5 percent slopes	5,934
	Silerton silt loam	2 to 5 percent slopes, eroded	1,000
	Silerton silt loam	5 to 8 percent slopes	5,402
	Silerton silt loam	5 to 8 percent slopes, eroded	645
	Taft silt loam		1,674
	Vicksburg loam (Ochlockonee)		512
	Vicksburg loam	local alluvium (Ochlockonee)	3,538
	Waynesboro clay loam	2 to 5 percent slopes, severely eroded	634
	Waynesboro clay loam	5 to 8 percent slopes, severely eroded	1,553
	Waynesboro fine sandy loam	2 to 5 percent slopes (Etowah)	1,064
	Waynesboro fine sandy loam	5 to 8 percent slopes (Etowah)	9,177
	Waynesboro very gravelly sandy loam	25 to 45 percent slopes (Saffell)	—
	Wolftever silt loam	0 to 2 percent slopes	4,412
	Wolftever silt loam	2 to 5 percent slopes	621
	Wolftever silt loam	2 to 5 percent slopes, eroded	3,165
	Wolftever silty clay loam	2 to 5 percent slopes, severely eroded	637
Total Farmland			**131,832**
Total Acres in County			**375,680**
Hawkins and Hancock Counties	Altavista silt loam		700
	Cloudland loam	2 to 5 percent slopes	2,150
	Dunning silty clay loam		160
	Ealy loam		300
	Emory silt loam		300
	Etowah silt loam	2 to 5 percent slopes	700
	Greendale silt loam		1,250
	Hamblen silt loam		6,185
	Holston loam	2 to 5 percent slopes	2,000
	Leadvale silt loam	2 to 5 percent slopes	610

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Hawkins and Hancock Counties (continued)	Lindside silt loam		530
	Melvin silt loam		1,030
	Minvale silt loam	2 to 5 percent slopes	140
	Sensabaugh gravelly loam		2,420
	Sequatchie loam		580
	Sewanee loam		2,360
	Shouns silt loam	3 to 12 percent slopes	2,000
	Staser silt loam		3,210
	Statler silt loam		600
	Sullivan loam		1,770
	Taft silt loam		940
	Whitesburg silt loam		2,200
	Whitwell loam		780
Total Farmland			**32,915**
Total Acres in County			**454,400**
Henderson County	Calloway silt loam	gently sloping phase	268
	Calloway silt loam	eroded gently sloping phase	665
	Dexter fine sandy clay loam	severely eroded gently sloping phase	142
	Dexter fine sandy loam	eroded gently sloping phase	704
	Dexter silt loam	gently sloping phase	810
	Dulac-Tippah silt loams	eroded gently sloping phase	358
	Dulac silt loam	eroded gently sloping deep phase	3,777
	Dulac-Tippah silt loams	gently sloping phases	137
	Freeland fine sandy loam	eroded gently sloping phase	218
	Freeland silt loam	eroded gently sloping phase	5,057
	Hatchie silt loam	gently sloping phase	4,314
	Hymon fine sandy loam (Iuka)		563
	Hymon fine sandy loam	local alluvium phase (Iuka)	4,955
	Hymon silt loam (Collins)		562
	Hymon silt loam	local alluvium phase (Collins)	6,126
	Ina fine sandy loam (Manatachie)		1,422
	Ina fine sandy loam	local alluvium phase (Manatachie)	5,971
	Ina loamy fine sand	local alluvium phase (Manatachie)	782
	Ina silt loam (Manatachie)		15,891
	Ina silt loam	local alluvium phase (Arkabutla)	—
	Lexington silt loam	eroded gently sloping phase	6,303
	Providence silt loam	eroded gently sloping phase	1,038
	Shannon silt loam	local alluvium phase (Vicksburg)	534
	Silerton silt loam	eroded gently sloping phase	424
	Tippah silt loam	gently sloping shallow phase	197

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Total Farmland			**61,218**
Total Acres in County			**329,600**
Henry County	Brandon silt loam	Undulating	
	Brandon silt loam	eroded, undulating	
	Briensburg fine sandy loam (Collins)		
	Briensburg silt loam (Collins)		
	Calloway silt loam	Level	
	Calloway silt loam	Undulating	
	Calloway silt loam	eroded undulating phase	
	Center silt loam	Level	
	Center silt loam	Undulating	
	Center silt loam	eroded, undulating	
	Dexter silt loam	Undulating (Lexington)	
	Dexter silt loam	eroded, undulating (Lexington)	
	Dulac silt loam	eroded, undulating	
	Dulac silt loam		
	Ennis silt loam (Pruition)		
	Freeland silt loam	Level	
	Freeland silt loam	Undulating	
	Freeland silt loam	eroded, undulating	
	Greendale cherty silt loam (Humphreys)		
	Grenada silt loam	Level	
	Grenada silt loam	Undulating	
	Hatchie fine sandy loam	Level	
	Hatchie fine sandy loam	Undulating	
	Hatchie silt loam	Level	
	Hatchie silt loam	Undulating	
	Hatchie silt loam	eroded, undulating	
	Hilly land	coastal plain material	
	Hymon fine sandy loam (Iuka)		
	Hymon silt loam (Collins)		
	Lax silt loam	Undulating	
	Lax silt loam	eroded, undulating	
	Lexington silt loam	Undulating	
	Lindside and Lobelville silt loams (Lindside)		
	Loring silt loam	Level	
	Loring silt loam	Undulating	
	Loring silt loam	eroded, undulating	
	Memphis silt loam	Level	
	Memphis silt loam	Undulating (Lexington)	
	Memphis silt loam	eroded, undulating (Lexington)	
	Paden silt loam	eroded, undulating	

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Henry County (continued)	Providence silt loam	Undulating	
	Providence silt loam	eroded, undulating	
	Shannon fine sandy loam (Ocklockonee)		
	Shannon silt loam (Vicksburg)		
	Tigrett fine sandy loam (Statler)		
	Tigrett silt loam (Statler)		
	Tippah silt loam	eroded undulating phase	
Total Farmland			**119,964**
Total Acres in County			**383,357**
Houston County	Briensburg silt loam		406
	Dickson silt loam	Undulating phase	20
	Dickson silt loam	eroded undulating phase	2,640
	Egam silty clay loam		1,783
	Ennis cherty silt loam		461
	Ennis silt loam		361
	Greendale cherty silt loam	Undulating phase	1,817
	Humphreys cherty silt loam		1,425
	Humphreys silt loam		9,251
	Lobelville cherty silt loam		1,096
	Lobelville silt loam		3,518
	Mountview silt loam	Undulating phase	1,207
	Mountview silt loam	eroded undulating phase	1,255
	Paden silt loam	eroded undulating phase	387
	Pickwick silt loam	Undulating phase	144
	Pickwick silt loam	eroded undulating phase	761
	Pickwick silt loam	eroded rolling phase	1,086
	Taft silt loam		338
	Tigrett silt loam		1,365
Total Farmland			**29,321**
Total Acres in County			**132,500**
Humphreys County	Dickson silt loam		6,272
	Ennis fine sandy loam		704
	Ennis gravelly silt loam		2,048
	Ennis silt loam		5,760
	Humphreys silt loam		13,632
	Huntington silt loam		5,184
	Huntington silt loam	dark-subsoil	896
	Huntington silty clay loam		2,496
	Huntington very fine sandy loam		768
	Lawrence silt loam		256
	Lindside silty clay loam		2,176
	Lindside silty loam		3,776
	Lindside silty clay loam	high-bottom	1,792
	Paden silt loam		5,952

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Humphreys County (continued)	Pope fine sandy loam		832
	Taft silt loam		320
	Wolftever silty clay loam		1,728
	Wolftever silty clay loam	Compact	4,480
	Wolftever silty clay loam	Deep	704
Total Farmland			**59,776**
Total Acres in County			**352,064**
Jefferson County	Beason silt loam	occasionally flooded	803
	Collegedale silt loam	2 to 5 percent slopes, eroded	501
	Decatur silt loam	2 to 5 percent slopes, eroded	1,668
	Dunmore silt loam	2 to 5 percent slopes, eroded	913
	Emory silt loam	rarely flooded	1,295
	Etowah silt loam	2 to 5 percent slopes	2,586
	Lindside silt loam	occasionally flooded	3,206
	Muse silt loam	2 to 5 percent slopes	894
	Nolichucky silt loam	2 to 5 percent slopes, eroded	2,884
	Nolin silt loam	occasionally flooded	1,437
	Staser fine sandy loam	overwash, rarely flooded	973
	Swafford silt loam	1 to 4 percent slopes, rarely flooded	2,084
	Tasso silt loam	2 to 5 percent slopes	1,276
	Whitesburg silt loam	occasionally flooded	551
Total Farmland			**21,071**
Total Acres in County			**200,900**
Johnson County	Camp silt loam		1,244
	Chewacla loam		130
	Chewacla gravelly fine sandy loam		282
	Congaree fine sandy loam		69
	Dunning silt loam		389
	Greendale silt loam		226
	Hamblen loam		1,340
	Hayter loam	Undulating phase	746
	Masada silt loam	Undulating phase	45
	Prader silt loam		622
	Sequatchie loam	Undulating phase	1,845
	Sequatchie silt loam	Undulating phase	834
	Staser fine sandy loam		151
	Tyler silt loam		122
	Whitwell silt loam		943
Total Farmland			**8,988**
Total Acres in County			**191,360**
Knox County	Alcoa silt loam	eroded undulating phase	334
	Camp (Emory) silt loam		210
	Chewacla silt loam		271
	Congaree fine sandy loam		390

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Knox County (continued)	Congaree fine sandy loam	low bottom phase	447
	Congaree silt loam		783
	Congaree silt loam	low bottom phase	92
	Cumberland silty clay loam	eroded undulating phase	295
	Decatur silt loam	Undulating phase	377
	Decatur silty clay loam	eroded undulating phase	1,556
	Dewey silt loam	Undulating phase	227
	Dewey silty clay loam	eroded undulating phase	1,257
	Emory and Abernathy (Lindside silt loams)		1,165
	Emory silt loam	Undulating phase	9,076
	Etowah silt loam	Undulating phase	208
	Etowah silty clay loam	eroded undulating phase	907
	Farragut silty clay loam	eroded undulating phase	421
	Fullerton loam (CR-L)	eroded undulating phase	224
	Fullerton loam (CR-L)	Undulating phase	187
	Fullerton silt loam (CR-SIL)	eroded undulating phase	1,014
	Fullerton silt loam (CR-SIL)	Undulating phase	327
	Greendale cherty silt loam	Undulating phase	255
	Greendale silt loam	Undulating phase	8,451
	Hamblen fine sandy loam		1,713
	Hamblen silt loam		1,190
	Huntington silt loam		779
	Huntington silt loam	low bottom phase	130
	Lindside silt loam		9,716
	Neubert loam	Undulating phase	895
	Oolteway (Hamblen) silt loam		1,284
	Staser fine sandy loam		275
	Staser fine sandy loam	low bottom phase	140
	Staser silt loam		933
	Waynesboro loam	eroded undulating phase	217
	Wolftever silty clay loam	eroded undulating phase	382
Total Farmland			**46,128**
Total Acres in County			**329,600**
Loudon County	Alcoa loam	gently sloping phase	211
	Barbourville silt loam		187
	Cumberland silty clay loam	eroded gently sloping phase	409
	Congaree loam	nearly level phase	1,053
	Congaree loam	sloping phase (Sequatchie)	252
	Decatur silty clay loam	eroded gently sloping phase	385
	Dewey silty clay loam	eroded gently sloping phase	748
	Emory silt loam		4,292
	Emory silty clay loam		441
	Etowah silt loam	gently sloping phase	654
	Farragut silty clay loam	eroded gently sloping phase	164
	Fullerton silt loam	gently sloping phase (Dewey)	814

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Loudon County (continued)	Greendale cherty silt loam		894
	Greendale silt loam		2,205
	Hermitage silt loam	gently sloping phase (Etowah)	1,589
	Huntington loam	nearly level phase	1,155
	Huntington loam	sloping phase (Sequatchie)	260
	Landisburg cherty silt loam	gently sloping phase (Tasso)	340
	Landisburg silt loam	gently sloping phase (Tasso)	667
	Leadvale silt loam	gently sloping phase	471
	Lindside silt loam		1,930
	Lindside silt loam	local alluvium phase	928
	Lobelville cherty silt loam		182
	Minvale silt loam	gently sloping phase	439
	Neubert loam		888
	Sequatchie fine sandy loam	gently sloping phase	236
	Sequatchie loam	gently sloping phase	264
	Sequatchie loam	sloping phase	264
	Taft silt loam		183
	Waynesboro loam	eroded gently sloping phase	153
	Wolftever silt loam	eroded moderately steep phase	801
Total Farmland			**23,459**
Total Acres in County			**151,323**
Marion County	Barbourville loam		2,036
	Capshaw silt loam	Undulating phase	270
	Capshaw silt loam	eroded undulating phase	1,780
	Cumberland silty clay loam	eroded undulating phase	366
	Emory silt loam		2,138
	Etowah silty clay loam	eroded undulating phase	1,946
	Greendale cherty silt loam		297
	Greendale silt loam		832
	Hamblen loam		2,063
	Hartsells fine sandy loam	Undulating phase	7,128
	Hartsells fine sandy loam	eroded undulating phase	1,073
	Hermitage silt loam	eroded undulating phase	221
	Huntington fine sandy loam		697
	Huntington loam		1,291
	Huntington silt loam		1,821
	Lindside silt loam		2,946
	Minvale silt loam	eroded undulating phase	116
	Pace silt loam	eroded undulating phase	392
	Sequatchie fine sandy loam	Undulating phase	1,049
	Sequatchie fine sandy loam	eroded undulating phase	357
	Sequatchie loam	Undulating phase	3,052
	Sequatchie loam	eroded undulating phase	4,395
	Staser fine sandy loam		1,422
	Staser loam		2,263
	Taft silt loam		976

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Marion County (continued)	Waynesboro loam	eroded undulating phase	188
	Whitwell loam		1,941
	Wolftever silt loam	Undulating phase	1,643
Total Farmland			44,699
Total Acres in County			333,500
McMinn County	Alcoa loam	eroded undulating phase	216
	Barbourville loam		825
	Cotaco loam		
	Cotaco silt loam		
	Cumberland silt loam	Undulating phase	251
	Cumberland silty clay loam	eroded undulating phase	172
	Decatur silty clay loam	eroded undulating phase	1,657
	Dewey clay loam	eroded undulating phase	255
	Dewey silty clay loam	eroded undulating phase	1,321
	Emory and Abernathy silt loams		
	Emory silt loam		689
	Etowah silt loam	Undulating phase	1,285
	Farragut silty clay loam	eroded undulating phase	815
	Fullerton loam	eroded undulating phase	448
	Fullerton silt loam	eroded undulating phase	569
	Greendale cherty silt loam		2,781
	Greendale silt loam		6,702
	Hamblen and Lindside silt loams		8,418
	Hamblen and Lindside silty clay loams		362
	Hayter loam	Undulating phase	175
	Hermitage silt loam	Undulating phase	2,396
	Holston loam	eroded undulating phase	193
	Holston loam	Undulating phase	270
	Jefferson loam	Undulating phase	334
	Leadvale silt loam	Undulating phase	1,320
	Monongahela silt loam		953
	Neubert loam		1,916
	Ooltewah silt loam		630
	Pace silt loam	Undulating phase	2,329
	Sequatchie fine sandy loam	Undulating phase	467
	Staser and Huntington silt loams		2,776
	Waynesboro loam	eroded undulating phase	176
	Whitesburg silt loam		1,310
	Wolftever silt loam	Undulating phase	196
Total Farmland			**42,207**
Total Acres in County			**278,400**

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Meigs County	Beason silt loam		1,020
	Capshaw silt loam	2 to 5 percent slopes	1,695
	Chagrin silt loam		390
	Decatur silt loam	2 to 5 percent slopes	355
	Egam silty clay loam		390
	Emory silt loam		1,225
	Ennis cherty silt loam		1,050
	Etowah silt loam	2 to 5 percent slopes	2,185
	Etowah gravelly silt loam	2 to 5 percent slopes	255
	Etowah gravelly silt loam	5 to 12 percent slopes	655
	Holston loam	2 to 5 percent slopes	240
	Humphreys silt loam	2 to 5 percent slopes	1,240
	Lindside silt loam		6,385
	Lobelville cherty silt loam		1,300
	Minvale cherty silt loam	5 to 12 percent slopes	1,350
	Newark silt loam		2,095
	Staser fine sandy loam	coarse subsoil variant	725
	Tarklin silt loam	2 to 8 percent slopes	965
	Tarklin cherty silt loam	2 to 5 percent slopes	405
	Tarklin cherty silt loam	5 to 12 percent slopes	505
	Whitwell loam	0 to 5 percent slopes	440
	Wolftever silt loam	1 to 5 percent slopes	1,035
Total Farmland			**25,905**
Total Acres in County			**122,240**
Monroe County	Alcoa loam	2 to 5 percent slopes	445
	Allegheny loam		830
	Altavista silt loam		1,170
	Atkins silt loam		605
	Beason silt loam		1,305
	Chagrin silt loam		1,270
	Decatur silt loam	2 to 5 percent slopes	1,770
	Dewey silt loam	2 to 5 percent slopes	1,180
	Dunmore silt loam	2 to 5 percent slopes	950
	Dunning silty clay loam		300
	Emory silt loam		2,820
	Etowah silt loam	2 to 5 percent slopes	3,195
	Greendale silt loam		905
	Hamblen silt loam		6,105
	Leadvale silt loam	2 to 5 percent slopes	
	Lobdell silt loam		
	Minvale silt loam	2 to 5 percent slopes	2,825
	Neubert loam		2,030
	Newark silt loam		1,860
	Philo silt loam		2,085
	Pope loam		1,455
	Sequatchie loam		365
	Staser loam		1,250
	Statler loam		2,355

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Monroe County (continued)	Transylvania loam		1,195
	Waynesboro loam	2 to 5 percent slopes	410
	Whitwell loam		480
Total Farmland			39,160
Total Acres in County			422,400
Moore County	Armour silt loam	0 to 2 percent slopes	
	Armour silt loam	2 to 5 percent slopes	
	Arrington cherty silt loam		
	Arrington silt loam		
	Capshaw silt loam	0 to 2 percent slopes	
	Capshaw silt loam	2 to 5 percent slopes	
	Dellrose cherty silt loam	2 to 5 percent slopes	
	Dickson silt loam	0 to 2 percent slopes	
	Dickson silt loam	2 to 5 percent slopes	
	Egam silt loam		
	Ennis cherty silt loam		
	Ennis silt loam		
	Etowah gravelly silt loam	2 to 5 percent slopes (cherty silt loam)	
	Fullerton cherty silt loam	2 to 5 percent slopes	
	Humphreys cherty silt loam	2 to 5 percent slopes	
	Humphreys silt loam	2 to 5 percent slopes	
	Lobelville cherty silt loam		
	Lobelville silt loam		
	Lynnville cherty silt loam		
	Lynnville silt loam		
	Maury silt loam	2 to 5 percent slopes	
	Mountview cherty silt loam	2 to 5 percent slopes (silt loam)	
	Mountview silt loam	2 to 5 percent slopes	
	Pickwick silt loam	2 to 5 percent slopes	
	Taft silt loam		
Total Farmland			**15,075**
Total Acres in County			**83,700**
Perry County	Bruno fine sandy loam	0 to 3 percent slopes	
	Bruno loamy fine sand	0 to 3 percent slopes	
	Egam silty clay loam		
	Emory silt loam	2 to 5 percent slopes	
	Ennis cherty loam	0 to 3 percent slopes	
	Ennis silt loam	0 to 3 percent slopes (cherty silt loam)	
	Greendale cherty loam	2 to 5 percent slopes	
	Humphreys cherty loam	1 to 5 percent slopes	
	Humphreys cherty loam	1 to 5 percent slopes, eroded	
	Humphreys silt loam	1 to 5 percent slopes (Armour)	

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Perry County (continued)	Humphreys silt loam	1 to 5 percent slopes, eroded (Armour)	
	Huntington silt loam	0 to 3 percent slopes	
	Lindside silt loam	0 to 3 percent slopes	
	Lindside silty clay loam	0 to 3 percent slopes	
	Lobelville cherty silt loam	0 to 3 percent slopes	
	Lobelville silt loam	0 to 3 percent slopes	
	Pace cherty silt loam	2 to 5 percent slopes	
	Paden silt loam	2 to 5 percent slopes, eroded	
	Paden silt loam	2 to 5 percent slopes	
	Pickwick silt loam	2 to 5 percent slopes	
	Sango silt loam	1 to 5 percent slopes (1 to 4 percent slopes)	
	Sequatchie fine sandy loam	1 to 6 percent slopes	
	Sequatchie fine sandy loam	1 to 6 percent slopes, eroded	
	Wolftever silt loam	1 to 6 percent slopes	
	Wolftever silty clay loam	1 to 6 percent slopes	
Total Farmland			**23,804**
Total Acres in County			**271,100**
Polk County	Arkaqua-Suches Complex	occasionally flooded	
	Congaree loam	rarely flooded	
	Decatur silt loam	2 to 6 percent slopes, eroded	
	Emory silt loam	occasionally flooded	
	Etowah silt loam	2 to 6 percent slopes	
	Hamblen silt loam	occasionally flooded	
	Leadvale silt loam	occasionally flooded (rare)	
	State loam	rarely flooded	
	Suches loam	occasionally flooded	
	Tate loam	2 to 8 percent slopes	
	Waynesboro loam	2 to 6 percent slopes, eroded	
Total Farmland			**19,715**
Total Acres in County			**282,900**
Rhea County	Abernathy silt loam (Emory)		960
	Allen very fine sandy loam	2 to 5 percent slopes (FSL)	448
	Apison very fine sandy loam	2 to 5 percent slopes (SIL)	256
	Apison very fine sandy loam	2 to 5 percent slopes, eroded (SIL)	192
	Burgin clay loam	(Dunning sil)	448
	Conasauga silt loam	2 to 5 percent slopes	896
	Crossville loam	2 to 5 percent slopes	320
	Cumberland gravelly fine sandy loam	2 to 5 percent slopes (Waynesboro gr-fsl)	192
	Cumberland silty clay loam	2 to 5 percent slopes, eroded	384
	Dewey silt loam	2 to 5 percent slopes	128
	Dewey silty clay loam	2 to 5 percent slopes, eroded	1,344
	Dunning silty clay loam		960

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Rhea County (continued)	Egam silty clay loam		576
	Emory silt loam	2 to 5 percent slopes	576
	Etowah silt loam	2 to 5 percent slopes	64
	Etowah silty clay loam	2 to 5 percent slopes, eroded	1,152
	Fullerton cherty silt loam	2 to 5 percent slopes	2,368
	Fullerton silt loam	2 to 5 percent slopes (Dunmore)	320
	Greendale silt loam	2 to 5 percent slopes	2,560
	Hartsells fine sandy loam	2 to 5 percent slopes	4,224
	Holston very fine sandy loam	2 to 5 percent slopes (FSL)	640
	Huntington fine sandy loam (Staser)		960
	Huntington silt loam		1,024
	Jefferson very fine sandy loam	2 to 5 percent slopes (FSL)	1,408
	Lindside silt loam		1,408
	Lindside silty clay loam		512
	Melvin silt loam		1,600
	Nolichucky fine sandy loam	1 to 5 percent slopes (2-5)	128
	Ooltewah fine sandy loam (Hamblen)		64
	Ooltewah silt loam (Hamblen)		1,600
	Philo fine sandy loam (SL)		2,368
	Philo silt loam		384
	Pope loamy fine sand (FSL)		320
	Pope silt loam		640
	Roane gravelly silt loam		3,200
	Roane silt loam (CR-SIL)		640
	Sequatchie fine sandy loam	0 to 2 percent slopes	2,176
	Sequatchie loamy fine sand	1 to 5 percent slopes (FSL)	1,408
	Staser loamy fine sand (FSL)		448
	Taft silt loam		1,088
	Waynesboro fine sandy loam	2 to 5 percent slopes	320
	Waynesboro gravelly fine sandy loam	2 to 5 percent slopes	128
	Wolftever silt loam	0 to 2 percent slopes	1,472
Total Farmland			**42,304**
Total Acres in County			**214,400**
Roane County	Allen very fine sandy loam		896
	Apison very fine sandy loam		576
	Greendale silt loam		1,208
	Hartsells very fine sandy loam (Lily)		448
	Huntington silt loam (Arrington)		3,904
	Jefferson gravelly fine sandy loam		640
	Leadvale very fine sandy loam		2,112

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Roane County (continued)	Lindside silt loam		896
	Nolichucky		768
	Philo very fine sandy loam (SIL)		1,920
	Pope gravelly fine sandy loam		2,560
	Pope loamy fine sand		1,728
	Pope very fine sandy loam		9,088
	Roane gravelly loam		3,584
	Sequatchie very fine sandy loam		1,856
	Waynesboro very fine sandy loam		576
	Wolftever silt loam		1,536
Total Farmland			**34,296**
Total Acres in County			**243,200**
Sevier County	Braddock loam	2 to 5 percent slopes, eroded	499
	Comb loam	rarely flooded	1,214
	Decatur silt loam	2 to 5 percent slopes	730
	Dewey silt loam	2 to 5 percent slopes, eroded	531
	Etowah loam	2 to 5 percent slopes	1,895
	Holston loam	2 to 5 percent slopes	1,131
	Leadvale silt loam	2 to 5 percent slopes	506
	Lonon gravel loam	2 to 5 percent slopes, eroded	553
	Pope sandy loam	occasionally flooded	2,280
	Rosman sandy loam	occasionally flooded	1,624
	Sequatchie loam	rarely flooded	2,675
	Shelockta silt loam	2 to 5 percent slopes	966
	Stedman silt loam	occasionally flooded	13,787
	Statler loam	occasionally flooded	1,688
	Waynesboro loam	2 to 5 percent slopes, eroded	753
	Whitesburg silt loam	occasionally flooded	1,348
Total Farmland			**32,180**
Total Acres in County			**250,200**
Stewart County	Armour silt loam	0 to 2 percent slopes, gravelly substratum	
	Armour silt loam	2 to 5 percent slopes, gravelly substratum	
	Armour silt loam	2 to 5 percent slopes, eroded	
	Bewleyville silt loam	2 to 5 percent slopes, eroded	
	Dickson silt loam	2 to 5 percent slopes, eroded	
	Dickson silt loam	2 to 5 percent slopes	
	Dickson silt loam	0 to 2 percent slopes	
	Egam silty clay loam	occasionally flooded	
	Humphreys gravelly silt loam	2 to 5 percent slopes	
	Lax silt loam	2 to 5 percent slopes	
	Lindside silt loam	occasionally flooded	
	Lobelville gravelly silt loam	occasionally flooded	

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Stewart County (continued)	Newark silt loam	occasionally flooded	
	Nolin silt loam	occasionally flooded	
	Ocana gravelly silt loam	occasionally flooded	
	Ochlocknee fine sandy loam	occasionally flooded	
	Paden silt loam	2 to 5 percent slopes, eroded	
	Sequatchie fine sandy loam	2 to 5 percent slopes	
	Sequatchie fine sandy loam	0 to 2 percent slopes, occasionally flooded	
	Staser fine sandy loam	occasionally flooded	
	Wolftever silt loam	2 to 5 percent slopes, occasionally flooded	
Total Farmland			**48,148**
Total Acres in County			**318,080**
Sullivan County	Bellamy loam	2 to 5 percent slopes	3,877
	Holston loam	2 to 5 percent slopes	1,688
	Pettyjon loam	0 to 2 percent slopes, rarely flooded	819
	Steadman silty clay loam	0 to 2 percent slopes, occasionally flooded	8,077
Total Farmland			**14,461**
Total Acres in County			**275,100**
Union County	Alluvial soils	undifferentiated (Lindside)	
	Caylor (Etowah) silt loam	Undulating phase	
	Dewey silt loam	Undulating phase	
	Emory silt loam	Undulating phase	
	Fullerton silt loam (CR-SIL)	Undulating phase	
	Greendale silt loam	Undulating phase	
	Lindside silt loam		
	Ooltewah (Lindside) silt loam		
	Phil fine sandy loam		
	Pope fine sandy loam		
	Sequatchie fine sandy loam		
Total Farmland			**7,732**
Total Acres in County			**158,505**
Washington County	Augusta loam		191
	Barbourville loam		566
	Chewacla loam		185
	Congaree fine sandy loam		1,124
	Congaree loam		316
	Cumberland silt loam	Undulating phase	948
	Emory silt loam		1,006
	Greendale silt loam		12,370
	Hamblen loam		686
	Hamblen silt loam		315
	Hayter loam	Undulating phase	350
	Hayter stony loam	Undulating phase	211

Table B-2 Prime Farmland — Tennessee (Continued)

County	Soil Name	Slope	Acres
Washington County (continued)	Hermitage silt loam	Undulating phase	693
	Holston loam	Undulating phase	250
	Jefferson loam	Undulating phase	413
	Leadvale silt loam	Undulating phase	636
	Lindside silt loam		4,575
	Masada loam	Undulating phase	226
	Melvin silt loam		1,230
	Monongahela loam		108
	Monongahela silt loam		259
	Ooltewah silt loam		532
	Pace silt loam	Undulating phase	3,418
	Sequatchie loam		862
	Staser loam		394
	Tyler silt loam		148
	Waynesboro loam	Undulating phase	212
	Weaver silt loam		2,128
	Whitesburg silt loam		687
Total Farmland			**35,039**
Total Acres in County			**209,790**
Wayne County	Armour silt loam	0 to 2 percent slopes, occasionally flooded	2,990
	Armour silt loam	gravelly substratum, 2 to 5 percent slopes	2,240
	Brandon silt loam	2 to 5 percent slopes	2,180
	Braxton silt loam	2 to 5 percent slopes	150
	Dickson silt loam	2 to 5 percent slopes	2,170
	Egam silty clay loam	occasionally flooded	100
	Ennis gravelly silt loam	occasionally flooded	11,060
	Hamblen silt loam	occasionally flooded	?
	Humphreys gravelly silt loam	2 to 5 percent slopes	7,250
	Lax silt loam	2 to 5 percent slopes	9,270
	Lee gravelly silt loam	occasionally flooded	3,750
	Lobelville cherty silt loam	occasionally flooded	6,070
	Luverne fine sandy loam	2 to 5 percent slopes	1,130
	Mountview silt loam	2 to 5 percent slopes	900
	Mountview silt loam	2 to 5 percent slopes, eroded	310
	Pickwick silt loam	2 to 5 percent slopes	730
	Silerton silt loam	2 to 5 percent slopes	4850
	Silerton silt loam	2 to 5 percent slopes, eroded	870
	Taft silt loam		770
	Wolftever silt loam	0 to 2 percent slopes, occasionally flooded	940
	Wolftever silt loam	2 to 5 percent slopes, rarely flooded	370
Total Farmland			**58,100**
Total Acres in County			**470,700**

Table B-3 Prime Farmland — North Carolina

County	Soil Name	Slope	Acres
Cherokee County (acreage not available)	Arkaqua loam	0 to 2 percent slopes, occasionally flooded	
	Braddock clay loam	2 to 8 percent slopes, eroded	
	Braddock gravelly loam	2 to 8 percent slopes, very stony	
	Braddock loam	2 to 8 percent slopes	
	Cullowhee fine sandy loam	0 to 3 percent slopes, occasionally flooded	
	Dillard loam	1 to 5 percent slopes, rarely flooded	
	Evard-Hayesville complex	2 to 8 percent slopes	
	Nantahala loam	2 to 8 percent slopes	
	Reddies loam	0 to 3 percent slopes, occasionally flooded	
	Rosman loam	0 to 3 percent slopes, occasionally flooded	
	Rosman-urban land complex	0 to 3 percent slopes, occasionally flooded	
	Statler loam	1 to 5 percent slopes, rarely flooded	
	Tate loam	2 to 8 percent slopes	
	Tate loam	8 to 15 percent slopes	
	Tate loam	15 to 30 percent slopes	
	Thurmont fine sandy loam	2 to 8 percent slopes	
	Thurmont-Dillard complex	2 to 8 percent slopes	
	Thurmont-Dillard complex	8 to 15 percent slopes	
	Toxaway loam	0 to 2 percent slopes, occasionally flooded	
Total Farmland			N/A*
Total Acres in County			N/A
Clay County	Arkaqua loam	0 to 2 percent slopes, rarely flooded	167
	Arkaqua loam	0 to 2 percent slopes, frequently flooded	718
	Braddock loam	2 to 8 percent slopes	638
	Braddock clay loam	2 to 8 percent slopes, eroded	351
	Dillard loam	1 to 6 percent slopes, rarely flooded	344
	French fine sandy loam	0 to 3 percent slopes, frequently flooded	939
	Hayesville loam	2 to 8 percent slopes	105
	Hayesville clay loam	2 to 8 percent slopes, eroded	470
	Lonon loam	2 to 8 percent slopes	250
	Reddies loam	0 to 2 percent slopes, frequently flooded	928
	Rosman fine sandy loam	0 to 2 percent slopes, rarely flooded	401
	Rosman fine sandy loam	0 to 2 percent slopes, frequently flooded	693

Table B-3 Prime Farmland — North Carolina (Continued)

County	Soil Name	Slope	Acres
Clay County (continued)	Statler loam	1 to 5 percent slopes, rarely flooded	533
	Tate loam	2 to 8 percent slopes	727
	Toxaway loam	0 to 2 percent slopes, frequently flooded	165
Total Farmland			**7,429**
Total Land in County			**141,126**
Graham County	Braddock clay loam	2 to 8 percent slopes, eroded	50
	Dillard fine sandy loam	1 to 5 percent slopes, rarely flooded	321
	Reddies loam	0 to 3 percent slopes, occasionally flooded	916
	Statler loam	2 to 8 percent slopes, rarely flooded	271
	Unison loam	2 to 8 percent slopes	231
	Thurmont-Dillard Complex	2 to 8 percent slopes	1,325
Total Farmland			**3,114**
Total Acres in County			**193,018**
Jackson County	Braddock clay loam	2 to 8 percent slopes, eroded	350
	Cullowhee fine sandy loam	0 to 2 percent slopes, occasionally flooded	945
	Dillard loam	1 to 5 percent slopes, rarely flooded	483
	Dillsboro loam	2 to 8 percent slopes	345
	Reddies fine sandy loam	0 to 2 percent slopes, occasionally flooded	318
	Rosman fine sandy loam	0 to 2 percent slopes, occasionally flooded	370
	Saunook gravelly loam	2 to 8 percent slopes	675
	Statler loam	1 to 5 percent slopes, rarely flooded	443
	Sylva-Whiteside complex	0 to 2 percent slopes	772
	Whiteside-Tuckasegee complex	2 to 8 percent slopes	2,435
Total Farmland			**7,136**
Total Acres in County			**316,877**
Swain County Not available			

Table B-4 Prime Farmland — Mississippi

County	Soil Name	Slope	Acres
Tishomingo	Guyton silt loam		542
	Jena silt loam		3,585
	Kirkville loam		5,115
	Mantachie loam		25,210
	Ora loam	2 to 5 percent slopes, eroded	1,945
	Paden silt loam	0 to 2 percent slopes	710
	Quitman fine sandy loam	0 to 2 percent slopes	1,145
	Ruston sandy loam	2 to 5 percent slopes, eroded	1,170
	Savannah silt loam	0 to 2 percent slopes	715
	Savannah silt loam	2 to 5 percent slopes, eroded	10,565
Total Farmland			**50,702**
Total Acres in County			**279,640**

Table B-5 Prime Farmland — Kentucky

County	Soil Name	Slope	Acres
Calloway County	Bibb loamy fine sand	Overwash	350
	Bibb silt loam		1,425
	Calloway silt loam	0 to 2 percent slopes	14,060
	Calloway silt loam	2 to 6 percent slopes	10,265
	Calloway silt loam	2 to 6 percent slopes, eroded	4,175
	Collins silt loam		9,970
	Falaya silt loam		12,210
	Grenada silt loam	0 to 2 percent slopes	15,720
	Grenada silt loam	2 to 6 percent slopes	27,515
	Iuka silt loam		4,665
	Loring silt loam	2 to 6 percent slopes	5,450
	Loring silt loam	2 to 6 percent slopes, eroded	4,565
	Mantachie silt loam		2,585
	Memphis silt loam	2 to 6 percent slopes	820
	Ochlocknee gravelly loam		1,565
	Ochlocknee silt loam		2,495
	Vicksburg silt loam		1,605
	Waverly silt loam		4,710
	Wheeling silt loam	2 to 6 percent slopes	260
Total Farmland			**124,410**
Total Acres in County			**245,760**
Livingston County	Ashton silt loam	0 to 4 percent slopes, occasionally flooded	3,520
	Chavies fine sandy loam	2 to 6 percent slopes	260
	Dunning silty clay	frequently flooded	670
	Elk silt loam	0 to 2 percent slopes	350
	Elk silt loam	2 to 6 percent slopes	1,830
	Henshaw silt loam	rarely flooded	4,740
	Huntington silt loam	frequently flooded	3,470
	Karnak silty clay	frequently flooded	1,120
	Licking silt loam	2 to 6 percent slopes	1,610
	Lindside silt loam	frequently flooded	9,580
	Loring silt loam	2 to 6 percent slopes	20,480
	McGary silt loam	rarely flooded	4,210
	Melvin silt loam	frequently flooded	820
	Memphis silt loam	2 to 6 percent slopes	1,810
	Nelse loam	frequently flooded	2,270
	Nelse-Huntington complex	frequently flooded	312
	Newark silt loam	frequently flooded	5,860
	Nolin silt loam	frequently flooded	5,080
	Otwell silt loam	2 to 6 percent slopes	4,870
	Peoga silt loam		1,680
	Wheeling silt loam	0 to 2 percent slopes	370
	Wheeling silt loam	2 to 6 percent slopes	1,490
Total Farmland			**76,402**
Total Acres in County			**219,085**

Table B-5 Prime Farmland — Kentucky (Continued)

County	Soil Name	Slope	Acres
Lyon County	Clifty gravelly silt loam		3,500
	Crider silt loam	2 to 6 percent slopes	1,500
	Elk silt loam	0 to 2 percent slopes	430
	Elk silt loam	2 to 6 percent slopes	250
	Hammack silt loam	2 to 6 percent slopes	370
	Lawrence silt loam		480
	Lax silt loam	2 to 6 percent slopes	2,100
	Lindside silt loam		2,900
	Melvin silt loam		650
	Newark silt loam		2,800
	Nicholson silt loam	0 to 2 percent slopes	20
	Nicholson silt loam	2 to 6 percent slopes	13,400
	Nolin silt loam		8,450
	Otwell silt loam	0 to 2 percent slopes	240
	Otwell silt loam	2 to 6 percent slopes	400
Total Farmland			**37,490**
Total Acres in County			**142,720**
Marshall County	Bibb loamy fine sand	Overwash	50
	Bibb silt loam		280
	Calloway silt loam	0 to 2 percent slopes	5,230
	Calloway silt loam	2 to 6 percent slopes	1,975
	Calloway silt loam	2 to 6 percent slopes, eroded	270
	Collins silt loam		7,790
	Falaya silt loam		12,440
	Forestdale silt loam		1,490
	Grenada silt loam	0 to 2 percent slopes	5,410
	Grenada silt loam	2 to 6 percent slopes	20,575
	Huntington silt loam		515
	Iuka silt loam		2,660
	Loring silt loam	2 to 6 percent slopes	4,725
	Loring silt loam	2 to 6 percent slopes, eroded	2,235
	Mantachie silt loam		1,360
	Memphis silt loam	2 to 6 percent slopes	1,290
	Ochlockonee gravelly loam		685
	Ochlocknoee silt loam		3,090
	Vicksburg silt loam		3,440
	Waverly silt loam		10,005
	Wheeling silt loam	2 to 6 percent slopes	565
Total Farmland			**86,080**
Total Acres in County			**193,920**
Trigg County	Clifty gravelly silt loam		7,500
	Crider silt loam	0 to 2 percent slopes	280
	Crider silt loam	2 to 6 percent slopes	12,500
	Elk silt loam	0 to 2 percent slopes	400
	Elk silt loam	2 to 6 percent slopes	**1,130**
	Hammack silt loam	2 to 6 percent slopes	**7,890**

Table B-5 Prime Farmland — Kentucky (Continued)

County	Soil Name	Slope	Acres
Trigg County	Lawrence silt loam		600
	Lax silt loam	2 to 6 percent slopes	6,800
	Lindside silt loam		6,640
	Melvin silt loam		430
	Newark silt loam		1,510
	Nicholson silt loam	0 to 2 percent slopes	100
	Nicholson silt loam	2 to 6 percent slopes	13,900
	Nolin silt loam		17,840
	Otwell silt loam	0 to 2 percent slopes	150
	Otwell silt loam	2 to 6 percent slopes	520
	Sadler silt loam	0 to 2 percent slopes	150
	Sadler silt loam	2 to 6 percent slopes	1,160
	Zanesville silt loam	2 to 6 percent slopes	820
Total Farmland			**80,320**
Total Acres in County			**275,840**

Table B-6 Prime Farmland — Georgia

County	Soil Name	Slope	Acres
Rabun and Towns Counties	Dillard sandy loam	2 to 6 percent slopes	860
	Tusquitee loam	4 to 10 percent slopes	2,570
Total Farmland			**3,430**
Total Acres in Counties			**341,760**
Fannin and Union Counties	Dillard fine sandy loam	2 to 6 percent slopes	2,690
	Suches loam	0 to 2 percent slopes, occasionally flooded	3,845
	Thurmont fine sandy loam	2 to 6 percent slopes	1,810
Total Farmland			**8,345**
Total Acres in Counties			**461,000**

Table B-7 Prime Farmland — Alabama

County	Soil Name	Slope	Acres
Colbert County	Bewleyville silt loam	2 to 6 percent slopes	6,716
	Capshaw silt loam	2 to 6 percent slopes	12,149
	Chenneby silt loam	0 to 2 percent slopes, occasionally flooded	19,417
	Chenneby silt loam	0 to 2 percent slopes, ponded	1,247
	Decatur silt loam	2 to 6 percent slopes	45,546
	Dickson silt loam	0 to 3 percent slopes	1,715
	Emory silt loam	0 to 2 percent slopes, ponded	13,596
	Etowah silt loam	2 to 6 percent slopes	3,694
	Fullerton cherty silt loam	2 to 6 percent slopes	2,641
	Pruitton and Sullivan silt loams	0 to 2 percent slopes, occasionally flooded	7,587
	Savannah loam	1 to 5 percent slopes	2,357
	Tupelo-Colbert complex	0 to 4 percent slopes	7,669
	Wynnville silt loam	2 to 6 percent slopes	9,460
Total Farmland			133,794
Total Acres in County			399,170
Franklin County	Albertville fine sandy loam	2 to 6 percent slopes, eroded	1,780
	Cahaba fine sandy loam	0 to 2 percent slopes	353
	Cahaba fine sandy loam	2 to 6 percent slopes	1,062
	Cane loam	2 to 6 percent slopes, eroded	280
	Captina silt loam	2 to 6 percent slopes (Leadvale)	862
	Decatur silt loam	2 to 6 percent slopes, eroded	1,451
	Decatur silty clay loam	2 to 6 percent slopes, severely eroded	3,278
	Greenville loam	2 to 6 percent slopes, eroded	770
	Greenville loam	2 to 6 percent slopes, severely eroded	267
	Huntington silt loam	local alluvium	646
	Iuka fine sandy loam		6,788
	Iuka fine sandy loam	local alluvium	806
	Lindside silt loam (Chenneby)		4,568
	Lindside silt loam	local alluvium (Chenneby)	297
	Linker fine sandy loam	2 to 6 percent slopes, eroded	2,295
	Ochlockonee fine sandy loam		7,274
	Ora fine sandy loam	2 to 6 percent slopes, eroded	2,479
	Ora fine sandy loam	heavy substratum, 2 to 6 percent slopes, eroded	610
	Prentiss fine sandy loam	0 to 2 percent slopes	990
	Prentiss fine sandy loam	2 to 6 percent slopes	702
	Ruston fine sandy loam	2 to 6 percent slopes (Smithdale)	2,272
	Savannah very fine sandy loam	0 to 2 percent slopes	355
	Savannah very fine sandy loam	2 to 6 percent slopes	1,900
	Savannah very fine sandy loam	2 to 6 percent slopes	19,223
	Talbott silt loam	2 to 6 percent slopes, eroded (Remlap)	3,264
	Tilden fine sandy loam	2 to 6 percent slopes, eroded (Ora)	553
Total Farmland			**65,125**
Total Acres in County			**413,830**

Table B-7 Prime Farmland — Alabama (Continued)

County	Soil Name	Slope	Acres
Jackson County	Abernathy fine sandy loam		853
	Abernathy silt loam	undulating phase	2,098
	Abernathy silt loam	level phase	1,379
	Allen fine sandy loam	eroded undulating phase	910
	Allen fine sandy loam	undulating phase	779
	Barbourville-Cotaco fine sandy loams		2,711
	Capshaw silt loam	undulating phase	5,716
	Capshaw silt loam	level phase	1,896
	Clarksville cherty silt loam	eroded undulating phase	108
	Clarksville cherty silt loam	undulating phase	586
	Crossville loam	undulating phase	4,628
	Cumberland loam	undulating phase	202
	Cumberland silt loam	eroded undulating phase	747
	Cumberland silty clay loam	eroded undulating phase	1,984
	Dewey cherty silt loam	eroded undulating phase	80
	Dewey silt loam	undulating phase	445
	Dewey silty clay loam	eroded undulating phase	1,122
	Egam silt loam		4,347
	Egam silty clay loam		2,817
	Enders silt loam	eroded undulating phase	485
	Enders silt loam	undulating phase	2,337
	Etowah loam	undulating phase	4,921
	Etowah loam	level phase	709
	Etowah silt loam	undulating phase	6,865
	Etowah silt loam	level phase	316
	Fullerton cherty silt loam	eroded undulating phase	1,138
	Fullerton cherty silt loam	undulating phase	1,038
	Fullerton silt loam	eroded undulating phase	127
	Fullerton silt loam	undulating phase	193
	Greendale cherty silt loam	eroded undulating phase	166
	Greendale cherty silt loam	undulating phase	3,592
	Greendale cherty silt loam	level phase	553
	Hanceville fine sandy loam	eroded undulating phase	74
	Hanceville fine sandy loam	undulating phase	750
	Hartsells fine sandy loam	eroded undulating phase	2,514
	Hartsells fine sandy loam	undulating shallow phase	7,338
	Hartsells fine sandy loam	eroded undulating shallow phase	519
	Hartsells fine sandy loam	undulating phase	47,152
	Hermitage silty clay loam	eroded undulating phase	288
	Hollywood silty clay	undulating phase	1,300
	Hollywood silty clay	level phase	2,104
	Holston loam	undulating phase	3,246
	Holston loam	level phase	1,787
	Huntington silt loam		6,182
	Jefferson fine sandy loam	eroded undulating phase	1,104
	Jefferson fine sandy loam	undulating phase	3,597

Table B-7 Prime Farmland — Alabama (Continued)

County	Soil Name	Slope	Acres
Jackson County (continued)	Lindside silt loam		7,622
	Lindside silty clay		588
	Lindside silty clay loam		3,862
	Monongahela loam	undulating phase	921
	Monongahela loam	level phase	697
	Philo-Atkins silt loams		8,208
	Pope fine sandy loam		190
	Sequatchie fine sandy loam	undulating phase	4,802
	Sequatchie fine sandy loam	level phase	1,268
	Taft silt loam		1,346
	Talbott silt loam	undulating phase	859
	Talbott silty clay loam	eroded undulating phase	2,506
	Tyler very fine sandy loam		3,133
	Waynesboro fine sandy loam	eroded undulating phase	433
	Waynesboro fine sandy loam	undulating phase	434
	Wolftever silt loam	undulating phase	561
	Wolftever silt loam	level phase	836
Total Farmland			**172,069**
Total Acres in County			**721,100**
Lauderdale County	Armour silt loam		1,274
	Chenneby silt loam		2,224
	Choccolocco silt loam		1,040
	Decatur silt loam	2 to 6 percent slopes	20,412
	Dewey silt loam	2 to 6 percent slopes	32,413
	Dickson silt loam	0 to 2 percent slopes	7,964
	Dickson silt loam	2 to 6 percent slopes	79,318
	Etowah silt loam	2 to 8 percent slopes	3,900
	Fullerton cherty silt loam	2 to 6 percent slopes	4,826
	Grasmere silty clay loam		7,877
	Humphreys cherty silt loam		888
	Lobelville cherty silt loam		18,331
	Pruitton silt loam		9,667
	Staser silt loam		1,420
Total Farmland			**191,554**
Total Acres in County			**460,030**
Lawrence County	Abernathy fine sandy loam	level phase	1,214
	Abernathy fine sandy loam	undulating phase	2,055
	Abernathy silt loam	level phase	8,330
	Abernathy silt loam	undulating phase	3,479
	Allen fine sandy loam	eroded undulating phase	1,388
	Barbourville fine sandy loam	eroded undulating phase	836
	Cotaco silt loam	eroded undulating phase	2,670
	Cumberland loam	undulating phase	7,462
	Cumberland loam		400
	Cumberland loam	undulating phase	7,000
	Cumberland loam	undulating phase	279

Table B-7 Prime Farmland — Alabama (Continued)

County	Soil Name	Slope	Acres
Lawrence County (continued)	Decatur and Cumberland silt loams	undulating phase	331
	Decatur and Cumberland silty clay loams	eroded undulating phase	17,467
	Dewey cherty silty clay loam	eroded undulating phase	466
	Enders loam	undulating phase	438
	Etowah loam	eroded undulating phase	17,765
	Etowah loam	undulating phase	2,395
	Etowah silt loam	undulating phase	289
	Etowah silty clay loam	eroded undulating phase	693
	Hamblen fine sandy loam		5,212
	Hartsells fine sandy loam	eroded undulating phase	187
	Hollywood silty clay		8,734
	Huntington silt loam		132
	Jefferson fine sandy loam	undulating phase	1,974
	Johnsburg loam		632
	Lindside silty clay loam		7,309
	Linker fine sandy loam	eroded undulating phase	3,140
	Monongahela and Holston fine sandy loams	eroded undulating phase	2,987
	Monongahela and Holston fine sandy loams	level phase	851
	Monongahela and Holston fine sandy loams	undulating phase	1,001
	Nolichucky fine sandy loam	eroded undulating phase	2,257
	Philo fine sandy loam		872
	Ruston sandy loam	undulating phase	185
	Sequatchie fine sandy loam	eroded undulating phase	1,423
	Sequatchie fine sandy loam	undulating phase	1,098
	Staser fine sandy loam		289
	Talbott silt loam	eroded undulating phase	1,017
	Talbott silt loam	undulating phase	470
	Talbott silty clay loam	eroded undulating phase	7,735
	Tilsit silt loam	eroded undulating phase	20,416
	Tilsit silt loam	undulating phase	2,900
	Tyler and Monongahela fine sandy loams	eroded undulating phase	1,742
	Tyler and Monongahela fine sandy loams	level phase	5,555
	Tyler and Monongahela fine sandy loams	undulating phase	2,259
	Tyler fine sandy loam		1,138
	Waynesboro fine sandy loam	eroded undulating phase	376
Total Farmland			**156,848**
Total Acres in County			**459,370**
Limestone County	Abernathy fine sandy loam		427
	Abernathy silt loam	undulating phase	2,037
	Abernathy silt loam	level phase	13,801

Table B-7 Prime Farmland — Alabama (Continued)

County	Soil Name	Slope	Acres
Limestone County (continued)	Baxter cherty silt loam	eroded undulating phase	5,612
	Baxter cherty silt loam	undulating phase	1,387
	Cumberland clay loam	eroded undulating phase	458
	Cumberland fine sandy loam	undulating phase	362
	Cookeville silt loam	eroded undulating phase	30,758
	Cookeville silt loam	undulating phase	2,427
	Capshaw loam		274
	Cumberland silty clay loam	eroded undulating phase	5,017
	Cumberland silt loam	undulating phase	760
	Cumberland silt loam	level phase	624
	Dickson cherty silt loam	eroded undulating phase	2,431
	Dickson cherty silt loam	undulating phase	1,215
	Dickson silt loam	eroded undulating phase	24,177
	Dickson silt loam	undulating phase	12,938
	Dickson silt loam	level phase	19,513
	Decatur silty clay loam	eroded undulating phase	16,960
	Dewey silt loam	slightly eroded undulating phase	1,395
	Dewey silt loam	level phase	768
	Decatur silt loam	slightly eroded undulating phase	6,493
	Decatur silt loam	level phase	7,240
	Dewey silty clay loam	eroded undulating phase	16,859
	Egam silty clay loam		526
	Ennis silt loam		4,255
	Ennis silt loam	shallow phase	503
	Ennis cherty silt loam		960
	Etowah silt loam	undulating phase	466
	Etowah silt loam	level phase	3,245
	Etowah silty clay loam	eroded undulating phase	773
	Greendale cherty silt loam	undulating phase	2,895
	Greendale silt loam	undulating phase	10,715
	Greendale silt loam	level phase	650
	Hollywood silty clay	level phase	623
	Huntington silt loam		2,963
	Humphreys silt loam	level phase	3,264
	Humphreys cherty silt loam	undulating phase	1,427
	Lawrence silt loam		9,762
	Maury silt loam	eroded undulating phase	994
	Sango silt loam		5,624
	Taft silt loam		3,708
	Wolftever silt loam		1,266
Total Farmland			**228,552**
Total Acres in County			**388,700**
Madison County	Abernathy cherty silt loam		1,222
	Abernathy fine sandy loam		3,665
	Abernathy silt loam		30,540
	Allen fine sandy loam	Undulating	407
	Allen fine sandy loam	eroded, undulating	4,377

Table B-7 Prime Farmland — Alabama (Continued)

County	Soil Name	Slope	Acres
Madison County (continued)	Baxter cherty silt loam	Undulating	1,120
	Baxter cherty silt loam	eroded, undulating	10,511
	Captina and Capshaw loams	Undulating	499
	Captina and Capshaw silt loams	Level	4,215
	Captina and Capshaw silt loams	Undulating	1,252
	Cookeville silt loam	undulating	2,779
	Cookeville silt loam	eroded, undulating	13,560
	Cumberland loam	Undulating	150
	Cumberland loam	eroded, undulating	5,382
	Decatur and Cumberland silt loams	level	2,688
	Decatur and Cumberland silt loams	undulating	11,524
	Decatur and Cumberland silty clays	gullied	1,731
	Decatur and Cumberland silty clay loams	eroded, undulating	48,944
	Dewey cherty silty clay loam	eroded, undulating	3,298
	Dickson cherty silt loam	undulating	3,410
	Dickson cherty silt loam	eroded, undulating	4,937
	Dickson silt loam	level	2,036
	Dickson silt loam	undulating	12,216
	Dickson silt loam	eroded, undulating	5,930
	Egam silty clay loam		1,832
	Etowah cherty silt loam	undulating	509
	Etowah loam	level	305
	Etowah loam	undulating	764
	Etowah loam	eroded, undulating	373
	Etowah silt loam	level	1,273
	Etowah silt loam	Undulating	2,749
	Etowah silty clay loam	eroded, undulating	2,659
	Greendale cherty silt loam		3,716
	Greendale silt loam		10,455
	Hamblen fine sandy loam		1,893
	Hartsells fine sandy loam	undulating	1,349
	Hartsells fine sandy loam	eroded, undulating	305
	Hartsells fine sandy loam Hartsells fine sandy loam	undulating, shallow eroded, undulating, shallow	244 214
	Hermitage cherty silt loam	eroded, undulating	2,688
	Hermitage silt loam	Undulating	814
	Hermitage silt loam	eroded, undulating	1,547
	Hollywood silty clay		2,400
	Hollywood silty clay	eroded, undulating	226
	Holston fine sandy loam	Level	2,647
	Holston fine sandy loam Humphreys cherty silt loam	Undulating	1,425 3,156
	Humphreys silt loam		2,698

Table B-7 Prime Farmland — Alabama (Continued)

County	Soil Name	Slope	Acres
Madison County (continued)	Huntington fine sandy loam		1,222
	Huntington silt loam		4,785
	Jefferson fine sandy loam	Undulating	682
	Jefferson fine sandy loam	eroded, undulating	1,298
	Lawrence silt loam		4,581
	Lee silt loam		5,294
	Lickdale silt loam		46
	Lindside silty clay loam		13,947
	Linker fine sandy loam	eroded, undulating	204
	Monongahela fine sandy loam		3,354
	Pearman loam		265
	Sequatchie fine sandy loam		1,222
	Sequatchie fine sandy loam	Eroded	1,731
	Taft silt loam		774
	Talbott cherty silty clay loam	eroded, undulating	1,043
	Talbott fine sandy loam	eroded, undulating	188
	Talbott silty clay loam	eroded, undulating	1,726
	Tyler very fine sandy loam		4,785
	Wolftever silt loam		560
	Wolftever silt loam	Eroded	366
Total Farmland			**271,929**
Total Acres in County			**520,380**
Marion County	Bama loam	2 to 6 percent slopes	920
	Bassfield loamy sand		750
	Cahaba fine sandy loam	0 to 2 percent slopes	760
	Cahaba fine sandy loam	2 to 6 percent slopes	1,200
	Choccolocco silt loam		284
	Kirkville loam		810
	Nauvoo loam	2 to 6 percent slopes	490
	Ora silt loam	2 to 6 percent slopes	12,600
	Ruston fine sandy loam	2 to 6 percent slopes	5,300
	Savannah loam	0 to 2 percent slopes	4,050
	Savannah loam	2 to 6 percent slopes	26,750
	Townley silt loam	2 to 6 percent slopes	491
Total Farmland			**54,405**
Total Acres in County			**475,870**
Marshall County	Albertville very fine sandy loam	eroded, gently sloping	16,653
	Alcoa silt loam	eroded, gently sloping	555
	Allen-Waynesboro fine sandy loams	eroded, gently sloping	5,690
	Captina silt loam	eroded, gently sloping	5,718
	Captina silty clay loam	severely eroded, gently sloping	222
	Captina-Colbert soils	gently sloping	333
	Crossville fine sandy loam	eroded, gently sloping, moderately deep	5,662

County	Soil Name	Slope	Acres
	Cumberland and Hermitage silty clay loams	severely eroded, gently sloping	2,220

Table B-7 Prime Farmland — Alabama (Continued)

County	Soil Name	Slope	Acres
Marshall County (continued)	Egam silty clay loam		1,443
	Egam silty clay loam	sandy substratum	1,110
	Egam-Newark silty clay loams		4,663
	Etowah loam	eroded, gently sloping	305
	Hartsells fine sandy loam	gently sloping	555
	Hartsells fine sandy loam	eroded, gently sloping, shallow	75,347
	Hartsells fine sandy loam	eroded, gently sloping, shallow	555
	Hartsells sandy clay loam	severely eroded, gently sloping, shallow	222
	Hollywood clay		56
	Huntington fine sandy loam		2,109
	Huntington loam	local alluvium	555
	Huntington silt loam		56
	Huntington silt loam	local alluvium	472
	Jefferson fine sandy loam	eroded, gently sloping	622
	Linker fine sandy loam	eroded, gently sloping	6,717
	Linker sandy clay loam	severely eroded, gently sloping	7,771
	Lobelville cherty silt loam	local alluvium	555
	Minvale cherty silt loam	gently sloping	555
	Minvale cherty silt loam	eroded, gently sloping	5,551
	Monongahela fine sandy loam	eroded, gently sloping	611
	Monongahela fine sandy loam	Overwash	555
	Philo and Stendall soils	local alluvium	2,470
	Pope fine sandy loam		111
	Taft silt loam	Level	361
	Taft silt loam	eroded, gently sloping	2,220
	Tilsit very fine sandy loam	gently sloping	555
	Tilsit very fine sandy loam	eroded, gently sloping	11,102
	Tyler fine sandy loam		111
	Wolftever silt loam	eroded, gently sloping	111
Total Farmland			**165,256**
Total Acres in County			**398,750**
Morgan County	Abernathy fine sandy loam		2,983
	Abernathy silt loam		5,125
	Allen fine sandy loam	eroded, undulating	3,797
	Allen fine sandy loam	Undulating	475
	Captina and Capshaw loams	Undifferentiated	1,695
	Captina and Capshaw silt loams	Undifferentiated	2,713
	Christian loam	Undulating	521
	Christian loam	Undulating	2,658

County	Soil Name	Slope	Acres
	Cotaco loam		2,983
	Crossville loam	Undulating	154
	Cumberland silt loam	Level	308
	Cumberland silt loam	Undulating	799
	Cumberland silty clay loam	eroded, undulating	3,717

Table B-7 Prime Farmland — Alabama (Continued)

County	Soil Name	Slope	Acres
Morgan County (continued)	Decatur silt loam	Undulating	606
	Decatur silty clay loam	eroded, undulating	2,947
	Dewey cherty silt loam	Undulating	864
	Dewey cherty silty clay loam	eroded, undulating	217
	Dewey silt loam	Undulating	1,146
	Dewey silty clay loam	eroded, undulating	1,473
	Egam silty clay loam		2,417
	Enders loam	eroded, undulating	2,084
	Enders loam	Undulating	1,319
	Etowah loam	Level	736
	Etowah loam	Undulating	1,723
	Etowah silty clay loam	eroded, undulating	560
	Hanceville fine sandy loam	eroded, undulating	1,244
	Hanceville fine sandy loam	Undulating	389
	Hartsells fine sandy loam	eroded, undulating	3,764
	Hartsells fine sandy loam	Undulating	5,116
	Hartsells fine sandy loam	Undulating	469
	Hartsells loam	Undulating	277
	Hollywood loam		249
	Hollywood silty clay		8,618
	Holston fine sandy loam	eroded, undulating	643
	Holston fine sandy loam	Level	3,336
	Holston fine sandy loam	Undulating	4,965
	Holston gravelly fine sandy loam	Undulating	312
	Holston gravelly fine sandy loam	eroded, undulating	347
	Huntington fine sandy loam	Sanded	540
	Huntington silt loam		1,055
	Jefferson fine sandy loam	eroded, undulating	2,140
	Jefferson fine sandy loam	Undulating	1,003
	Johnsburg loam		778
	Lindside silty clay loam		5,849
	Linker fine sandy loam	eroded, undulating	4,789
	Linker fine sandy loam	Undulating	2,303
	Monongahela fine sandy loam		3,478
	Nolichucky fine sandy loam	Undulating	129
	Nolichucky fine sandy loam	eroded, undulating	117
	Nolichucky gravelly fine sandy loam	eroded, undulating	250
	Philo fine sandy loam		1,485
	Philo-Lindside soils	Undifferentiated	5,461

County	Soil Name	Slope	Acres
	Pope fine sandy loam		664
	Sequatchie fine sandy loam		2,541
	Sequatchie fine sandy loam	eroded	1,682
	Taft silt loam		1,097
	Talbott loam	eroded, undulating	1,457
	Talbott silt loam	Undulating	2,146

Table B-7 Prime Farmland — Alabama (Continued)

County	Soil Name	Slope	Acres
Morgan County (continued)	Talbott silty clay loam	eroded, undulating	3,964
	Tilsit silt loam	eroded, undulating	12,024
	Tilsit silt loam	Level	1,384
	Tilsit silt loam	Undulating	9,685
	Tyler fine sandy loam		1,346
	Tyler silt loam		4,118
	Waynesboro fine sandy loam	eroded, undulating	6,910
	Waynesboro fine sandy loam	Undulating	821
	Wolftever silt loam		1,149
Total Farmland			**154,114**
Total Acres in County			**383,460**
Winston County	Bama sandy loam	2 to 6 percent slopes	—
	Hartsells fine sandy loam	2 to 6 percent slopes	—
	Enders fine sandy loam	2 to 6 percent slopes	—
	Savannah fine sandy loam	2 to 6 percent slopes	—
	Locust fine sandy loam	0 to 2 percent slopes	—
	Locust fine sandy loam	2 to 6 percent slopes	—
	Albertville silt loam	2 to 6 percent slopes	—
	Leadvale silt loam	0 to 2 percent slopes	—
	Leadvale silt loam	2 to 6 percent slopes	—
	Nauvoo fine sandy loam	2 to 6 percent slopes	—
	Townley fine sandy loam	2 to 6 percent slopes	—
	Holston fine sandy loam	2 to 6 percent slopes	—
	Taft silt loam	0 to 2 percent slopes	—
	Wynnville fine sandy loam	0 to 2 percent slopes	—
	Wynnville fine sandy loam	2 to 6 percent slopes	—
Total Farmland			**not known**
Total Acres in County			**404,290**

Appendix F

Response to Comments on the DEIS

Appendix F

Appendix F1

Introduction and Overview

Table of Contents

List of Tables

List of Acronyms

DEIS	Draft Environmental Impact Statement
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
ROS	Reservoir Operations Study
TVA	Tennessee Valley Authority
USFWS	U.S. Fish and Wildlife Service

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F1 Introduction and Overview

The Draft Programmatic Environmental Impact Statement (DEIS) on the Tennessee Valley Authority's (TVA's) Reservoir Operations Study (ROS) was distributed in July 2003 for review and comment. Approximately 1,530 copies of the DEIS were sent to affected tribal governments, agencies, organizations, and individuals. The Notice of Availability of the DEIS was published in the *Federal Register* on July 3, 2003. The comment period closed on September 4, 2003, but TVA continued to accept comments through mid-October from tribes and persons who informed the agency that their comments would be late.

Appendix F contains TVA responses to substantive comments on the ROS DEIS. In response to some comments, changes were made to improve the content of this Final Programmatic Environmental Impact Statement (FEIS). Regardless of whether a comment generated a modification to the FEIS text, TVA provided a response to the issue raised.

Comments were provided by members of the public, organizations, and interested agencies at 12 interactive workshops held around the Tennessee Valley region after the DEIS was released. Approximately 1,700 individuals registered at the workshops (Table F1-01). Attendees were able to discuss issues with TVA and EIS contractor staffs, obtain material about the study, and view information displays and a short video. Workshop participants learned the results of analyses performed, including model results of the impacts of the policy alternatives on pool elevations, flow releases, and power generation for specific reservoirs. During these workshops, comments could be made in writing, using comment cards; given to court reporters; or entered on computer terminals through an interactive software program that was specially designed to assist the public in providing comments. TVA posted a copy of the DEIS on its official agency internet web site, where comments also could be made. In addition, TVA accepted comments by surface or electronic mail, telephone, and facsimile.

While the ROS proceeded, TVA continued to meet with its cooperating agencies and with members of the Public Review Group and Interagency Team to receive their input on the DEIS. TVA conducted special briefings with resource agency staffs, including the U.S. Environmental Protection Agency, to apprise them of ROS analyses and progress. These briefings provided interested agencies multiple opportunities to help direct and influence the scope and substance of the study, the EIS process, and associated analyses. TVA also held briefings with about 200 community leaders and representatives of interest groups to share information and to receive their input on the DEIS (Table F1-02).

The U.S. Fish and Wildlife Service (USFWS) has served multiple roles in the ROS. It provided input as part of the Interagency Team and submitted comments on the DEIS that were part of the letter from the U.S. Department of the Interior. This letter is reproduced in Appendix F4. The USFWS is also obligated to respond to TVA's determinations about potential impacts on threatened and endangered species under the Endangered Species Act (ESA). This is fulfilled by the USFWS's Biological Opinion in Appendix G. TVA's response to the USFWS's ESA determinations and comments on the DEIS are in the text of the EIS and Appendix F4, as appropriate.

Table F1-01 ROS Community Workshop Attendance

Date	Location	Attendance
July 21, 2003	Murfreesboro, TN	30
July 22, 2003	Knoxville, TN	58
July 24, 2003	Bristol, TN	299
July 28, 2003	Morristown, TN	479
July 29, 2003	Murphy, NC	53
July 31, 2003	Blairsville, GA	407
August 5, 2003	Chattanooga, TN	53
August 7, 2003	Decatur, AL	106
August 12, 2003	Gilbertsville, KY	105
August 14, 2003	Pickwick, TN	70
August 19, 2003	Muscle Shoals, TN	54
August 21, 2003	Columbus, MS	10
Total workshop attendance		**1,724**

Table F1-02 ROS Special Stakeholder Briefings Attendance

Date	Location	Attendance
July 17, 2003	Morristown, TN	55
July 21, 2003	Murphy, NC	15
July 22, 2003	Blairsville, GA	28
July 24, 2003	Dalton, GA	6
July 29, 2003	Guntersville, AL	27
July 29, 2003	Decatur, AL	24
July 31, 2003	Gilbertsville, KY	14
August 6, 2003	Columbus, MS	6
August 6, 2003	Muscle Shoals, AL	25
Total briefing attendance		**200**

TVA and the cooperating agencies sincerely appreciate the time and effort of private citizens representing different stakeholder interests on the Public Review Group, as well as those agency representatives who participated as part of the Interagency Team. Their involvement ensured continued public and agency involvement throughout the ROS, and provided independent oversight of study activities and analyses.

F1.1 Overview of Comments Received on the DEIS

Including form letters and petitions, TVA received a total of 2,320 sets of comments on the DEIS (Table F1-03). These sets of comments included input from almost 7,000 individuals, 7 federal agencies, 14 state agencies, 1 tribal government, 8 county and local government agencies, and 42 other organizations. TVA has carefully reviewed all of the comments, has identified specific comments about the EIS contained in each of them, and has associated similar comments to produce a list of approximately 3,264 separate comments (Table F1-04). These comments are arranged in three major sections: general comments, issues, and concerns; specific public comments; and federal and state agency comments. Comments received from federal and state agencies were also published separately.

Due to their large volume and similarity, the general comments, issues, and concerns were summarized and combined into categories of comments (Table F1-05; also see Section F2). These general comments were categorized for easier public review and to avoid repetition. A single response is provided for comments that fell into each category. The names of people who provided comments under each category are listed following the summary of comments within the category. Additionally, 4,602 individuals signed a petition supporting pool stabilization during fish spawning, and multiple individuals signed form letters supporting specific alternatives or resource concerns.

Because the general comments, issues, and concerns were summarized, the exact wording of the comments was not always used. Also, in many cases, the commenters listed with a combined comment may not have raised all of the points in the comment summary, but they supported the primary premise or issue captured by the combined comment. For example, most of the comments that TVA received simply "voted" for one or more of the identified alternatives. A large number of individuals supported Reservoir Recreation Alternatives A and B. Many of those supporting these alternatives said they did so because reservoir levels would be held up longer in summer, thereby increasing recreation opportunities, lake-front property values, scenic beauty, and recreation-related expenditures.

Other commenters listed under the combined comment, Support for Reservoir Recreation Alternative A, however, may have simply stated, "I support Recreation A" and did not give a reason or did not mention any of the other points in the combined comment. Therefore, it should not be assumed that all commenters identified with a combined comment necessarily support all facets of that comment. While summarizing and combining comments, TVA has attempted to retain all important discrete nuances or differences among comments. A number of summarized comments may still be somewhat repetitious because further refinements could have distorted an important element of a specific combined comment.

Table F1-03 ROS DEIS Comment Source and Number of Comment Segments

Source of Comment	Number of Sets
Comment card	57
Court report transcript	140
E-mail	27
Fax	13
Governmental	22
Letters from general public	268
Telephone	31
Internet web site	825
Workshop—Blairsville, GA	306
Workshop—Bristol, TN	111
Workshop—Chattanooga, TN	51
Workshop—Columbus, MS	3
Workshop—Decatur, AL	42
Workshop—Florence	13
Workshop—Gilbertsville, KY	72
Workshop—Knoxville, TN	29
Workshop—Morristown, TN	261
Workshop—Murfreesboro, TN	16
Workshop—Murphy, NC	19
Workshop—Pickwick Dam, TN	14
Total number of comments	**2,320**

Table F1-04 Number of Comments on Alternatives and Resource Areas

Subject	Number of Comments
Alternatives	
Base Case	148
Reservoir Recreation A	916
Reservoir Recreation B	307
Summer Hydropower	33
Equalized Summer/Winter Flood Risk	26
Commercial Navigation	54
Tailwater Recreation	41
Tailwater Habitat	16
Study Areas	
Air resources	13
Aquatic plants	23
Aquatic resources	44
Climate	1
Cultural resources	14
Dam safety	4
Flood control	155
Groundwater resources	2
Invasive terrestrial and aquatic animals and terrestrial plants	8
Shoreline development and land use	6
Managed areas and ecological significant sites	13
Navigation	30
Power	32
Prime farmland	3
Recreation	80
Fishing	89
Shoreline erosion	68
Social and economic resources	86
Terrestrial ecology	70
Threatened and endangered species	27
Vector control	23
Visual resources	13
Water quality	51
Water supply	24
Wetlands	31
Water levels	571
Cumulative impacts	2
Mitigation	8
NEPA process	163
Minimum flow	3
Out of scope	48
Policy	5
Authority	13
Total number of comments	**3,264**

Table F1-05 General Comments, Issues, and Concerns Raised by Members of the Public

Environmental Review Process and Public Involvement
1. EIS and public involvement
2. Operating priorities
3. Changes to the environmental impact statement
4. Communications
Alternatives
1. Base Case – Support for Base Case; prefer Base Case – Opposed to Base Case
2. Reservoir Recreation Alternative A – Support for Reservoir Recreation Alternative A – Opposed to Reservoir Recreation Alternative A
3. Reservoir Recreation Alternative B – Support for Reservoir Recreation Alternative B – Opposed to Reservoir Recreation Alternative B
4. Summer Hydropower Alternative – Support for Summer Hydropower Alternative – Opposed to Summer Hydropower Alternative
5. Equalized Summer/Winter Flood Risk Alternative – Support for Equalized Summer/Winter Flood Risk Alternative – Opposed to Equalized Summer/Winter Flood Risk Alternative
6. Commercial Navigation Alternative – Support for Commercial Navigation Alternative – Opposed to Commercial Navigation Alternative
7. Tailwater Recreation Alternative – Support for Tailwater Recreation Alternative – Opposed to Tailwater Recreation Alternative
8. Tailwater Habitat Alternative – Support for Tailwater Habitat Alternative – Opposed to Tailwater Habitat Alternative
9. Prefer Reservoir Recreation Alternatives A or B, A over B, B over A, or B or Tailwater Recreation Alternatives – Prefer Reservoir Recreation Alternative A or Reservoir Recreation Alternative B – Prefer Reservoir Recreation Alternative A over Reservoir Recreation Alternative B – Prefer Reservoir Recreation Alternative B over Reservoir Recreation Alternative A – Prefer Reservoir Recreation Alternative B or Tailwater Recreation Alternative – Other preferences
10. Higher and longer reservoir pool levels
11. Proposed combination/modification of alternatives
12. Proposed project modifications
Study Areas
1. Water levels for fish spawning
2. Migratory shorebirds
3. Shoreline erosion
4. Economic analysis and adverse effects on jobs and local economy
Out of Scope
1. Logs and debris
2. Boater safety
3. Jet skis
4. Water pollution

Specific public comments are organized into 35 sections, generally matching the major subject areas and sections in the EIS. Within the subject areas, comments are ordered based on similarity and not according to the number of people who made a comment. At the end of each comment is the name of the author and an identifying number (#XX) that refers to the number of the original comment segments (numbers reflect the order in which the comments were received).

Except for letters from state and federal agencies, comments received from workshops, letters, and other sources are all categorized and listed together. Agency comments are reprinted verbatim in Appendix F4. Responses to individual agency comments are included after each letter.

Some comments were extensive and contained many sub-issues or elements. Not all sub-issues or elements were separately answered if TVA's primary response was applicable.

To assist the reader with navigating the appendix, along with a table of contents, Appendix F includes an index (Appendix F5). The index provides a list of commenters and references page number(s) where commenters are listed throughout Appendix F.

F1.2 How TVA Responded to Comments Received

Since its inception, the ROS process has been driven by public values and concerns. Without public participation, it would be difficult for TVA to attain its goal of identifying changes to existing operating policies that would improve the overall public value of the TVA reservoir system. Issues and concepts identified by public and agency comments during scoping—along with input from the Public Review Group and Interagency Team—helped define the scope of the study and the contents of the DEIS. Several issues and concepts presented in comments on the DEIS have been used to improve the content of the FEIS. Comments on the DEIS will also assist TVA and other agencies as they make more detailed decisions about how to manage the operation of the Tennessee River in such as way that will increase its value for the people of the region.

TVA developed a Preferred Alternative that combines and adjusts desirable features of the alternatives identified in the DEIS to create a more feasible alternative that is responsive to public comments. TVA has also attempted to capture the characteristics of the preferred alternative in succinct, understandable ways to aid the TVA Board to better appreciate the implications of the decisions it will be asked to make by TVA staff, as a result of this process.

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Appendix F2

Response to General Comments, Issues, and Concerns

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Table of Contents

List of Acronyms

Corps	U.S. Army Corps of Engineers
DEIS	Draft Environmental Impact Statement
EIS	Environmental Impact Statement
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
ROS	Reservoir Operations Study
TVA	Tennessee Valley Authority

F2 Response to General Comments, Issues, and Concerns

Most of the public comments simply voiced support for or objections to one or more alternatives. Typically, reasons were also given for the stated positions. This type of comment is referred to as "voting" for or against alternatives. Such comments have unique value in a study and process of this kind because they provide expressions of value or preferences. The actual number of commenters supporting or opposing specific alternatives (or raising discrete issues), however, has less importance. By the very nature of Environmental Impact Statement (EIS) processes, commenters are self-selected and they do not necessarily reflect the values of the public at large. No matter how extensive the effort made by federal agencies to obtain the broadest possible public involvement in their decisions and EIS processes, only a relatively small number of individuals choose to participate. Recognizing this, TVA strives to be guided by the substance of comments rather than the number of comments.

While voting comments were considered in completing this EIS and formulating the Preferred Alternative, they do not require a substantive response from TVA. The responses to such comments simply acknowledge that we have received them and counted them. Although most of the comments were of this nature, it is noteworthy that when voting for specific alternatives, many people recognized that trade-offs are involved in how TVA "spends" the water in its reservoir system. Even individuals with strong views about certain alternatives frequently qualified their support by stating that they did not want TVA to implement their chosen alternative in ways that would worsen water quality or increase flood risk. When formulating the Preferred Alternative, TVA took these concerns into consideration.

Similar to comments received during scoping, a large number of commenters expressed preferences for alternatives that improved recreation—either on the reservoirs or below dams in the tailwaters. A large number of commenters supported actions that would afford greater environmental protection of reservoir system natural resources, especially water quality. A smaller number of individuals endorsed the Base Case, as did most of the commenting agencies.

F2.1 Environmental Review Process and Public Involvement

EIS and Public Involvement

Summary of Comments

Of those who commented on the EIS process, 34 individuals expressed their appreciation for TVA's efforts in considering the views of the public and 20 individuals complimented the agency on its efforts in undertaking the study and developing the EIS. Five individuals questioned whether TVA would really change its policy, two others thought that the information and alternatives presented were overly complicated and biased, and two thought that there was not enough time to fully understand all the information provided.

Commenters

Barbara A. Walton, Oak Ridge, TN
Beth Carey, Woodstock, GA
Bill Parker, Blairsville, GA
Bob Garrison, Blairsville, GA
Bob Graham, Harrison, TN
Brian L. Thomas, Hiawassee, GA
Bruce and Emma Anderson, Talbott, TN
Bruce M. Proske, Sr., Murphy, NC
Carolyn Lakes, Bean Station, TN
Charles and Kristie Wallis, Sevierville, TN
Chip Miller, Hixson, TN
Colman B. Woodhall, Johnson City, TN
David Trotter, D.D.S., Sevierville, TN
Dan Owens, Woodstock, GA
Diane Layton, Dandridge, TN
Erik Brinke, Murphy, NC
Franklin D. Brown, Bristol, TN
Gary and Myran Rosenbalm, Seymour, TN
Gary Hauser, Knoxville, TN
John Honey, Dandridge, TN
John S. McClellan, Dandridge, TN
Juanita Phillips, Paducah, KY
Kathy Pearce, Cumming, GA
Kevin M. McCarthy, Peachtree City, GA
Larry Allbritten, Dandridge, TN
Linda Wingo, Blairsville, GA
Marianne O. Hatchett, Hayesville, NC
Marilyn Allbritten, Dandridge, TN
Mickey Carter, Knoxville TN
Mike Harris, Knoxville, TN
Mr. and Mrs. Schaffer
Norman K. Owen, Murphy, NC
Paul Morris, Benton, KY
Ray Murphy, Dandridge, TN
Robert E. Craig, Decatur, AL
Robert MacDonald, Baneberry, TN
Roger Gant, Corinth, MS
Scott Davis, Executive Director, Tennessee Chapter of The Nature Conservancy, Nashville, TN
Steve and Becky Mishket, Dandridge, TN
Susan Kuehl, Dandridge, TN
Terry Peters, Elizabethton, TN
Thomas H. Hollingsworth, Rogersville, AL
Thomas L. Parker, Murphy, NC
Tim Allbritten, Dandridge, TN
Tom Fitzgerald
Richard C. "Dick" Crawford, President & CEO, TVPPA, Chattanooga, TN
Vincent L. and June D. Greaves, Blairsville, GA
W. G. Cahoon, Dandridge, TN

RESPONSE TO COMMENTS

TVA appreciates the feedback on its efforts in conducting the study, producing the EIS, and involving the public in the process.

Operating Priorities

Flood Control

Summary of Comments

Most individuals who commented on flood control indicated that, as it has historically, flood control should continue to be TVA's number one priority. Several individuals mentioned the critical importance of flood control to the region and its economy. A number of individuals expressed surprise that TVA would consider options that increase flood risk in order for a few people in the region to participate in recreation activities. One individual acknowledged that flood control is critical, but that there will always be flood risk to those who choose to live within the floodplain. Other comments provided on flood control are listed below.

- Flood damage is long-lasting, and emotionally and financially burdensome.
- Flood control should not be compromised for recreation benefits.

- The purpose of dams in general is for the protection of people and their livelihoods downstream.
- Protection of human life is paramount.
- Many jobs, family farms, and billions of dollars of economic activity depend on reliable flood control.
- Flood control has critical impacts on navigation, a clean water supply, sustainable economic development, agriculture, and recreation.
- It is imperative that no restriction be placed on TVA concerning reservoir levels.
- No alternative should be considered that increases flood damages; some additional flood risk could be accommodated, while avoiding property damage.
- With increased development, proliferation of litigation, and selective memories on what a floodplain means, there is a need to preserve or even improve the ability to protect properties.
- Stop flooding or pay us for what we lose.
- Recreation for some is not worth the flood risk to the many downstream.

Commenters

Anonymous (2)
Ben Robinson, Rogersville, AL
Betty M. Fulwood, Corinth, MS
Caruthersville Marine Service, Inc, Caruthersville, MO
Charles Robinson, Morristown, TN
Clifford J. Rabalais, Counce, TN
Clnton Horton, Benton, KY
David Madison, Caruthersville, MO
Dean and Mary Jane Heavener, Chattanooga, TN
Doug Goodman, Hickman, KY
Douglas Lawler, Abingdon, VA
Glenn Howell, Fulton, KY
Gwen Thomas, Morristown, TN
Jack C. Cole, Abingdom, VA
Jerri Mitchell, Abingdom, VA
Jim L. Collins, Decatur, AL
Jimmy and Amy Owens, Dandridge, TN
Jimmy W. Peoples, Talbott, TN
Joe Brang, Dandridge, TN
John W. Musser, Soddy Daisy, TN
John Ashe, Hayesville, NC
Daryl Carpenter
Lane Marte, Decatur, AL
Marianne T. Helton, Chattanooga, TN
Mark Seaton, Eva, TN
Mark Wiggins, Cordova, TN
Michael Sledjeski, Del Rio, TN
Mike, Huntsville, AL
Mike Harriss, Knoxville, TN
Mike Major, Hickman, KY
Paul Howell, Selmer TN
Richard Simms, Chattanooga, TN
Robert A. Lamm, Hiawassee, GA
Ron Boyd, Athens, AL
Stephen L. Keever, Chattanooga, TN
Suzie Reed, Louisville, TN
The Honorable Zach Wamp, U.S. House of Representatives, Washington, DC
Thomas L. Parker, Murphy, NC
Richard C. "Dick" Crawford, President & CEO, TVPPA, Chattanooga, TN
W. L. Panter, Soddy Daisy, TN
Walter E. Flood, Friendsville, TN
Wendell Choate, East Prairie, MI
Winona and Hilton Tunnell, Powell, TN

RESPONSE TO COMMENTS

Section 9a of the TVA Act establishes the priorities for operation of the TVA reservoir system. The primary priorities are navigation, flood control, and the generation of power. Consistent with meeting those priorities, TVA also operates the system to meet other goals such as water quality and recreation. Under the Preferred Alternative, potential damages from flood events with less than a 500-year frequency are lower than under the other action alternatives and essentially the same as under the Base Case.

Power Generation

Summary of Comments

Comments about power generation as a priority indicated that it should be TVA's second priority after flood control, that cheap electricity was a primary purpose of TVA—along with flood control, and that power rates should not increase. Several people mentioned that the entire TVA customer base should not be penalized with higher generating costs in order to satisfy a small number of landowners in the upper reservoirs, who knew the drawdown schedules when their property was purchased.

Commenters

Ben Robinson, Rogersville, AL
Betty M. Fulwood, Corinth, MS
David Cook, Blairsville, GA
Doug Goodman, Hickman, KY
Richard Simms, Chattanooga, TN
Suzie Reed, Louisville, TN
Terry C. Smith, Killen, AL
Winona and Hilton Tunnell, Powell, TN

RESPONSE TO COMMENTS

TVA formulated its Preferred Alternative to reduce potential cost impacts on power generation; however, increased costs could not be entirely eliminated.

Water Quality and Water Supply

Summary of Comments

Individuals who commented on water quality and water supply as a priority identified these issues as their major concerns. They did not want to see any changes that would degrade water quality or affect water supply—most to the extent that they supported making no changes to the existing policy, which effectively is the Base Case.

Commenters

Alice Russell, Hayesville, NC
Angela Boyda, Abingdon, VA
Anonymous
Betty M. Fulwood, Corinth, MS
Charlotte E. Lackey, for WNC Group, NC Chapter, Sierra Club, Asheville, NC
Dean and Mary Jane Heavener, Chattanooga, TN
Don A. Brown
Herbert and Lois Hill, Cherokee, AL
Jane A. Rowe, Decatur, AL
Jean Prater, Athens, AL
John Allen Moore, Hayesville, NC
John J. Ross, Savannah, TN
Katie Dalton, Corinth, MS
Linda Coons, Decatur Athens, AL
Stephen L. Keever, Chattanooga, TN
Steven J. Milcheck, Mooresburg, TN
Terry Sisk, Gray, TN

RESPONSE TO COMMENTS

Good water quality is an important public value. TVA carefully studied and considered water quality as it developed alternatives and created the Preferred Alternative. TVA formulated the Preferred Alternative to avoid or reduce impacts that would substantially degrade water quality and, in fact, to enhance water quality at certain locations. However, given the inherent uncertainties with any environmental analyses, TVA has identified monitoring and mitigation measures that would help offset potential adverse impacts on water quality should they occur.

Recreation

Summary of Comments

Individuals who commented on recreation as a priority indicated that they wanted TVA to give it a higher priority than in the past for in decisions about water levels. A number thought that recreation should be second in priority to flood control. One individual noted that it should not be given priority over protection of the environment, especially water quality and aquatic habitat protection.

Commenters

Barbara Cavagnini, Dandridge, TN
Bob Harrell, Dalton, GA
Carol McKee, Dandridge, TN
Chris Offen, Blairsville, GA
Edwin D. Breland, Jr., Rogersville, AL
Ivey Wingo, Blairsville, GA
Jeff Ramsey, Kodak, TN
Joe Brang, Dandridge, TN
John J. Ross, Savannah, TN
Kevin Abel, Abingdon, VA
Marianne T. Helton, Chattanooga, TN
Michael P. Van Winkle, Clarkesville, GA
Richard Simms, Chattanooga, TN
Steven J. Milcheck, Mooresburg, TN

RESPONSE TO COMMENTS

One of the driving issues that prompted the Reservoir Operations Study (ROS) was stakeholder concerns about the summer drawdowns and the resulting adverse impact on recreation. TVA developed the Preferred Alternative in the Final EIS (FEIS) to reduce flood damage to acceptable levels, while preserving increased opportunities for recreation and reducing impacts on other objectives.

Changes to the EIS

Summary of Comments

Several individuals suggested changes to the Draft EIS (DEIS). Specific comments regarding resource issues are addressed in Appendices F3 and F4. The more general comments and those including the Executive Summary were:

- Make the document less complicated.
- Table ES-01 – highlight flood risk.

- Table ES-02 - errors in using [brackets] for negative numbers in gross regional product and employment (3).
- Cite information as a range of values, including error terms, variances, and other sources of uncertainty.
- Use one description for current operations—Base Case, no-policy alternative, or no-action alternative.
- Use scientific data in the determination of which alternative to use.
- Provide site-specific spatial and temporal information concerning projected water elevations and releases for each reservoir and associated tailwater for all alternatives.
- Clarify the difference in information presented in material entitled "Weighing the Alternatives" containing charts listing Base Case and seven policy alternatives—as distributed in color handouts and as part of the video—and the same document presented on the TVA web site.
- Include charts that represent drawdown dates and summer pool dates compared to Base Case (4).
- Include copies of curves used at workshops to show different alternatives.
- Graphically depicted impacts of each alternative on lake levels could be in the handouts and supporting materials. It can be challenging to determine what the impact of each alternative is predicted to be on lake levels.
- Explain how the identified objectives were ranked.
- Further delineate the summary of projected impacts (i.e., explain better what is meant by “slightly adverse” or “beneficial”).

Commenters

Barbara A. Walton, Oak Ridge, TN
Colman B. Woodhall, Johnson City, TN
David Slagle, Hayesville, NC
Janice L. Jones, Executive Director, Tennessee River Valley Association, Decatur , AL
Jim L. Collins, Decatur, AL
John De Freitas, Gilbertsville, KY
Robert MacDonald, Baneberry, TN
Valerie Smith, Chattanooga, TN
W. H. Cross, Hiawassee, GA
W. L. Panter, Soddy Daisy, TN
John Defratsu

RESPONSE TO COMMENTS

The text has been changed to correct these errors. As suggested, Appendix C provides copies of elevation probability plots along with flood guide curves for tributary reservoirs, operating guide curves for mainstem reservoirs for the Base Case and the Preferred Alternative, and elevation data and box plots for all alternatives.

Communications

Summary of Comments

Several individuals requested that TVA provide early or daily notification through the media of projected changes in reservoir levels to prevent their boats from being stranded and docks from being damaged:

- Provide notification of when you plan to drop the water level (i.e., earlier than is presently done).
- Provide projected reservoir water level fluctuations on radio, weather channel, and/or internet on a daily basis (4).
- Provide advance storm warnings for major storm events if Alternative A is selected.

Commenters

Anonymous
Bob Holdman, Gilbertsville, KY
Clay Wright Rock Island, TN
Charles Wallis, Sevierville, TN
Greg Batts, Cadiz, KY
L. Sean Mullins, Bristol, TN
Mike Kelley, Savannah, TN
Roy Baker, Eddyville, KY
Sandy Roberson, Abingdon, TN
William Schneider

RESPONSE TO COMMENTS

Water release schedules and reservoir system data are routinely posted on TVA's external web site and also accessible via TVA's toll-free reservoir information phone line. Storm notification is provided by the U.S. Weather Service.

F2.2 Alternatives

Base Case

Support for Base Case

Summary of Comments

Most individuals who made comments supporting the Base Case thought that the changes proposed under the action alternatives would deprive migratory shorebirds and wading birds of critical habitat, and result in other unacceptable impacts. Several individuals thought that the existing system, as defined by the Base Case, works well and accomplishes the primary purposes for which the system was constructed: flood control, commercial navigation, and power generation. Furthermore, several individuals thought the system should be managed to address the overall needs of the people of the region and not just the needs of a select few. The comments that supported the Base Case are summarized below.

BALANCED APPROACH

- Balances well all constraints on the system.
- Benefits of recreation alternatives will never outweigh adverse effects on flood control, water quality, and power supply.
- Meets the needs of all users, including recreation, barge traffic, power generation, and economic development; and reduces the risk of flooding to valuable wildlife habitat along the Tennessee River system.
- All other alternatives have too high a cost or too negative an impact on the environment.
- Why do we look at extended levels when benefits accrue to a few?

ENVIRONMENTAL CONCERNS

- Creates great habitat for migratory shorebirds, including flats and sandbars that sandhill cranes rely on for roosting and feeding.
- Action alternatives are detrimental to plant life, as well as nesting grounds for many aquatic birds.
- Maintains high fish productivity.
- Protects water quality and electricity production over needs of recreation.
- Protects water supply.
- Avoids degradation of both state and federal major game and non-game wildife areas.
- Changing reservoir levels would negatively affect a wide variety of resources, ranging from shoreline habitat loss to flooding of wetlands and farmland along the Tennessee River, especially on Kentucky Reservoir.
- Longer levels would increase the use of fossil-fueled generation.

RECREATION

- The existing reservoir system provides prime bird-watching habitat.

ECONOMIC

- Is the least expensive.
- A 9-foot navigation channel is adequate.

FLOOD CONTROL

- Reduces flooding.

Commenters

Alfred Denny, Oak Ridge, TN
Anonymous (6)
Anonymous, Chattanooga, TN (2)
Anthony Morris, Muscle Shoals, AL
Barbara G. McMahan, Chattanooga, TN
Barbara A. Walton, Oak Ridge, TN
Barron Crawford, Paris, TN
Benny Thatcher, Knoxville, TN
Bettie Mason, Knoxville, TN
Bill Sullivan, Knoxville, TN
Brenda Cummings, Huntsville, AL
Brian Sullivan, Bristol, VA
Bunny Johns, Chair, Swain County Economic Development Commission, Bryson City, NC
C. Terry Wallace, President, Decatur-Morgan County Convention and Visitors Bureau, Decatur, AL
Carole Gobert, Knoxville, TN
Charles, Maryville, TN
Christine Liberto
City of Guntersville Alabama
Clayton Ferrell, New Johnsonville, TN
Clifford J. Rabalais, Counce, TN
Cynthia Mitchell, Clarksdale, MS
Dan Feather, Nashville, TN
Dan Fuqua, Paris, TN
Jim Garner, Madison, MS
John Taylor, Springville, TN
John W. Musser, Soddy Daisy, TN
Juanita Phillips, Paducah, KY
Junior Miller, Honaker, VA
Karen Schultz, Louisville, TN
Karl Forsbach, Jr., Savannah, TN
Katie Dalton, Corinth, MS
Ken Shepard , Kingston, TN
Kenneth Dickerson, Paducah, KY
Larry Waters, County Mayor, Sevier County, TN
Leslie J. Gibbens, Del Rio, TN
Linda Coons, Decatur Athens, AL
M. Stroup, Newport, TN
Marian Fitzgerald, Maryville, TN
Marvin and Lili Scott, Chattanooga, TN
Mary Stevens, Jackson, MS
Michael A. McMahan, Chattanooga, TN
Michael Smith, Ballatin, TN
Michael Sylva Sledjeski, Del Rio, TN
Mike H. Eddings, Jr., Blairsville, GA
Mike Kelley, Savannah, TN
Mike Major, Hickman, KY
Michael Todd, McKenzie, TN
Monte Doran, Savannah, TN

David A. Aborn, Ph.D, Chattanooga, TN
David Cook, Blairsville, GA
David Vogt, Chattanooga, TN
Debbie Blackwelder, Savannah, TN
Dennis Bain, Savannah, TN
Don Waldon, Columbus, MS
Donald Blackwelder, Savannah, TN
Doris and Richard Wheeler, Blairsville
Dr. K. Dean Edwards, Knoxville, TN
Dwight Cooley, Athens, AL
Earl Nyman, Abingdon, VA
Elizabeth Wilkinson-Singley, Kingston, TN
Gary Hauser, Knoxville, TN
Gaynell Thomas, Del Rio, TN
Guy Larry Osborne, Jefferson City, TN
H Ray Threlkeld, Loudon, TN
Holly Jones, Knoxville, TN
Howard Lowden, Rome , GA
J. Don Burgess, Killen, AL
James Brooks, Jonesborough, TN
James W. Elliott, Jr., Bristol, TN
Jason P. Smith, Blairsville, GA
Jay Desgrosellier, Nashville, TN
Jerry Hadder, Oak Ridge, TN
Jim Carpenter, Knoxville, TN
Richard Vornehm, Knoxville, TN
Richard Connors, Nashville, TN
Richard Holland, Env. Mgr., Counce, TN
Robert Wheat, Paris, TN
Roger Gant, Corinth, MS
Roger W. Hill, Jr., Blairsville, GA
Roseanna Denton, Science Hill, KY
Ruth Pullen
Stanley L. McClellan, Hartselle, AL
Stephen L. Keever, Chattanooga, TN
Steve McCadams, Paris, TN
Suzie Reed, Louisville, TN
Terry C. Smith, Killen, AL
Thomas L. Parker, Murphy, NC
Tony E. Branan, Hiawassee, GA
W.L. Panter, Soddy Daisy, TN
Walter E. Flood, Friendsville, TN
Wendell Choate, East Prairie, MI
William Dearing, Chattanooga, TN
William DeLoch
William H. Dyer, Paducah, KY
William L. Hoover, Naples, FL
Charles Muise
Noreen Kenny
Jim Crigger, Knoxville, TN

RESPONSE TO COMMENTS

TVA's Preferred Alternative was formulated in part to address these recommendations and concerns.

<u>Opposed to Base Case</u>

Summary of Comments

The majority of individuals who opposed TVA continuing to operate the system as it has been in the past indicated that the Base Case is not acceptable or needs to be changed. A limited number of those opposing the Base Case provided a reason for doing so. Typical reasons are given below.

MANAGEMENT APPROACH

- Needs to be abandoned for better ways to spend the water.
- Outdated and needs to be changed.
- Flats and mud holes are detrimental to TVA's and East Tennessee's image.
- Detrimental to overall economic activity.
- Creates erosion.
- Not a good alternative for South Holston.

RECREATION USE

- Diminishes recreation use and enjoyment during the peak summer period.
- Needs to be changed to enhance recreational opportunities and beauty of tributary reservoirs.

Commenters

Angela Yates, Abingdon, VA
Carolyn Varner, Ocala, FL
Chris Offen, Blairsville, GA
Christine M. Robinson, Abingdon, VA
Curtis E. Johnson
Dalie T. Thomas, Bristol, TN
Dean Henderson, Richlands, VA
Doug Triestram, Blairsville, GA
Doyle and Pat Ricks, Memphis, TN
Greg Robinson, Abingdon, VA
Harold L. Oliver, Marietta, GA
Jeff Blankenship, Cedar Bluff, VA
Jeff Ramsey, Kodak, TN
Jimmy and Amy Owens, Dandridge, TN
Joe Brang, Dandridge, TN
John W. Musser, Soddy Daisy, TN
Joseph A. Robinson, Jr., Abingdon, VA
Kathy Mesmer, Oak Ridge, TN
Marjorie C. Wintermute, Blairsville, GA
Marti Steffen, Dandridge, TN
Mary M. Johnson, Bristol, VA
Michael A. O'Brien, Kennesaw, GA
Richard Wagner, Blairsville, GA
Robert O. Bruce, Bristol, TN
Roger Williams, Knoxville, TN
Ron Toney, Cedar Bluff, VA
S. Dean Yates, Abingdon, VA
Sandy Robinson, Abingdon, VA
Taulbee Lester, Honaker, VA
Teddy Murrell, Sevierville, TN
Theresa Toney, Cedar Bluff, VA
Thomas Carey, Woodstock, GA
Tom A. Yates, Bristol, VA
Tom Carlton, Blairsville, GA

RESPONSE TO COMMENTS

TVA's Preferred Alternative was formulated in part with these comments in mind.

Reservoir Recreation Alternative A

Support for Reservoir Recreation Alternative A

Summary of Comments

Most individuals who commented on the reservoir operations policy alternatives endorsed Reservoir Recreation Alternative A (extending tributary and mainstem summer pool levels to Labor Day, increasing and limiting minimum flow releases to 25,000 cfs August 1 to Labor Day, raising tributary winter flood guides equal to Base Case March 15 levels, and raising main river winter flood guides by 2 feet with a 1-foot operating range). The reasons most widely cited by almost 800 individuals supporting this alternative are listed below.

PROVIDES A BALANCED APPROACH

- Provides an excellent balance of competing factors for reservoir operations and a substantial improvement to lake levels—both in summer and winter—without major impacts to those downstream.
- Provides an excellent compromise, giving consideration to flood control, power generation, water supply, and the environment, as well as recreation.

- Provides flood control and hydropower, while still giving the public a full summer use of the reservoirs.
- Benefits the most people in the TVA system with the least negative impacts.
- Best fits the overall needs of our community and surrounding property owners.
- Fairest of the alternatives that were presented.

INCREASES RECREATION VALUE AND USE

- Places a higher priority on recreation.
- Provides recreational users of the reservoirs maximum benefit of facilities.
- Improves recreation opportunities year-round while minimizing impacts on safety, economic and environmental concerns.
- Provides a longer period of recreation opportunities for both residents and visitors.
- Gives boaters more recreational time in summer and fall.
- Increases season for fishing, boating and other water sports.

SCENIC BEAUTY

- Improves aesthetics of area and region.
- Rivers and lakes provide a place to relax from ever-increasing stress levels of work.
- Eliminates flats.
- Improves the looks of the lake during winter months.
- Leaves reservoir at a fairly good place.

ENVIRONMENTAL BENEFITS

- Offers the least undesirable impacts—less adverse impacts on flood control, water, fish, and aquatic vegetation.
- Helps fish and improves aquatic life and water quality.
- Satisfies the need for flood control, even though flooding could be increased.
- Reduces shoreline erosion.
- Solves some of the problems created by the Base Case.
- Increases economic benefits.
- Benefits local and surrounding businesses, including everyone in the real estate business.
- Increases property value and development—enhancing the tax base.
- Increases revenue for local area with minimal effects.
- Benefits local communities, counties, the region, and TVA.
- Benefits tourism of the area, extends tourist season, and generates more income from tourism.
- Stimulates investment to encourage economic growth.
- Keeps folk in county and region, rather than having them move elsewhere.
- Allows for more jobs and navigational benefits.
- Allows hydropower units to operate more efficiently.
- Eliminates choke points on main river for navigation.
- Reduces damage to boat docks and marinas.
- Relieves political pressure to make recreation a primary purpose for the TVA lakes and rivers.

USE OF PROPERTY

- Allows use of boats and dock until Labor Day.
- Produces greater return on investments.

- Increases usage of facilities.
- Reduces navigation hazards.

Commenters

Anonymous (14)
Anonymous, Blairsville, GA (18)
A. G. Sherman, Blairsville, GA
A. Hurn, Atlanta, GA
Alberta Bavis, Blairsville, GA
Alice Russell, Hayesville, NC
Aline Hail, Gilbertsville, KY
Allan Nelson, Atlanta, GA
Amy Stevenson, Blairsville, GA
Andrew Atkins, Morristown, TN
Andrew Drkae, Atlanta, GA
Andrew Fogle, Madison, AL
Andy and Jocelyn Kutler
Andy Williams, Blairsville, GA
Angela Yates, Abingdon, VA
Ann Bridges, Blairsville, GA
Ann R. Warner, Memphis, TN
Ann W. Roginsky, Blairsville, GA
Ann and Charles Wooten, Jr., Blairsville, GA
Anna Medlin, Smyrna, TN
Anne Gunderson, Marietta, GA
Anne Lee
Anonymous (18)
Anthony Lambert, Bristol, VA
Anthony Lester, Hanover, WV
Anthony Childress II, Abingdon, VA
Anthony Lagratta, Blairsville, GA
Arlene Gray, Blairsville, GA
Arlene Loesel, Blairsville, GA
Arline Hodgson, Blairsville, GA
Audrey Fincher, Mosheim, TN
Austin Foreman, Blairsville, GA
B. Gray Appleton, Hayesville, NC
Barbara Dean, Powder Springs, GA
Barbara Merriken, Dandridge, TN
Barbara Tigrett
Barron Crawford, Paris, TN
Barry & Lynn Varian, Blairsville, GA
Barry Hinkle, Bristol, TN
Ben Keeler
Ben Sharrett, Abingdon, VA
Beth Carey, Woodstock, GA
Betty Lavelle, Dandridge, TN
Betty Sullivan, Franklin, NC
Beverly Wooten, Blairsville, GA
Bill and Deborah Eisel
Bill Delashmutt, Dandridge, TN
Bill Harwood, Columbia, SC
Bill Herold, Hiawassee, GA
Bill Hintermister
Bill Pave, Blairsville, GA
Billie D. Elliott, Blairsville, GA
Kathryn A. Jones, Blairsville, GA
Kathryn Foreman, Blairsville, GA
Kay Elgin, Hendersonville, TN
Kelly and Bo Hairston
Kelly Larrison, Bristol, VA
Ken and Sandy Russell, Dandridge, TN
Ken Horton
Ken Newsome, Cumming, GA
Kenneth A. Turner
Kenneth Story, Pickwick Dam, TN
Kevin and Tracy Swain, Blairsville, GA
Kevin Miller, Bristol, VA
Kim Shipley, Hayesville, NC
Kirk Peterson, Woodstock, GA
Kristen N. Morgan, Marietta, GA
Kristen Yartz, Dandridge, TN
Kryssa Cooper, Alpharetta, GA
L. Ross Whatley III, M.D., Blairsville, GA
L. Sean Mullins, Bristol, TN
Lamar and Jackie Franklin, Blairsville, GA
Lamar Franklin, Blairsville, GA
Larry and Amelie Hagen, Blairsville, GA
Larry Johnson, Decatur, AL
Larry Mero, Blairsville, GA
Laurie Danko, Dandridge, TN
Lawrence Wright, Warner Robins, GA
Lawton Wofford, Hiawassee, GA
Leah Viersh, Vansant, VA
Lee and Betty Harrell, Rome, GA
Lee Ann Geisenhaver, Abingdon, VA
Lee S. Horne, Lebanon, VA
Leigh Ann Alexander, Atlanta, GA
Leon Bobo, Canton, GA
Leon Bryant, Dandridge, TN
Lesley Ann Wheeler, Blairsville, GA
Leslie Wickham, Hayesville, NC
Leslie Forthman, Hiawassee, GA
Leslie Leduc, Bradenton, FL
Leslie Shamblin, Dandridge, TN
Lester Deaver, Blairsville, GA
Lewis E. Blair, Morristown, TN
Lewis O'Donnell, Blairsville, GA
Lillian and R. K. Buchanan, St. Lucie, FL
Linda and Eldon Achbuger
Linda Bell, Hiawassee, GA
Linda Dale Squires, Dandridge, TN
Linda R. Witaker, Atlanta, GA
Linda Ray, Monroe, GA
Linda Wingo, Blairsville, GA
Lindsay Blackwell, Blairsville, GA
Lloyd and Holly Massman, Blairsville, GA
Lloyd V. Bible, Dandridge, TN

Billy and Eva Dicker, Blairsville, GA
Billy Keaton, Bluff City, TN
Billy Payne, Blairsville, GA
Bob Anderson, Hiawassee, GA
Bob Dorman, Blairsville, GA
Bob Garrison, Blairsville, GA
Bob Harrell, Dalton, GA
Bob Lee, Dalton, GA
Bob Russum, Piney Flats, TN
Bobbie Davis, Dandridge, TN
Bobby Joe Dishner, Blountville, TN
Bobby Keene, Abingdon, VA
Bona Allen, Young Harris, GA
Brian and Lynn Batko
Brian Mazzei, Abingdon, VA
Brian Roberge, Lavergne, TN
Brian Thurman, Cherry Log, GA
Bruce Tuthill, Blairsville, GA
Bud Mcneal, Savannah, TN
C. P. Brindle, Crandall, GA
C. Vaughn Leslie, Dandridge, TN
Calisse Finchum, Newport, TN
Camille Little, Heyworth, IL
Candy Cox Ellis, Bristol, VA
Carl and Rebecca Foutz, Marietta, GA
Carl Hatfield, Dandridge, TN
Carol Kutzner, Hayesville, NC
Caroline Goins, Dandridge, TN
Carolyn Miller
Carolyn R. Clarkson, Blairsville, GA
Carolyn Varner, Ocala, FL
Cathleen and Bill Carpenter, Alexandria, TN
Cathy Cooper, Morristown, TN
Cecil G. Boland, Blairsville, GA
Chad and Kristi Lariscy, Blairsville, GA
Charles A. Goins, Dandridge, TN
Charles and Marylou Pentico, Blairsville, GA
Charles B. and Eileen Davis
Charles Butler, Powder Springs, GA
Charles E. Hulten, Blairsville, GA
Charles Hamilton, Blairsville, GA
Charles Wooten, Jr., Blairsville, GA
Charlie Davis, Blairsville, GA
Charlie Pollett, Blairsville, GA
Charlotte Israel
Charlotte Licata, Cherry Log, GA
Cheryl Askew, Dandridge, TN
Cheryl L. Prosak, Dandridge, TN
Cheryl S. Smith, Blairsville, GA
Chip Sparks, Abington, VA
Chris and Margaret Offen, Blairsville, GA
Chris McLean, Blairsville, GA
Chris Offen, Blairsville, GA
Chris Perkins, Florence, AL
Christine M. Robinson, Abingdon, VA
Cindy Pack, Blue Ridge, GA
Cindy Perry
Clarence and Patricia Ricketts, Blairsville, GA
Lowell Smith, Raven, VA
Loyd and Mona Prewitt, Seneca, SC
Luella Windham, Rutledge, TN
Lyndon and Laura Sidelinger, Roswell, GA
Lynn and Barry Varian, Blairsville, GA
Lynn and Donald Fountain, Blairsville, GA
Lynn Peterson, Blairsville, GA
M'liss and Stephen Miller, McMinnville, TN
Madeline Roose, Blairsville, GA
Mae Musick, Bristol, TN
Major M. Pounders, Abingdon, VA
Malcolm P. Cotton, Dandridge, TN
Marcus Fortier
Margaret H. Schramke, Blairsville, GA
Margaret L. McCamy, Hiawassee, GA
Margaret White, Dandridge, TN
Margy King, Dandridge, TN
Marie E. Geesa, Blairesville, GA
Mark and Melanie Midkiff, Roswell, GA
Mark Donahue, Blairsville, GA
Mark Heatherly, Sevierville, TN
Mark Patterson, Brentwood, TN
Mark Weddle, Marion, VA
Mark Wiggins, Cordova, TN
Marsh and Julia Freemyer, Marietta, GA
Marsha Dorta, Young Harris, GA
Martha Jarrard, Hiawassee, GA
Martha Sunyog, Blairsville, GA
Martin Milkman, Murray, KY
Marty Godfrey, Blairsville, GA
Mary and Herbert Arnold, Blairsville, GA
Mary Bondurant, Bristol, TN
Mary C. Cook, Bryson City, NC
Mary D. Milh, Blairsville, GA
Mary Dishner, Blountville, TN
Mary Hopper, Dandridge, TN
Mary Horne, Lebanon, VA
Mary Lou Stager, Blairsville, GA
Mary M. Johnson, Bristol, VA
Mary MacDonald, Baneberry, TN
Mary Twiggs, Blairsville, GA
Matthew and Patti McIsaac, Blairsville, GA
Matthew Stricklin, Murfreesboro, TN
Matthews Gwynn, Blairsville, GA
John R. McCamy III, Charlotte, NC
Megan Peterson, Woodstock, GA
Melissa White
Mia Crowe, Blairsville, GA
Micah and Misty Garrison
Michael and Patricia Cole, Blairsville, GA
Michael and Evelyn Fink, Dandridge, TN
Michael Brock, Hiawassee, GA
Michael Gailey, Dunwoody, GA
Michael Guffey, Seymour, TN
Michael Mekas
Michael P. Van Winkle, Clarkesville, GA
Michael R. Adamson, Blairsville, GA
Michael Schutt, Blairsville, GA

Claude D. Keaton, Dandridge, TN
Cliff Nelson, Hayesville, NC
Clyde Long, Blairsville, GA
Colman B. Woodhall, Johnson City, TN
Connie and Jim Varian, Blairsville, GA
Corrie Zylstra, Blairsville, GA
Craig and K.K. Wiseman, Rock Island, TN
Curtis E. Johnson
Dale Elliott, Blairsville, GA
Dale Hartsell, Newport, TN
Dalie T. Thomas, Bristol, TN
Dan Watson, Blairsville, GA
Dan and Sophia Brown, Blairsville, GA
Dan Kauffman, Ducktown, TN
Dan Meek, Kodak, TN
Dan Meek, Knoxville, TN
Daniel and Karen Malte
Daniel D. Phelan, Morganton, GA
Dave Baxter, Eddyville, KY
Dave Cooper, Alpharetta, GA
David and Melody Snidgrass, Brentwood, TN
David B. Smalley
David DeLong, Bryson City, NC
David E. Larson, Hayesville, NC
David Graves, Acworth, GA
David Herndon, Greeneville, TN
David J. Spacek, New Market, AL
David P. Montieth, Bryson City, NC
David R. Chrisman, New Market, TN
David Verble, Sevierville, TN
Dean Henderson, Richlands, VA
Dan Owens, Woodstock, GA
Deborah Austin, Morristown, TN
Debra Jensen, Young Harris, GA
Debra Williams, Morristown, TN
Denise Endsley, Snellville, GA
Dennie Stone, Blairsville, GA
Dennis Moorehead
Dewey Ragwell
Diana Swindel, Hiawassee, GA
Diane Daige
Diane Layton, Dandridge, TN
Diann Stone, Atlanta, GA
Dianna Mullins, Bristol, TN
Dick and Jane Soehnere
Dixie A. Cantley, Bluff City, TN
Don Barnette, McDonough, GA
Don W. Harrison, Blairsville, GA
Donald Mcglynn, Hiawassee, GA
Donald E. Webb, Powder Springs, GA
Donald Hauber, Rock Island, TN
Donald Ruth, Hiawassee, GA
Donia R. Prada, Morristown, TN
Donna Corn
Dorothy D. Brock, Blairsville, GA
Dorothy D. Byrd, Blairsville, GA
Doug and Judy Leman, Blairsville, GA
Doug and Nancy Triestram, Blairsville, GA
Michelle Batko, Retired
Michelle K. Maloney, Blairsville, GA
Mickey Carter, Knoxville, TN
Mike Fishman, Morristown, TN
Mike Murphy, Hayesville, NC
Mike Perssley, Canton, NC
Miranda Burnett, Calvert City, KY
Molly Ann Zeuch
Mr. and Mrs. Gerald W. Might, Blairsville, GA
Mr. and Mrs. Kevin Smith, Marietta, GA
Mr. and Mrs. Robert E. Smith, Blairsville, GA
Mr. and Mrs. David W. King, Blairsville, GA
Mr. and Mrs. Don Lachman, Blairsville, GA
Mr. and Mrs. Haskel Drake, Blairsville, GA
Mr. and Mrs. Mark J. Versharm, Blairsville, GA
Mr. and Mrs. Richard Davis, Blairsville, GA
Mr. Charles Arnold, Lawrenceville, GA
Mr. William J. Gray, Blairsville, GA
Mr. and Mrs. Joseph L. Johnson, Jr., Newport News, VA
Mrs. Darlene Helton
Mrs. Julia Freemyer, Marietta, GA
Mrs. Linda Hammond, Young Harris, GA
Muriel Jefferson, Blairsville, GA
Myron Engebretson, Marietta, GA
Myron Squires, Dandridge, TN
Nancy Frazier, Hayesville, NC
Nancy Triestram, Blairsville, GA
Neal D. Stone, Jr.
Neil and Ruby McCullough, Hiawassee, GA
Norman Cooper
Norman Kaye, Blue Ridge, GA
Norris Wood
Not Legible, Blairsville, GA
Paige Brown, Cumming, GA
Pam Mero, Blairsville, GA
Pamela Fairfax, Rock Island, TN
Pamela R. Brownhill, Blairsville, GA
Parmelle and Edwina Ward, Blairsville, GA
Pat and Deb Robinson, Clarkston, MI
Pat Davis, Dandridge, TN
Pat Unferth, Morristown, TN
Patricia L. Neubert, Hiawassee, GA
Patricia M. Karpick, Dandridge, TN
Patricia M. Smith, Blairsville, GA
Paul and Marcy Erwin
Paul Brownhill, Blairsville, GA
Paul Chapman, Russellville, TN
Paul Dumbacher, Huntsville, AL
Paul Gunderson, Marietta, GA
Paul Howell, Selmer, TN
Paul Morris, Benton, KY
Paul Tucker, Fernandina Beach, FL
Paul Williams, Atlanta, GA
Peg Flora
Peggy Ferguson, Hayesville, NC
Peggy Smith, Blairsville, GA
Penny and Al Caudill

Doug Roe
Doug Triestram, Blairsville, GA
Douglas E. Bondurant, Bristol, TN
Douglas Lawler, Abingdon, VA
Doyle and Pat Ricks, Memphis, TN
Dr. Judy K. Campbell, Hiawassee, GA
Drew Danko, Dandridge, TN
Drucille J. Fox, Blairsville, GA
Dwayne and Antoineet Boudreaue
E. Bloom, Blairsville, GA
Earle Seaverns, Hayesville, NC
Ed Moore, Hiawassee, GA
Ed Prieto, Blairsville, GA
Ed Rains
Eddie Allen, Blairsville, GA
Edward and Mary Hoefs, Blairsville, GA
Edward Cozart, Abingdon, VA
Edward L. and Melissa F. Parrish, Walling, TN
Edward L. Hollen, Blairsville, GA
Edward MacDonald, Morganton, GA
Edwina Johnson, Atlanta, GA
Elaine Farris, Bristol, VA
Elizabeth Gunderson, Marietta, GA
Elizabeth Southers, Dunwoody, GA
Ellen C. Montieth, Bryson City, NC
Ellen Moore, Hiawassee, GA
Ellen Sullivan, Blairsville, GA
Elmer Simmons, Abingdon, VA
Eric J. Benz, Ormond Beach, FL
Ervell and Salena Arnold, Blairsville, GA
Eugene Beatty, Cumming, GA
Flake and June Hewett, Blairsville, GA
Floretta Campbell, Blairsville, GA
Floyd Abrams, Bristol, TN
Frank and Patricia Seidel, Blairsville, GA
Frank Howell, West Palm Beach, FL
Frank Pack, Blairsville, GA
Franklin D. Brown, Bristol, TN
Fred and Marie Geesa, Blairsville, GA
Fred Maloney, Blairsville, GA
Fred T. Necessary, Abingdon, VA
Frederic R. Guyonneau, Rosewell, GA
G. J. Ashworth, Hiawassee, GA
Gail Galloway, Knoxville, TN
Gail Poteet, Blairsville, GA
Gale and Anne Roberts, Dandridge, TN
Gary and Ruth Peitsch, Hiawassee, GA
Gary Sherrod, Knoxville, TN
Gary Silver, Atlanta, GA
George F. White, Cordele, GA
George Pisciotta, Marietta, GA
George Vonnoh, Blairsville, GA
George Ward, Dandridge, TN
Gerald and Aleta Richardson, Murfreesboro, TN
Gerald T. Burger, Blairsville, GA
Geraldine Phebus, Blairsville, GA
Gerldine Preston, McMinnville, TN
Gigi Garrett, Blue Ridge, GA
Penny F. Wilson, Canton, GA
Peter G. Ferre, Nashville, TN
Peter Reilly, Alpharetta, GA
Peter Robinson, Norcross, GA
Phil Fauver, Roswell, GA
Phillip Davis, Dandridge, TN
Phillis Williamson
Phyllis J. Jones, Blairsville, GA
Phyllis Miller, Bristol, VA
Piper Solomon, Blairsville, GA
R Joseph, Dandridge, TN
R. Trent Sipsy
R. J. Hampton
Ralph Sheets, Abingdon, VA
Randy and Judy Reck, Nashville, TN
Randy Cress, Grayson, GA
Ray and Elsie Johnston, Blairsville, GA
Raymond G. Morris, Cartersville, GA
Rebecca St.John, Blairsville, GA
Regina Frisbey, Blairsville, GA
Reileen and Eugene Beatty, Blairsville, GA
Reileen Beatty, Cumming, GA
Renee Mason-Mazzei, Abingdon, VA
Rex Mallory, Bristol, VA
Rich Gilbert, Blairsville, GA
Richard and Janet Davis, Almunt, MI
Richard and Lisa Nesz, Marietta, GA
Richard and Claire Sterline, New Concord, KY
Richard Bell, Blairsville, GA
Richard Burnell, Blairsville, GA
Richard Simms, Chattanooga, TN
Richard Smith, Blue Ridge, GA
Richard Sullivan, Hayesville, NC
Richard T. Braun, Bowling Green, KY
Richard Wagner, Blairsville, GA
Rick and Judy Butler, Dandridge, TN
Rita Gunter, Blairsville, GA
Robert and Florence Campbell, Blairsville, GA
Robert and Jacquelyn Crupi, Dandridge, TN
Robert and Shelia Garrison, Blairsville, GA
Robert A. Lamm, Hiawassee, GA
Robert A. Rohde, Dandridge, TN
Robert and Mary Jane McGuire, Blairsville, GA
Robert Berlin, Bryson City, NC
Robert Bray, Murfreesboro, TN
Robert Canaan, Hiawassee, GA
Robert E. Craig, Decatur, AL
Robert E. Sanchez, Blairsville, GA
Robert J. Reynolds, Morristown, TN
Robert Kazmier, Roswell, GA
Robert M. Misdom, Blairsville, GA
Robert MacDonald, Baneberry, TN
Robert O. Bruce, Bristol, TN
Robert P. Gill, President, Blue Ridge Mountain Chapter, Trout Unlimited
Robert P. Taylor, Hamlin, KY
Robert Pardue, Dandridge, TN
Robert Schaefer, Blairsville, GA

Glen and Janet Withre, Blairsville, GA
Glen Boland, Blairsville, GA
Glenda B. Owens, Woodstock, GA
Glenn Jones, Bryson City, NC
Glenn L. Schuman, New Smyrna, FL
Grant Treiber, Blairsville, GA
Greg Robinson, Abingdon, VA
H. D. Windsor, Blairsville, GA
H. L. and P. J. Williams, Blairsville, GA
Hans and Wendy Tremel, Sharpsburg, GA
Harold J. Williams, Blairsville, GA
Harold L. Oliver, Marietta, GA
Harry E. Hodgson, Blairsville, GA
Harry Smith, Blairsville, GA
Harry Williams, Blairsville, GA
Harvey and Cindy Cohen, Blairsville, GA
Harvey and Wendy Holden, Blairsville, GA
Hattie Moon
Helen Hewitt, Knoxville, TN
Henry Glore, Blairsville, GA
Herman A. Moon
Howard C. Davis, Blairsville, GA
Howard Smrz, Young Harris, GA
Howard T. and Linda R. Sartain, Chattanooga, TN
Howard W. Walters, Blairsville, GA
Hugh Newsom, Knoxville, TN
Ivey Wingo, Blairsville, GA
J. D. Smith, Doran, VA
J. C. Perry
J. Cathryn Christopher, Murray, KY
J. Dan Gladney, Lawrenceville, GA
J. Mike Alters
Jack and Mary Couch, Hiawassee, GA
Jack C. Etheridge, Blairsville, GA
Jack Miller, Kennesaw, GA
Jack Miller, Hiawassee, GA
Jack Moody, Hayesville, NC
Jacquelina Maloney, Woodstock, GA
James A. Doughty, Young Harris, GA
James A. Savage III, Bone Cave, TN
James B. and Elizabeth F. Eppes, Hiawassee, GA
James B. Dore
James E. and Sandra L. Grantham, Blairsville, GA
James Finchum, Newport, TN
James H. Wheeler, M.D., Atlanta, GA
James Hall, Smyrna, TN
James J. Morris, Blairsville, GA
James L. Clonts, Blairsville, GA
James M. Galloway, Knoxville, TN
James Malte, Blairsville, GA
James Seaver, Morristown, TN
Jamie Whitman, Bluff City, TN
Jan Dalton, Murray, KY
Jan Hackett, Morganton, GA
Jan Simon, Blairesville, GA
Robert W. Boyd, Blairsville, GA
Roberta Baxter, Eddyville, KY
Roger Helton, Honaker, VA
Roger Williams, Knoxville, TN
Ron and Judi Smith, Blairsville, GA
Ron and Martha Sunyog, Blairsville, GA
Ron and Janet Lander, Blairsville, GA
Ron Gillespie, Blue Ridge, GA
Ron Voyle
Ronald A. Burke, Cumming, GA
Ronald E. Exum, Franklin, TN
Ronald Frohlich, Blairsville, GA
Ronald H. McKuew, Blairsville, GA
Ronald Huffaker, Knoxville, TN
Ronald Morgan, Marietta, GA
Ronald Whitener, Dandridge, TN
Ronnie Offen, Blairsville, GA
Ronnie Offen, Maietta, GA
Roy and Beverly Cardell, Blairsville, GA
Roy Walker, Franklin, TN
Ruby Warren
Rufus H. Stark II, Hayesville, NC
Russell Stevenson, Hayesville, NC
Ruth Kwapinski, Sec., Rock Island, TN
Ryan J. Morgan, Blairsville, GA
Ryan Morgan, Marietta, GA
S. Dean Yates, Abingdon, VA
Sabrina Brown, Bristol, TN
Samantha Morgan and Family, Marietta, GA
Sandi Jernigan, Cumming, GA
Sandy Robinson, Abingdon, VA
Sara R. Troemel, Blairsville, GA
Scott Thomas
Sharon Robish, Morristown, TN
Shawn Maloney, Woodstock, GA
Sheila Garrison, Blairsville, GA
Sheila White, Cordele, GA
Shelby Morris, Cartersville, GA
Shelia Bondurant, Bristol, TN
Sherri Hinkle, Bristol, TN
Sherry D. Barnes, Blairsville, GA
Shirley Dominick, Dandridge, TN
Shooks Marina, Murphy, NC
Sondra Judy Sharp, Dandridge, TN
Stan Gunter, Blairsville, GA
Stefan A. Prada, Morristown, TN
Steve and Becky Mishket, Dandridge, TN
Steve and Karen Osborn, Rock Island, TN
Steve and Meredith Driskill, Andersonville, TN
Steve Marshall, Dandridge, TN
Steve Petty, Bell Buckle, TN
Steve Setlock, Blairsville, GA
Stone Brown, Cumming, GA
Sue Hill, Blairsville, GA
Sue Turner
Susan DeLong, Bryson City, NC
Susan Quinn, Harrison, TN
Susanna White

Jane O. Stone
Jane Stone, Blairsville, GA
Janet Penilo, Dandridge, TN
Janice Boland, Blairsville, GA
Jean Stone, Blairsville, GA
Jeff and Jan Jensen, Blairsville, GA
Jeff Blankenship, Cedar Bluff, VA
Jeff Maples
Jeff Ramsey, Kodak, TN
Jeff Stevenson, Atlanta, GA
Jeffery P. Jones, Blairsville, GA
Jerome Alton Connor, Jr., Powder Springs, GA
Jerri Mitchell, Abingdon, VA
Jerry and Brenda Snow, Dandridge, TN
Jerry F. Taylor, Athens, AL
Jerry Powers, Bristol, VA
Jessica MacLean, Zionsville, IN
Jetta J. Cooper, Blairsville, GA
Jill Blake, Davidson, NC
Jim and April Russell, Dandridge, TN
Jim and Nancy Malte, Blairsville, GA
Jim and Ruth Flemister
Jim Davis, Dandridge, TN
Jim Ebert, Lilburn, GA
Jim Fields, Lafollette, TN
Jim Mootrey, Blairsville, GA
Jo Ann Strickland
Jo Ellen Young, Rock Island, TN
Joan Freisen, Hayesville, NC
Joan Tuthill
Joanne K. Morris "Whistlestop", Blairsville, GA
Joanne Klingbeil, Hiawassee, GA
Joanne Ward, Blairsville, GA
Jocelyn and Jamie Richards, Washington, DC
Joe Chase, Abingdon, VA
Joe Hill, Nashville, TN
John and Kathryn Williams, Blairsville, GA
John and Linda Jackson, Marietta, GA
John C. Ashe, Hayesville, NC
John Delk, Alpharetta, GA
John Jones, Birmingham, AL
John N. Gillham, Jr., Hayesville, NC
John Olexick, Blairsville, GA
John R. McCamy, Stone Mountain, GA
John Sillay, Marietta, GA
John W. Musser, Soddy Daisy, TN
Jonathan Brown, Bristol, TN
Joseph A. Robinson, Jr., Abingdon, VA
Joseph Lindahl, Gallatin, TN
Joseph Reback, Iebulou, NC
Josephine Williams, Murphy, NC
Joy Lyle, Ellijay, GA
Joyce Morgan, Marietta, GA
Judi Stevenson, Franklin, NC
Judith Mills, Damascus, VA
Judy Dyer, Blairsville, GA
Judy Keane, Baneberry, TN
Judy Myers, Blairsville, GA
Swaim, Blairsville, GA
Taulbee Lester, Honaker, VA
Ted Bollman, Morristown, TN
Tennessee Valley Towing, Inc., Bill Dyer, Paducah, KY
Teresa Joel, Atlanta, GA
Teresa Mears, Benton, KY
Terry Topjun, Dandridge, TN
Thomas C. Roberts, Morganton, GA
Thomas Carey, Woodstock, GA
Thomas E. Karpick, Dandridge, TN
Thomas H. Windham, Rutledge, TN
Thomas L. Parker, Murphy, NC
Thomas M. Malafronte, Dandridge, TN
Thomas Peters, Franklin, TN
Thomas Robinson, Morristown, TN
Thomas Whitman, Bluff City, TN
Tim and Patrice Pollock, Blairsville, GA
Timothy R. Murry, Blairsville, GA
Todd Nelson
Tom and Martha Scissom and Allison Carlton, Blairsville, GA
Tom A. Yates, Bristol, VA
Tom Carlton, Blairsville, GA
Tom Gunderson, Marietta, GA
Tom Murphy, Blairsville, GA
Tony and Suzanne Lagratta, Blairsville, GA
Tony E. Branan, Hiawassee, GA
Top of Georgia Tech, Inc., Blairsville, GA
Tracy A. Swatt, Blairsville, GA
Vern Barnes
Vern On, Morristown, TN
Veronica Brown, Cumming, GA
Vert and Elaine Morris, Dandridge, TN
Virginia Sisson-Jewell, Morristown, TN
Vivian Keling, Blairsville, GA
Vivian R. Hopkins, Blairsville, GA
W. J. Flora
Wade J. Cook, Bryson City, NC
Walter Lake, Dandridge, TN
Walter Layton, Dandridge, TN
Walter Mitchell, Dunwoody, GA
Walter Thomson, Murray, KY
Warren, Blairsville, GA
Warren Schwartz, Blairsville, GA
Warren T. Zeuch, Jr.
Wayne and Mary Ann Anderson, Hiawassee, GA
Wayne Chaney, Bristol, TN
Wayne DeMars, Blairsville, GA
Wayne Hellaud, Blairsville, GA
Wayne Reynolds, Chattanooga, TN
Wes and Jennifer King, Blue Ridge, GA
William and Martha Sue Shelton, Crandall, GA
William Brown, Cumming, GA
William E. Underwood, Iuka, MS
William Eckstein, Blairsville, GA
William Edwards, Mt. Juliet, TN
William H. Jones, Blairsville, GA

Julia Householder, Pigeon Forge, TN
Julie Morgan, Marietta, GA
June H. Lich and Doris Hays, Dandridge, TN
June Kephart, Blairsville, GA
June Parks, Hiawassee, GA
Junior Miller, Honaker, VA
K. Pindzola, Johnson City, TN
K. E. Competiello, Atlanta, GA
Kaitlin Louise Smalley
Karen Adamson, Blairsville, GA
Karen McKin, Young Harris, GA
Karen Rohde, Dandridge, TN
Karin Davis, Hiawassee, GA
Katherine B. McNeil, Dandridge, TN
Katherine Marshall, Dandridge, TN
Jonathon Brown
Steve Burnett
Andrew Drake
Bill Harold
Cheryl S. Himson
Joseph R. Lavelle
Spencer Overstreet
Terry C. Wallace, President, Morgan County Convention & Visitors Bureau, Decatur, AL
Bunny Johns, Chair, Swain County Economic Development Commission
William H. Dietrich, Hayesville, NC
William Harvey, Rock Island, TN
William J. Smith, Blairsville, GA
William L. Hoover, Naples, FL
William L. Reeves, Blue Ridge, GA
William M. Brown, Murray, KY
William Vander-Ryder, Blairsville, GA
Willie Mae Ayers, Rouston, GA
Wills Brown, Cumming, GA
Windel Lester, Iaeger, WV
Windle Nelson
Winona Bailey, Blue Ridge, GA
Wn. F. Walsh, Chattanooga, TN
Woody Chastain, Athens, GA
Yvonne Carney, Bryson City, NC
Zoe W. Horton
Zondra H. Leazer, Baneberry, TN
Gwen Bushyhead, Director, Chamber of Commerce Center, Swain County, NC
Charles Kelly
Donald McGlynn
James Phelps
Josh Smalley
Thomas Vernon
Virginia B. Williams
Geraldine Preston

RESPONSE TO COMMENTS

The comments cited by those supporting Reservoir Recreation Alternative A express the intent of this alternative (i.e., to enhance reservoir recreation opportunities). A number of those commenting recognized the trade-offs that are involved in operating the reservoir system but indicated that the benefits to be gained from increased recreation opportunities would more than compensate for any adverse environmental impacts. TVA's Preferred Alternative was formulated to enhance recreational opportunities and to achieve many of the benefits sought by these commenters.

<u>Opposed to Reservoir Recreation Alternative A</u>

Summary of Comments

Most individuals who made comments opposing Reservoir Recreation Alternative A cited environmental degradation as their primary reason—specifically loss of flats habitat for migratory bird species. This and other reasons are listed below.

ENVIRONMENTAL IMPACTS

- Results in loss of flats that are important to a variety of wildlife, including waterfowl, eagles, wading birds, and shorebirds.
- Adverse impact on the willow/buttonbush community, which is a major nesting area for a number of uncommon bird species and an important component of the fishery.

- Reduces spawning habitat.
- Reduces water and air quality.
- Increases flood risk.
- Increases shoreline erosion, affecting cultural resources.

RECREATION IMPACTS

- Decreases waterfowl hunting, birding, and fishing.

SOCIAL AND ECONOMIC TRADE-OFFS

- Increases in revenue are offset by the adverse environmental consequences.
- Lakeshore property owners and developers get all the benefits; everyone else in the population served by TVA has to bear the burden.
- Lowers gross regional product.
- Increases power costs; best to use the hydropower when temperature and climate conditions predispose to highest pollution levels.
- Damage to public areas by increased erosion.

Commenters

Barron Crawford, Paris, TN
Bettie Mason, Knoxville, TN
Bob Graham, Harrison, TN
Guy Larry Osborne, Jefferson City, TN
John Taylor, Springville, TN
Michael A. McMahan, Chattanooga, TN
Michael Sylva Sledjeski, Del Rio, TN
Robert Wheat, Paris, TN

RESPONSE TO COMMENTS

Most of the individuals opposing Reservoir Recreation Alternative A thought that benefits to be gained by a limited few were offset by the adverse environmental impacts on local areas and the region. The Preferred Alternative was formulated to enhance recreational opportunities, while reducing potential environmental impacts associated with Reservoir Recreation Alternative A.

Reservoir Recreation Alternative B

Support for Reservoir Recreation Alternative B

Summary of Comments

About 250 individuals supported Reservoir Recreation Alternative B (extending tributary and main river summer pool levels to Labor Day; raising tributary winter flood guides to levels needed to store only inflow volume of the 7-day, 500-year storm; and raising main river winter flood guides by 2 feet with a 1-foot operating range). Similar to those supporting Reservoir Recreation Alternative A, most individuals cast their vote or stated their preference for Reservoir Recreation Alternative B as the best plan for the region. When given, the primary reasons cited by those supporting Reservoir Recreation Alternative B are listed below.

PROVIDES A BALANCED APPROACH

- Pros outweigh cons; provides the most positive effects with fewer adverse effects than other alternatives.
- Provides a good balance between recreational use and flood control.
- Better for the economy, scenic beauty, recreation, property values, aquatic life, and shoreline erosion.
- Addresses increasing value of recreation on the lakes, while still providing adequate protection from floods and also providing a water source for communities along the river system.
- Broadest range of benefits with least damage to the system as it now exists.

INCREASES RECREATION VALUE AND USE

- Enhances recreational use; provides additional recreations opportunities.
- Improves fall fishing and reduces fish kill.
- Increases recreation and visual benefits.
- Allows full use of the lake (reservoir) during the traditional summer season.

SCENIC BEAUTY

- Enhances beauty of the lake.
- Reduces the amount of bare shore that develops as water levels are drawn down.
- Attracts tourist to area.

ECONOMIC EFFECTS

- More recreation dollars.
- Enhances property values.
- Helps local and regional economy.
- Creates more jobs.
- Spurs future growth and development.
- The cost to the average electric user of $3.66 per year in rate increase is offset by the improvement in the local economy.

ENVIRONMENTAL EFFECTS

- Little if any negative environmental effects.
- Places high priority on water quality; no major effects to water quality.
- Helps aquatic life.
- More stable environment improves fish spawn.
- Reduces shoreline erosion.
- No impact on flooding; later drawdown allows adequate time to prepare for winter and spring floods.
- Improves navigation with reduced cost.
- Safer for boaters with less chance of grounding.

USE OF PROPERTY

- Allows year-round personal dock access to lake.
- Allows use of boats and docks until Labor Day.
- Allows maintenance of pier.

Commenters

Alice Jane Jessee, Abingdon, VA
Allan B. Brown, Gilbertsville, KY
Andrew Newton, Weldon, IL
Angela Boyda, Abingdon, VA
Angela Mack, Huntsville, AL
Angie Borst, New Market, TN
Anonymous (10)
Barbara Garrow, Dandridge, TN
Beltz, Richard and Kay, Abingdon, VA
Ben Robinson, Rogersville, AL
Bennett G. Arvey, Fletcher, NC
Beverly Cardell, Blairsville, GA
Bill Coward, New Market, TN
Bill Dearing, Soltewah, TN
Bill Evans, Iuka, MS
Billy Hughes, Heiskell, TN
Bob Graham, Harrison, TN
Bob Mc Alister, Athens, AL
Bob Mc Alister, Athens, AL
Bob McDonald, Blairsville, GA
Bob Robertson, Dandridge, TN
Bob Weaver, Gainesville, GA
Brad Davenport, Seymour, TN
Brandon Grimsley, Blairsville, GA
Brian L. Thomas, Hiawassee, GA
Bryan Arnold, Bristol, VA
Bud Mcneal, Savannah, TN
Carl Fleischer, Roswell, GA
Carol Repovich, Gilbertsville, KY
Charles and Kristie Wallis, Sevierville, TN
Charles Fudge, Dandridge, TN
Charles Patton, Talbott, TN
Cheryl Harrison, Blairsville, GA
Chip Miller, Hixson, TN
Chris Berry, Blue Ridge, GA
Christopher Plemons, Knoxville, TN
Christy Tucker, Knoxville, TN
Connie Burlingham, Sevierville, TN
Dan McArthur, Dandridge, TN
Danny L. Smith, Bristol, TN
Dave Baxter, Eddyville, KY
Dave Cooper, Morristown, TN
David Deutsch, Blue Ridge, GA
David L. Schmitz, Memphis, TN
David Meek, Sevierville, TN
Dedra Anderson, Talbott, TN
Denny Lambert, Bristol, VA
Derek Wintermute, Blairsville, GA
Dexter Douglas, Hardin, KY
Dick Robish, Morristown, TN
Don Baldus, Bean Station, TN
Don Harrison, Blairsville, GA
Don Morrell, Athens, AL
Don Wintermute, Kennesaw, GA
Don Wintermute Jr., Colorado Springs, CO
Kathy Leedy, Sevierville, TN
Kathy Miller, Dandridge, TN
Kathy Pearce, Cumming, GA
Kay, 2517 Hills Chapel, TN
Ken Cole, Dandridge, TN
Ken Thompson, Benton, KY
Kenneth A. Turner
Larry Akins, Blairsville, GA
Larry Allbritten, Dandridge, TN
Larry Rinaca, Georgetown, TN
Leroy Miller, Dandridge, TN
Leslie Leduc, Bradenton, FL
Lorraine Shaffer, Murphy, NC
Lynn Swanson, Hiawassee, GA
MacDonald Pickens, Dandridge, TN
Marilyn Allbritten, Dandridge, TN
Marjorie C. Wintermute, Blairsville, GA
Mark D. King, Conyers, GA
Mark Shope, Morristown, TN
Marlin Seaton, Calvert City, KY
Martha McDonald, Blairsville, GA
Martin Milkman, Murray, KY
Mary Miller, Hiawassee, GA
Max Fuller, Bristol, VA
Melinda Baumunk, Dandridge, TN
Melissa Harrison, Bristol, VA
Michael Houser, Bristol, TN
Michael K. Smith, Morristown, TN
Michael Ryan, Dandridge, TN
Mike McWilliams
Milton Akins, Blairsville, GA
Mitch Rader, Sevierville, TN
Mr. and Mrs. Jackie C. Kelley, Dandridge, TN
Mrs. Jean Roberts, Morristown, TN
Name Not Provided
Nancy Fudge, Dandridge, TN
Nita Wintermute, Blairsville, GA
Norman Findley, Atlanta, GA
Norman K. Owen, Murphy, NC
Pam Brownhill, Blairsville, GA
Pat Finch, Brentwood, TN
Patricia E. Yates, Baneberry, TN
Patricia Burdett, White Pine, TN
Patricia Rippetoe, Dandridge, TN
Patsy Stuart, Blue Ridge, GA
Pattie Heitzman, Sand Springs, OK
Paul Baker, Big Sandy, TN
Paul Q. Merritt, Rutledge, TN
Pete and Mary Jo Zurcher, Sevierville, TN
Pete Barile, Morristown, TN
R. P. DeCicco, Ooltewah, TN
Rachel Baumunk, Dandridge, TN
Randy Newcomb, Gilbertsville, KY
Rick Rice, Marietta, GA
Richard and Linda Larson, Dandridge, TN

Donald Cook, Abingdon, VA
Donna Akins, Blairsville, GA
Douglas Rippetor, Dandridge, TN
Edd White, Blairsville, GA
Eddie Fisher, Kodak, TN
Edward J. O'Neill, Abingdon, VA
Edward Reynolds, Hiawassee Ga
Edwin D. Breland, Jr., Rogersville, AL
Elizabeth O'Donnell, Blairsville, GA
Erma Robb, Benton, KY
Fane Fisher, Kodak, TN
Forrest Liles, New Concord, KY
Frank Aparicio, Sevierville, TN
Frank Dahlberg, Dandridge, TN
G. W. Bud McCoig, Dandridge, TN
Gary Holiway, Dandridge, TN
Gary Jordan, Bryson City, NC
Gary Whitaker, Morristown, TN
George and Betty Lowers, Dandridge, TN
George Pisciotta, Marietta, GA
Gerard Gadbois, Dandridge, TN
Gill Davidson, Dawsonville, GA
Glesma Davis, Dandridge, TN
Gloria Dahlberg, Dandridge, TN
Harry Johnson, Dandridge, TN
Helen Dearing
Howard Mauney, Morristownhoo.Com, TN
J. B. Harmon, Mayfield, KY
Jackie Baker, Big Sandy, TN
James and Lavada Mansfield, Benton, KY
James E. Barker, Kodak, TN
James Froyd, Bryson City, NC
James W. McCabe, Dandridge, TN
James Wheeler, Dandridge, TN
Janna Davenport, Blairsville, GA
Jeremy Tucker, Knoxville, TN
Jerry Messick, Bristol, TN
Jill Parker, Blairsville, GA
Jim and Pat Halloran, Hiwassee, GA
Jim Folck, President, Norris Lake Marina Association, Norris TN
Jim Miscichoski, Dandridge, TN
Jim Prosak, Dandridge, TN
John and Beverly Kramer, Strawberry Plains, TN
John Ashe, Hayesville, NC
John Baumunk, Jr., Dandridge, TN
John De Freitas, Gilbertsville, KY
John Stafford, Sevierville, TN
John S. McClellan, Dandridge, TN
Joseph L. Mansell, Largo, FL
Joyce Balin, Bryson City, NC
Judy Akin, Marietta, GA
Judy Delashmutt, Dandridge, TN
Judy Edwards, Murphy, NC
Kathryn Johnson, Dandridge, TN
Kathryn Miller, Dandridge, TN
Kathy Napier, Blairsville, GA
Rita Dumbacher, Huntsville, AL
Robert A. Rohde, Dandridge, TN
Robert E. Mitchell
Robert Haist, Rome, GA
Robert L. Seeley, Young Harris, GA
Robert Leduc, Bradenton, FL
Robert Rohde, Dandridge, TN
Roberta Baxter, Eddyville, KY
Roger W. Dixon, Young Harris, GA
Ron Boyd, Athens, AL
Ronald J. Leduc, Dandridge, TN
Roy Sanders, Dandridge, TN
Russell Foust, Morristown, TN
Sandra Marinucci, Orland Park, IL
Scott Bardenwerper, Helen, GA
Scott Pisciotta, Marietta, GA
Sharon Smith, Birchwood, TN
Sharon Chilson, Bryson City, NC
Sharon L McCabe, Dandridge, TN
Sheila Cochran, New Market, TN
Sherry Ryan, Dandridge, TN
Shirley Cook, Abingdon, VA
Shirley Hartsell, Dandridge, TN
Steve Drake, Blairsville, GA
Steven L Grubb, Knoxville, TN
Steven Cook, Kingsport, TN
Steven L. Matney, Abingdon, VA
Tad Byrd, Sevierville, TN
Teddy Murrell, Sevierville, TN
Terry Weingarten, Hiawassee, GA
Thomas Cernilli, Roswell, GA
Thomas H. Hollingsworth, Rogersville, AL
Thomas Hodge, Dandridge, TN
Thomas R. White, Hampton, TN
Tim and Betty Lynne Leary, South Berwick, ME
Tim Allbritten, Dandridge, TN
Tim Doyle, Dandridge, TN
Todd Forthman, Hiawassee, GA
Tom and Judy Wolterman, Dandridge, TN
Tom Carlton, Blairsville, GA
Tom Fowler, Fontana Lake Estates, NC
Tom Gladfelter, Hiawassee, GA
Tommy Vann, Knoxville, TN
Tony Whitfield, Gilbertsville, KY
Troy Ward, Blairsville, GA
Unknown, Decatur, TN
Vernon Roberts, Morristown, TN
Vickie Stanton, Sevierville, TN
Victoria Witkowski, Bryson City, NC
Vonda M. Laughlin, Jefferson City, TN
Walter Carpus, Bean Station, TN
Waylon Spurgeon, Athens, AL
Wayne and Sigrid Burge, Athens, AL
Wayne Gallik, Dandridge, TN
Wayne Goodwin, Bristol, TN
Wes Davis, Gilbertsville, KY
William Wood, Bryson City, NC
William M. Thompson, Morristown, TN

Richard Wagner, Blairsville, GA
Rick Lewis, Dandridge, TN
Bob McAlister
Don Wintermute, Jr.
William McIntosh, Blairsville, GA
Wm. F. Walsh, Chattanooga, TN
Terry Wenberg

RESPONSE TO COMMENTS

Most individuals who gave reasons for supporting Reservoir Recreation Alternative B thought the higher reservoir levels and delayed drawdown until after Labor Day would improve the local area by increasing recreational opportunities, property values, and the local economy. A number of individuals questioned the study's conclusions that fewer recreational jobs would be created. This issue is addressed in Section F2.3 under "Economic Analysis and Adverse Effects on Jobs and Local Economy." Others mistakenly thought that since flooding occurs in spring and never in fall, Reservoir Recreation Alternative B would not affect flood control because water would be released after Labor Day to create flood storage. The Preferred Alternative was formulated to enhance recreational opportunities while reducing potential environmental impacts associated with Reservoir Recreation Alternative B.

<u>Opposed to Reservoir Recreation Alternative B</u>

Summary of Comments

Several of the individuals who made comments opposing Reservoir Recreation Alternative A also opposed Reservoir Recreation Alternative B for basically the same reasons: environmental degradation, specifically loss of flats habitat for migratory bird species. This and other reasons cited by those opposing Reservoir Recreation Alternative B are listed below.

ENVIRONMENTAL IMPACTS

- Results in loss of flats that are important to a variety of wildlife, including waterfowl, eagles, wading birds, and shorebirds.
- Adverse impact on the willow/buttonbush community, which is a major nesting area for a number of uncommon bird species and an important component of the fishery.
- Reduces spawning habitat.
- Reduces water and air quality.
- Increases flood risk.
- Increases shoreline erosion, affecting cultural resources.

RECREATION IMPACTS

- Decreases waterfowl hunting, birding, and fishing.

SOCIAL AND ECONOMIC TRADE-OFFS

- Increases in revenue would be offset by the adverse environmental consequences.
- Lakeshore property owners and developers get all the benefits; everyone else in the population served by TVA has to bear the burden.
- Lowers gross regional product.

- Increases power costs; best to use the hydropower when temperature and climate conditions predispose to highest pollution levels.
- Damage to public areas by increased erosion.

Commenters

Barron Crawford, Paris, TN
Bettie Mason, Knoxville, TN
Bob Russum, Piney Flats, TN
Danny Farmer, Camden, TN
David Cook, Blairsville, GA
John Taylor, Springville, TN
Mae Musick, Bristol, TN
Michael Sylva Sledjeski, Del Rio, TN

RESPONSE TO COMMENTS

Compared to those supporting Reservoir Recreation Alternative B, individuals opposing this alternative thought that benefits to be gained by a limited few were offset by the adverse environmental impacts on local areas and the region. The Preferred Alternative seeks to enhance recreational opportunities, while reducing the potential for environmental impacts associated with Reservoir Recreation Alternative B.

Summer Hydropower Alternative

Support for Summer Hydropower Alternative

Summary of Comments

Most individuals who made comments supporting the Summer Hydropower Alternative cited its benefits for water quality and aquatic life. This and other reasons are listed below:

- It is best overall for the system because it is as close to a natural river system as possible.
- It provides benefits for freshwater mussel populations, shorebirds, wildlife, waterfowl, and fisheries.
- It decreases power costs; and it provides better water quality.

Commenters

Chris Perkins, Florence, AL
David Cook, Blairsville, GA
Joan Ayer, Hiawassee, GA
Mark Seaton, Eva, TN
Tony Arnold, Russellville, KY

RESPONSE TO COMMENTS

The Preferred Alternative was formulated to reduce potential impacts on hydropower. Unfortunately, not all increases in power costs could be eliminated without substantially reducing opportunities for increased recreation on the river system.

Opposed to Summer Hydropower Alternative

Summary of Comments

Most individuals who opposed the Summer Hydropower Alternative considered this alternative to be unacceptable and recommended that it be removed from consideration because of the asserted devastating impacts on many businesses, property values, and the region. They considered the negative impacts on recreation, navigation, flood risk, water quality, fish habitat and spawning, and scenic beauty unacceptable, given no appreciable advantage to hydropower.

Commenters

Anonymous
Anthony Morris, Muscle Shoals, AL
Austin Carroll, Hopkinsville, KY
Barron Crawford, Paris, TN
Bill Dearing, Ooltewah, TN
Bob Russum, Piney Flats, TN
Bud McNeal, Savannah, TN
Dave Baxter, Eddyville, KY
George Pisciotta, Marietta, GA
Ivey Wingo, Blairsville, GA
Jerri Mitchell, Abingdon, VA
Joe Brang, Dandridge, TN
John Ashe, Hayesville, NC
John Olexick, Blairsville, GA
John Taylor, Springville, TN
Joseph A. Robinson, Jr., Abingdon, VA
Kathy Mesmer, Oak Ridge, TN
Michael A. McMahan, Chattanooga, TN
Robert Pardue, Dandridge, TN
Roberta Baxter, Eddyville, KY
Scott Pisciotta, Marietta, GA
Tom and Martha Schlechty
Tom Carlton, Blairsville, GA
Tom Hampton, Marion, VA
Vonda M. Laughlin, Jefferson City, TN
W. L. Panter, Soddy Daisy, TN
Wayne and Sigrid Burge, Athens, AL
William Dearing, Chattanooga, TN

RESPONSE TO COMMENTS

The Preferred Alternative was formulated to reduce potential power cost impacts while enhancing potential recreational opportunities compared to the alternatives identified in the DEIS.

Equalized Summer/Winter Flood Risk Alternative

Support for Equalized Summer/Winter Flood Risk Alternative

Summary of Comments

Most individuals endorsing the Equalized Summer/Winter Flood Risk Alternative cited the lack of negative impacts while extending the recreation season. These and other comments are listed below:

- Extends the recreation season the longest with only minimal cost impact and minimal water impacts.
- Flood condition seems to be tolerable.
- Is consistent with the original goal of TVA.

- Is best alternative with few negative effects to help reduce downstream flooding and loss of crops.
- Stops most of the flooding.
- Makes less of lake usable.

Commenters

Fran D'Antonio, Atlanta, GA
Lane Marte, Decatur, AL
Max Wilson, Hickman, KY
Paul Howell, Selmer, TN
Scott Pisciotta, Marietta, GA
Terry C. Smith, Killen, AL
Walter E. Flood, Friendsville, TN

RESPONSE TO COMMENTS

The Preferred Alternative was formulated to avoid or reduce the potential for increased flood risk that was associated with the policy alternatives that would improve recreation opportunities. As explained in Section 5.22, the Preferred Alternative would reduce flood risk to acceptable levels.

Opposed to Equalized Summer/Winter Flood Risk Alternative

Summary of Comments

Most individuals opposing the Equalized Summer/Winter Flood Risk Alternative thought that this alternative should never have been considered and should be deleted. They noted that it offers no appreciable benefits, costs too much in power benefits, reduces recreational opportunities due to lower and shorter summer pool levels, and drastically affects area businesses. One individual also noted the adverse impact on migratory shorebirds and on wetlands that support a variety of wildlife.

Commenters

Austin Carroll, Hopkinsville, KY
Bob Russum, Piney Flats, TN
Dave Baxter, Eddyville, KY
Douglas Lawler, Abingdon, VA
Jerri Mitchell, Abingdon, VA
Joe Brang, Dandridge, TN
John Taylor, Springville, TN
Julia Householder, Pigeon Forge, TN
Kathy Mesmer, Oak Ridge, TN
Kenneth Story, Pickwick Dam, TN
Michael A. McMahan, Chattanooga, TN
Robert Pardue, Dandridge, TN
Roberta Baxter, Eddyville, KY
Tom Carlton, Blairsville, GA
Wayne and Sigrid Burge, Athens, AL
William Dearing, Chattanooga, TN

RESPONSE TO COMMENTS

The Preferred Alternative was formulated in part to address these concerns.

Commercial Navigation Alternative

Support for Commercial Navigation Alternative

Summary of Comments

Most individuals who made comments endorsing the Commercial Navigation Alternative (raising mainstem winter flood guides by 2 feet, where possible, to provide a 13-foot navigation channel; reducing winter operating range to 1 foot for those reservoirs raised 2 feet in winter; and increasing minimum flows at several key lower river projects with major navigation locks) recognized the increased economic benefits and minimal environmental impacts. The primary reasons given by those supporting this alternative are listed below:

ECONOMIC EFFECTS

- Only alternative that offers positive economic benefits to the region.
- Supports commercial navigation.
- Greater economic impact now and in the future; very important to local economy.
- Lower river shipping costs will allow businesses to remain competitive.
- Slightly improves number of jobs and provides good-paying jobs.

USE OF FACILITIES

- Provides greater access to docks at minimal winter pool level.

ENVIRONMENTAL EFFECTS

- Positive effects on water quality.
- Fewer negative effects than other alternatives.
- Improves navigation and safety.

Commenters

Aline Hail, Gilbertsville, KY
Anonymous
Austin Carroll, Hopkinsville, KY
Cargill Decature, Decatur, AL
Clifford J. Rabalais, Counce, TN
Dana J. Mullins, Hillsboro, AL
David Edgin, Charlotte, TN
Donna Long, Haertselle, AL
Grant Posey, Town Creek, AL
J. Richard Hommrich, Nashville, TN
Jack D. Wycoff, Abingdon, VA
Janice L. Jones, Executive Director, Tennessee River Valley Association, Decatur, AL
Jim Loew, Florence, AL
Joe Vancil, Tiline, KY
John De Freitas, Gilbertsville, KY
Joseph A. Robinson, Jr., Abingdon, VA
K. Pritchard, Decatur, AL
Larry Pawlosky, Bridgeport, AL
Lynn Fowler, Mayor, City of Decatur, Decatur, AL
Mark Hommrich, Nashville, TN
Nancy Muse, Florence, AL
Patsy K. Cornelius, Savannah, TN
Robert Brewer, Paducah, KY
Russ Randall, Gibertsville, KY
Richard C. "Dick" Crawford, President & CEO, TVPPA, Chattanooga, TN
Wayne and Sigrid Burge, Athens, AL
Jim Loew

RESPONSE TO COMMENTS

The Preferred Alternative contains elements to enhance commercial navigation.

Opposed to Commercial Navigation Alternative

Summary of Comments

Most individuals who made comments opposing the Commercial Navigation Alternative simply stated that they are against it, or that it is not acceptable, or that it should be deleted. Primary reasons given by others opposing this alternative included adverse impacts on shoreline erosion, commercial fishing, migratory shorebirds, water quality, and other environmental resources—including increased flood risk to public lands during winter. Those commenting thought that these negative impacts outweigh the economic gains to commercial navigation. Three individuals made reference to this alternative further subsidizing the navigation industry.

Commenters

Anonymous
Bill Dearing, Ooltewah, TN
Donald Blackwelder, Savannah, TN
George Pisciotta, Marietta, GA
Joe Brang, Dandridge, TN
John Ashe, Hayesville, NC
John Taylor, Springville, TN
Kathy Mesmer, Oak Ridge, TN
Maudie Melson, Savannah, TN
Michael A. McMahan, Chattanooga, TN
Scott Pisciotta, Marietta, GA
Steve McCadams, Paris, TN
Terry C Smith, Killen, AL
Tom Carlton, Blairsville, GA

RESPONSE TO COMMENTS

The Preferred Alternative was developed in part to better balance operating objectives for the TVA system. Navigation would be enhanced under the Preferred Alternative, while potential adverse impacts on flood risk and other resources would be substantially reduced.

Tailwater Recreation Alternative

Support for Tailwater Recreation Alternative

Summary of Comments

Most individuals who commented in favor of the Tailwater Recreation Alternative (extending the summer pool period to Labor Day; changing winter tributary flood guides to the 7-day, 500-year storm inflow and raising winter mainstem reservoir levels by 2 feet, where possible; maintaining minimum releases from June 1 to Labor Day; and giving priority to providing additional recreational releases at specific projects) asked that TVA adopt this alternative and provide additional recreation releases. A number of individuals asked that presently scheduled releases be modified to provide a range of flows. Reasons why individuals endorsed this alternative are listed below:

- Helps local communities; benefits economic development.
- River releases are critical to the economy and survival of Polk County and its neighbors.

- The Ocoee River has the potential to become the premier whitewater center in the world.
- Provides recreational flows that balance beneficial uses, while providing ecological functions in the Apalachia Bypass.
- Provides additional benefits; rivers are not just for power production.
- Addresses needs of water quality.
- Improves scenic quality.
- A compromise that TVA desperately needs.
- Negative impacts are overstated.

Commenters

Angelina Carpenter, Jefferson City, TN
Anonymous
Chris Lyles, Atlanta, GA
Elyse Lee, Nashville, TN
Ira Smith, Knoxville, TN
J. C. Goodwin, Tuscaloosa, AL
Kathy Pearce, Cumming, GA
Mark Weddle, Marion, VA
Michael Jackson, Jr., CPA, Vestavia Hills, AL
Nancy MacNair, Athens, GA
Richard Simms, Chattanooga, TN
Richard Wagner, Blairsville, GA
Roy Teal, Signal Mountain, TN
Wayne and Sigrid Burge, Athens, AL

RESPONSE TO COMMENTS

The Preferred Alternative contains elements to enhance tailwater recreation at selected locations.

Opposed to Tailwater Recreation Alternative

Summary of Comments

Most individuals opposing the Tailwater Recreation Alternative indicated environmental concerns (loss of flats and wildlife habitat, increased shoreline erosion, impacts on water quality, and increased flood risk). Other reasons noted by those opposing this alternative included: that it was not a good alternative systemwide, but might be reasonable in discrete locales such as Apalachia; the cost was too much for someone trying to pay a power bill on a fixed income; and the alternative provides too much emphasis on rafting.

Commenters

Austin Carroll, Hopkinsville, KY
Barron Crawford, Paris, TN
Bill Dearing, Ooltewah, TN
David Slagle, Hayesville, NC
Erik Brinke, Murphy, NC
Joe Brang, Dandridge, TN
John Ashe, Hayesville, NC
John Taylor, Springville, TN
Joseph A. Robinson, Jr., Abingdon, VA
Michael A. McMahan, Chattanooga, TN
Scott Pisciotta, Marietta, GA
Tom Carlton, Blairsville, GA

RESPONSE TO COMMENTS

The Preferred Alternative was developed in part to address these concerns while still enhancing tailwater recreation opportunities.

Tailwater Habitat Alternative

Support for Tailwater Habitat Alternative

Summary of Comments

The individuals who made comments endorsing the Tailwater Habitat Alternative (retaining 75 percent of reservoir inflow and releasing Base Case minimum flows, or 25 percent of the inflow—whichever is greater, as a relatively continuous minimum flow with no turbine peaking) found it acceptable given the benefits to aquatic resources, including biodiversity and federal-protected species. They considered those benefits worth the trade-offs. One individual noted that this alternative offers a reasonable solution to seasonal drawdown and that it would provide year-round access to his property.

Commenters

Bill Dearing, Ooltewah, TN
Jeff Garner, Florence, AL
Joe Payne, Knoxville, TN
John J. Ross, Savannah, TN

RESPONSE TO COMMENTS

This alternative resulted in a number of potential impacts that could not be reduced to acceptable levels, such as the impact on flood risk. However, the Preferred Alternative includes a commitment to provide minimum flows in the Apalachia tailwater, and TVA remains committed to providing minimum flows in a number of tailwaters to improve aquatic habitat.

Opposed to Tailwater Habitat Alternative

Summary of Comments

Individuals who made comments opposing the Tailwater Habitat Alternative stated that the alternative is not acceptable, not important, or inferior to other alternatives; costs too much in terms of power costs and benefits few users; and increases flood risk to public lands.

Commenters

Austin Carroll, Hopkinsville, KY
Bettie Mason, Knoxville, TN
John Ashe, Hayesville, NC
John Taylor, Springville, TN
Joseph A. Robinson, Jr., Abingdon, VA

RESPONSE TO COMMENTS

See response to previous comment. The Preferred Alternative was formulated to better balance operating objectives for the TVA system.

Prefer Reservoir Recreation Alternatives A or B, A over B, B over A, or B or Tailwater Recreation Alternative

Prefer Reservoir Recreation Alternative A or Reservoir Recreation Alternative B

Summary of Comments

Most individuals preferring Reservoir Recreation Alternative A or B simply stated their preference. Some indicated that keeping lake (reservoir) levels up to Labor Day would increase recreational opportunities and improve the local and regional economy. These and other reasons stated for their preference are listed below:

PROVIDES A BALANCED APPROACH

- Maximizes benefits, while giving some consideration to recreation users.
- Allows for some benefits, while minimizing negative effects on power cost.

ENVIRONMENTAL EFFECTS

- Would not hurt flood risk in August and September because it is typically lower in those months.

ECONOMIC EFFECTS

- Improves economy of local area and region due to increased recreation opportunities.
- Improves tourism development.
- Is invaluable to local businesses.

USE OF PROPERTY

- Provides potential to expand docks and marinas.

Commenters

Andy Hardin, Nashville, TN
Brett Hadley, Dandridge, TN
Carroll and Gail Johnson, Dandridge, TN
Dan Meek, Kodak, TN
David B. Seifert, Sevierville, TN
Dennis Yates, Baneberry, TN
Donald Blackwelder, Savannah, TN
Erik Brinke, Murphy, NC
Gary and Myran Rosenbalm, Seymour, TN
Gerald McKinney, Bryson City, NC
Joe and Julia Moon, Dandridge, TN
Lamar Paris, Sole Commissioner, Union County, GA
[I] Tolly G. Shelton, Decatur, AL
Nanette M. McCarthy, Peachtree City, GA
O. M. and Susan Goodman, Dandridge, TN
Parmelle and Edwina Ward, Blairsville, GA
Paul Hargrove, Athens, AL
Robert Brock
Robert Hilty, Lafollette, TN
Teresa Joel, Atlanta, GA
Terry Coil, Blairsville, GA
Tom Jirik, Blairsville, GA
Vicky Murrell, Sevierville, TN
Vivian Hill, Blairsville, GA
William Deloch

RESPONSE TO COMMENTS

Comment noted. Several individuals questioned the adverse impact on flood risk and jobs under Reservoir Recreation Alternatives A and B. Sections 5.22 and 5.25 describe these impacts. The alternative identified in the FEIS as TVA's Preferred Alternative is a hybrid or blend of the recreation and other alternatives. It was formulated to address these and other adverse impacts of the action alternatives in the DEIS, while still enhancing recreational opportunities and providing other benefits.

Prefer Reservoir Recreation Alternative A over Reservoir Recreation Alternative B

Summary of Comments

A small number of individuals who commented on the alternatives stated that Reservoir Recreation Alternative A was their first choice and Reservoir Recreation Alternative B would be their second choice. They noted that Reservoir Recreation Alternative A would provide ample recreational opportunities without producing the adverse environmental impacts of Reservoir Recreation Alternative B—including adverse impacts on flood control, power supply, water quality, shoreline erosion, and fish and wildlife.

Commenters

Anonymous
Bob Anderson, Hiawassee, GA
Bruce O. Anderson, Emma L. Anderson, Talbott, TN
Carolyn Varner, Ocala, FL
Christine Robinson, Abingdon, VA
David and Marylin Miles, Dandridge, TN
Greg Robinson, Abingdon, VA
Joseph A. Robinson, Jr., Abingdon, VA
Michael and Evelyn Fink, Dandridge, TN
Robert L. Stump, Jr., Marion, VA
Sandy Robinson, Abingdon, VA
Steve Poole, Bethlehem, GA
Suzy Jenkins, Blairsville, GA
Teresa Joel, Atlanta, GA
Wes and Jennifer King, Blue Ridge, GA

RESPONSE TO COMMENTS

Comment noted.

Prefer Reservoir Recreation Alternative B over Reservoir Recreation Alternative A

Summary of Comments

Reasons given by those who preferred Reservoir Recreation Alternative B over Reservoir Recreation Alternative A included more stable and longer summer pool levels, resulting in less shoreline erosion, improved scenic beauty, safer fishing and boating, and greater recreation opportunities provided under Reservoir Recreation Alternative B. Others expressed that Reservoir Recreation Alternative B was better for the area economy and would result in an insignificant power loss.

Commenters

All Westlake, Athens, AL
Anthony Lambert, Bristol, VA.
Bill Beutjer, Athens, AL
Bruce and Emma Anderson, Talbott, TN
Fran D'Antonio, Atlanta, GA
Glenn Glafenhein, Knoxville, TN
Jeff Ramsey, Kodak, TN
Jack C. Cole, Aingdon, VA.
John and Lisa Keith, Bristol, TN
Larry Allbritten, Dandridge, TN
Linda and Jackie Stump, Abingdon, VA
Lynn Swanson, Hiawassee, GA
Myron Engebretson, Marietta, GA
Parmelle and Edwina Ward, Blairsville, GA
Paul Reams, Macon, GA
Robert Hilty, Lafollette, TN
Robert Leduc, Bradenton, FL
Scott Pisciotta, Marietta, GA
Terry Topjun, Dandridge, TN
Thomas Cernilli, Roswell, GA
Wayne and Sigrid Burge, Athens, AL

RESPONSE TO COMMENTS

Comment noted.

Prefer Reservoir Recreation Alternative B or Tailwater Recreation Alternative

Summary of Comments

Reasons given by those who preferred Reservoir Recreation Alternative B or the Tailwater Recreation Alternative included economic and recreation benefits with few impacts on other factors, including flooding.

Commenters

Kathy Pearce, Cumming, GA
Patti Grubb, Knoxville, TN
Paul Howell, Selmer, TN

RESPONSE TO COMMENTS

Comment noted.

Other Preferences

Summary of Comments

A few individuals listed a number of alternatives in the order of preference that they would favor:

- Reservoir Recreation Alternative B, Commercial Navigation Alternative, and Tailwater Recreation Alternative.
- Tailwater Recreation Alternative, followed by Reservoir Recreation Alternative B and Reservoir Recreation Alternative A.

Commenters

Robert A. Lamm, Hiawassee, GA
Wayne and Sigrid Burge, Athens, AL
William Dearing, Chattanooga, TN

RESPONSE TO COMMENTS

Comment noted.

Higher and Longer Reservoir Pool Levels

Support for Higher and Longer Summer and Winter Pool Levels

Summary of Comments

Most individual who made comments endorsing higher pool levels did not mention specific dates; most wanted higher levels through the fall color season or as long as possible, if not year-round. Of those who mentioned a specific drawdown date, about 100 individuals favored Labor Day, three favored September 15, 69 favored October 1, five favored October 15, 12 favored November 1, and one favored December 1. Additionally, 28 individuals specifically mentioned favoring higher winter levels and 13 individuals favored earlier (March to May) fill dates. Those who objected to higher pool levels were identified earlier in this section under "Support for Base Case." Reasons given to support higher pool levels are listed below:

RECREATION IMPACTS

- Provides year-round recreation opportunities.
- Improves opportunities for boating and fishing.
- Improves quality of the region.

SCENIC BEAUTY

- Eliminates flats.
- Improves the looks of the lake during winter months.
- Provides more desirable vacation spots.
- Minimizes impacts on boater safety.

ENVIRONMENTAL EFFECTS

- Minimal adverse impacts.
- Critical of flood control impacts.
- Reduces shoreline erosion.
- Improves fishing.

ECONOMIC EFFECTS

- Improves economy; adds tax revenue.
- Encourages tourism; extends tourist season.
- Helps area businesses; allows for more jobs.
- Keeps people in the area.
- Improves property values.

- Reduces damage to boat docks and marinas.
- Reduces navigation hazards.
- Reduces dock maintenance.
- Improves commercial navigation.

USE OF PROPERTY

- Increases use of boats and marinas.

Commenters

A. Mack
Al Caudell, Marietta, GA
Alan Click, Bryson Ciyt, NC
Alice Jane Jesseel, Abingdon, VA
Alice Russell, Hayesville, NC
Aline Hail, Gilbertsville, KY
Allan Nelson, Atlanta, GA
Amy Barnette, McDonough, GA
Andrew Akins, Blairsville, GA
Andrew Atkins, Morristown, TN
Ann Bitting, Hiawassee, GA
Anne H. Brindle, Crandall, GA
Anonymous (9)
B. Governale, Buford, GA
Barb Banghart, Blue Ridge, GA
Barbara Banghart, Blue Ridge, GA
Barbara Cavagnini, Dandridge, TN
Barbara Mason Poole, Blairsville, GA
Barbara Phillips, Lexington, KY
Bart Dastolfo, Dandridge, TN
Ben Robinson, Rogersville, AL
Ben Sharrett, Abingdon, VA
Bernard Johnson, Dandridge, TN
Beth Russum, Piney Flats, TN
Beth Smith, Sevierville, TN
Betty Whillock, New Market, TN
Bill Beutjer, Athens, AL
Bill Coward, New Market, TN
Carl Hatfield, Dandridge, TN
Carl Lakes, Bean Station, TN
Carol Ann Mancini, Blairsville, GA
Carol McKee, Dandridge, TN
Carol Repovich, Gilbertsville, KY
Carol Roberts, Dandridge, TN
Carol Simon, Young Harrisi, GA
Carolyn Henderson, Kodak, TN
Carolyn Ippisch, Morgantown, GA
Carolyn Lakes, Bean Station, TN
Carolyn R Clarkson, Blairsville, GA
Carolyn Varner, Ocala, FL
Cecil G. Boland, President, Blairsville, GA
Chad Armstrong, Talbott, TN
Chad Necessary, Abingdon, VA
Charles & Kristie Wallis, Sevierville, TN
Charles Wooten, Jr., Blairsville, GA
Bill Delashmutt, Dandridge, TN
Bob Anderson, Hiawassee, GA
Bob Garrison, Blairsville, GA
Bob Graham, Harrison, TN
Bob Holdman, Gilbertsville, KY
Bob Milhorn, Abingdon, VA
Bob Reynolds, Morristown, TN
Bobbie Merritt, Dandridge, TN
Bonnie Morris, Dandridge, TN
Bonnie Ragland, Bryson City, NC
Brad Malone, Blairsville, GA
Brian Beisel, Golden Pond, KY
Brian Cavagnini, Avon, IN
Brian L. Thomas, Hiawassee, GA
Brian Mazzei, Abingdon, VA
Bruce and Alyssa Crowder, Knoxville, TN
Bryon Horner, Morristown, TN
Burley Miller, Honaker, VA
C. D. Wallin, Blue Ridge, GA
C. W. West, Guntersville, AL
Calisse Finchum, Newport, TN
Cargill Decature, Decatur, AL
Carl and Joy Meade, Property Owners, Sevierville, TN
Ed Orton
Edda S. Miracle, Sevierville, TN
Eddie Atzenhofer, Blairsville, GA
Eddie Graham, Blairsville, GA
Eddie Fisher, Kodak, TN
Edward Stricklin, Murfressboro, TN
Elaine Dilbeck, Blue Ridge, GA
Eleanor McRae, Cadiz, KY
Elizabeth G. Roberts, Appalachia, VA
Eric Brown, Knoxville, TN
Eugene Beatty, Cumming, GA
Eugene Hendereson, Kodak, TN
Floyd Cross, Blairsville, GA
Frank Aparicio, Sevierville, TN
Fred A. Murray, Dandridge, TN
Fred Overbay, Talbott, TN
Fred Schaffer, Dandridge, TN
Frederick Steel, Kodak, TN
G. L. and Billie Bowman, Dandridge, TN
G. W. Norton, Dandridge, TN
G. W. Bud McCoig, Dandridge, TN

Chip Miller, Hixson, TN
Chuck Albury, Young Harris, GA
Clarence R. Bailey, Dandridge, TN
Claudette Geofffrion
Colman B. Woodhall, Johnson City, TN
Conley Miracle, Sevierville, TN
Connie Burlingham, Sevierville, TN
Curtis E. Johnson
D.C. Robinson, Weaverville, NC
D. W. Campbell, Blairsville, GA
Dalie T. Thomas, Bristol, TN
Dan Hartley, Dandridge, TN
Dan Meek, Kodak, TN
Dana Etheridge, Blairsville, GA
Daniel B. Harris Jr., Morristown, TN
Danny Matas, Richland, VA
Darcelle Green, Palmetto, GA
David and Sandra Jamison, Dalton, GA
David B. Seifert, Sevierville, TN
David C. Johnigk, Cadiz, KY
David Jones, Hiawassee, GA
David Slagle, Hayesville, NC
Dean and Mary Jane Heavener, Chattanooga, TN
Debbie Sims
Denise N. Gladfelter, Hiawassee, GA
Dennis Mack, Huntsville, AL
Diane Layton, Dandridge, TN
Dixie A Cantley, Bluff City, TN
Don Cross, Bluff City, TN
Don Helton, Old Hickory, TN
Don Ratliff and Family
Donna Lee Demuth, Hiawassee, GA
Dorie Stratton, Blairsville, GA
Dorthy McArthur, Dandridge, TN
Dot Goins, Dandridge, TN
Doug Reffitt, Baneberry, TN
Ed Murrey, Pulaski, TN
E. Bloom, Blairsville, GA
Earl J. Munro Jr., Baneberry, TN
Earl Nyman, Abingdon, VA
James Blankenship, Cedar Bluff, VA
James F. Smith, Ringgold, GA
Jane Chinnici, Hiawassee, GA
Janelle Neas, Dandridge, TN
Janet Kammann, Baneberry, TN
Janet Penilo, Dandridge, TN
Jay and Libby Wise, Johnson City, TN
Jean Christian, Marietta, GA
Jean Prater, Athens, AL
Jeff Blankenship, Cedar Bluff, VA
Jeff Cabe, Robbinsville, NC
Jeff Ramsey, Kodak, TN
Jennifer Huskey, Sevierville, TN
Jeri Peterson, Dandridge, TN
Jerry Dyer, Blairsville, GA
Jerry Huskey, Sevierville, TN
Jerry Powers, Bristol, VA
Garland Wyatt, Benton, KY
Gary Connaughty, Hiawassee, GA
Gary Holiway, Dandridge, TN
Gary Thurston, Hayesville, NC
Gene and Gina Rossetti, Bristol, TN
George A, GAntte, Dandridge, TN
George F. White, Cordele, GA
George Gantte, Dandridge, TN
George Pisciotta, Marietta, GA
George Plack
George Turnis
George Ward, Dandridge, TN
Gilbert Moebes, Decatur, AL
Glen and Janice Boland, Blairsville, GA
Glenda Wade, Bristol, TN
Gordon Conklin, Dandridge, TN
Gordon Marshall, Dandridge, TN
Greg Puett, Blairsville, GA
Greg Robinson, Abingdon, VA
Greg Worley, White Pine, TN
Gwen Thomas, Morristown, TN
H. Lee Fleshood, Nashville, TN
H. E. Wayt, Haley Cricle, Blairsville, GA
Harold E. Jackson, Jr., Nashville, TN
Harry and Sharon Thompson, Blairsville, GA
Harry Nolan, Atlanta, GA
Harvey and Wendy Holden, Blairsville, GA
Heath Alvey, Dandridge, TN
Helen Atzenhofer, Blairsville, GA
Howard Miracle, New Market, TN
J. H. Derden, Sevierville, TN
J. D. Matney, Abington, VA
J. D. Smith, Doran, VA
Jack Moody, Hayesville, NC
Jackie Baker, Big Sandy, TN
Jackie F. and Brenda Sise, Dandridge, TN
Jackie Scarborough, Dandridge, TN
Jacquelyn O'Connell, MCcaysville, GA
K Pindzola, Johnson City, TN
Karen A. Spence, Sevierville, TN
Karl Kammann, Baneberry, TN
Kathy Joseph, Decatur, AL
Kathy Mesmer, Oak Ridge, TN
Kathy Pearce, Cumming, GA
Kathy Schubert, Dandridge, TN
Kelli Carr, Knoxville, TN
Kelly Brawner Chadwick, Buchanan, TN
Ken Thompson, Benton, KY
Kenneth Norton, Sevierville, TN
Kenny Stuart, Blue Ridge, GA
Kevin Abel, Abingdon, VA
Kim Hatcher, Bluff City, TN
Kimberly S. Brackett, Hixson, TN
Lamar Franklin, Blairsville, GA
Lamar Paris, Sole Commissioner, Union County, GA
Larry and Shirley Anglea, Jefferson City, TN
Larry Akers, Abingdon, VA

Jerry Stephens, Bluff City, TN
Jim and April Russell, Dandridge, TN
Jim Crigger, Knoxville, TN
Jim Davis, Dandridge, TN
Jim Fields, Lafollette, TN
Jim and Pat Gantt, Sevierville, TN
Jim Graham Jr., Memphis, TN
Jimmy & Amy Owens, Dandridge, TN
Jimmy W. Peoples, Talbott, TN
Joan M. Garlock, Sevierville, TN
Joan McCoig, Dandridge, TN
Joanne Wenberg, Blairsville, GA
Joe and Julia Moon, Dandridge, TN
Joe Brang, Dandridge, TN
Joe Depew, Kodak, TN
Joe L. Chase, Abingdon, VA
Joe Nicholson, Maryville, TN
John and Riki Falvey, Louisville, KY
John Archambault, Dandridge, TN
John Ashe, Hayesville, NC
John C. Ashe, Hayesville, NC
John Honey, Dandridge, TN
John James III, Piney Flats, TN
John McNeill, Blue Ridge, GA
John Parker, Dandridge, TN
John Sillay, Marietta, GA
Joseph A. Robinson, Jr., Abingdon, VA
Joseph Nofil, Hayesville, NC
Juanita Phillips, Paducah, KY
Judith A and Ronald W. Acks, Hayesville, NC
Judy Akin, Marietta, GA
Judy Cosby, Dalton, GA
Judy Cosby, Dalton, GA
Judy Delashmutt, Dandridge, TN
Judy Edwards, Murphy, NC
Judy Kirchner, Huntsville, AL
Judy M. Munro, Baneberry, TN
Judy Myers, Blairsville, GA
Julia Schneider, Dandridge, TN
Julius Papatyi, Blairsville, GA
Michael Guffey, Seymour, TN
Michael Kovich, Benton, KY
Michael Ryan, Dandridge, TN
Michael R. Adamson, Blairsville, GA
Micheal R. Williams, Maynardville, TN
Michelle Maloney, Blairsville, GA
Mike, Blairsville, GA
Mike, Huntsville, AL
Mike Cassidy, Waverly, TN
Mike Everett, Kingsport, TN
Mike Harriss, Knoxville, TN
Mike Johnson, Bristol, TN
Mr. and Mrs. John Bayme, Dandridge, TN
Mr. and Mrs. John R. Scott, Dunwoody, GA
Mr. and Mrs. Richard Roach, Dandridge, TN
Mrs. Jean Roberts, Morristown, TN
Nadien T. Brown, Sevierville, TN
Nancy B. Cosentino, Dandridge, TN
Larry Clark, Dandridge, TN
Larry Mancini, Blairsville, GA
Larry Pawlosky, Bridgeport, AL
Larry Rinaca, Georgetown, TN
Larry Sample, Blairsville, GA
Lavada Mansfield, Benton, KY
Lee Harrell, Big Sandy, TN
Linda Bartolini, Blairsville, GA
Linda Wingo, Blairsville, GA
Lori Miller, Dandridge, TN
Louis Duval, Dandridge, TN
Louis Murray, Dandridge, TN
Lowell Smith, Raven, VA
Lucille Canter, Dandridge, TN
Lynn Archambault, Dandridge, TN
Lynn Johnson, Bristol, VA
Lynn Peterson, Blairsville, GA
Madeline Roose, Blairsville, GA
Marcia Kammann, Baneberry, TN
Marcia Papatyi, Blairsville, GA
Marcie Lanz, Morristown, TN
Margaret B. Howard, Dandridge, TN
Marianne O. Hatchett, Hayesville, NC
Marie E. Geesa, Blairsville, GA
Mark and Patti Heitzman, Sand Springs, OK
Mark A. Jackson, Dandridge, TN
Martha Jarrard, Hiawassee, GA
Mary and Herbert Arnold, Blairsville, GA
Mary Crosby, Dandridge, TN
Mary Jones, GAtlinburg, TN
Mary Kitchen, Blairsville, GA
Mary Lou Stone, Clarkesville, GA
Mary M. Johnson, Bristol, VA
Mary Teaster, Kodak, TN
Melvin Peterson, Dandridge, TN
Merlin W. Larimer, Benton, KY
Michael A. O'Brien, Kennesaw, GA
Michael and Evelyn Fink, Dandridge, TN
Michael Aparicio, Seveirville, TN
Richard West, Jackson, TN
Ricky and Sabrina Rich, Blairsville, GA
Rita Dumbacher, Huntsville, AL
Ron Boyd, Athens, AL
Robert A. Costner, Jr., Oak Ridge, TN
Robert Browning, Hayesville, NC
Robert Hinton, Thompsons Station, TN
Robert J. Reynolds, Morristown, TN
Robert McNamara, Dandridge, TN
Robert Owens, Marietta, GA
Robert Pardue, Dandridge, TN
Robert Penilo, Ft. Oglehtorpe, GA
Robin Gantte, Dandridge, TN
Rod Ogan, Blountville, TN
Rodney Napier, Jr.
Ron Gillespie, Blue Ridge, GA
Ron Witkowski
Ronald Harrison, Birmingham, MI
Ronald Morgan, Marietta, GA

Nancy Bryant, Dandridge, TN
Nancy Malte, Blairsville, GA
Nancy Winter, Sevierville, TN
Nancy Zambonie, Ex. Director, Morriston, TN
Norma Gailey, Dunwoody, GA
Norman Findley, Atlanta, GA
Norton Samples, Dandridge, TN
Pat Allen
Pat McAlister, Athens, AL
Patricia Osborn
Patsy Stuart, Blue Ridge , GA
Pattie Heitzman, Sand Springs, OK
Paul Baker, Big Sandy, TN
Paul Brownhill, Blairsville, GA
Paul Hargrove, Athens, AL
Paul Morris, Benton, KY
Pete and Diane Heinen, Dandridge, TN
Peter Skop, Norcross, GA
Phil Kammann, Baneberry, TN
Quillian and Linda Millsap, Cartersville, GA
R. A. Kyker, Sevierville, TN
Ralph Davis, Sevierville, TN
Ralph Duff, Saltville, VA
Randomseye Ra, Athens, AL
Randy Newcomb, Gilbertsville, KY
Randy Palmer, Huntsville, AL
Ray Fabery, Decatur, AL
Raymond Phillips, Dandridge, TN
Reileen Beatty, Cumming, GA
Rene Conklin, Dandridge, TN
Renee Mason-Mazzei, Abingdon, VA
Richard and June Peterson, Hiawassee, GA
Richard and Linda Larson, Dandridge, TN
Richard and Margaret Harwood, Dandridge, TN
Richard C. Kammann, Owner/Manager, Banesberry, TN
Richard L. King, Dandridge, TN
Richard P. Emigholz, Pres. Funtimers Fishing Club, Kuttawa, KY
Richard Rodriguez, Sevierville, TN
Thomas G. Sandvick, Morganton, GA
Tim Kirchner, Huntsville, AL
Tom A. Yates, Bristol, VA
Tom Loesel, Blairsville, GA
Tom Murphy, Blairsville, GA
Tom Nichols
Tommy Stephens, Blairsville, GA
Tony Carruth, Rome, GA
Tonya G. Whillock, New Market, TN
Vincent L. and June D. Greaves, Blairsville, GA
Vonda M. Laughlin, Jefferson City, TN
W. E. Wade, Bristol, TN
W. H. Cross, Hiawassee, GA
Walter E. Flood, Friendsville, TN
Walter Lake, Dandridge, TN
Walter Mitchell, Dunwoody, GA
Bill Dearing, Ooltewah, TN
Bill Dyer, Paducah, KY
Rosa Yellig, Evansville, IN
Ross Demuth, Hiawassee, GA
Roy and Beverly Cardell, Blairsville, GA
Roy and Vitron Wilmont, Blairsville, GA
Roy Baker, Eddyville, KY
Roy Keith Stepp, Athens, AL
Ruth Ann Parker, Dandridge, TN
S. Dean Yates, Abingdon, VA
Sam and Billie Hammond, Jefferson City, TN
Sandra Lawson, Eddyville, KY
Sandra Whitener, Dandridge, TN
Sandy Robinson, Abingdon, VA
Sara Harris Mullins, Johnson City, TN
Scott McKee, Dandridge, TN
Sharon L. McCabe, Dandridge, TN
Stan Veltkamp, Baneberry, TN
Stanley L. McClellan, Hartselle, AL
Stephen D. Hiland, Eddyville, KY
Steve and Becky Mishket, Dandridge, TN
Steve Marshall, Dandridge, TN
Steven J Milcheck, Mooresburg, TN
Sue and Michael Wade, Raven, VA
Sue King, Dandridge, TN
Sue King, Dandridge, TN
Susan D. Jones, Dandridge, TN
Susan Kuehl, Dandridge, TN
Susan Chase, Abingdon, VA
Taulbee Lester, Honaker, VA
Terry Aparicio, Sevierville, TN
Terry Glass
Terry Matney, Abingdon, VA
Terry Peters, Elizabethton, TN
Terry Schwartz, Blairsville, GA
Terry Sisk, Gray, TN
Terry, Frank, Lizette Aparicio, Sevierville, TN
The Honorable Zach Wamp, U.S. House of Representatives, Washington, DC
Theresa Toney, Cedar Bluff, VA
Thomas T. Kitchen, Blairsville, GA
Thomas Atkinson, Blairsville, GA
Thomas Browning, Hayesville, NC
Thomas C. Roberts, Morganton, GA
Walter Shubert, Dandridge, TN
Wayne DeMars, Blairsville, GA
Wayne King, Dandridge, TN
Wes Hardy, Atlanta, GA
Wilbur Neil, Gilbertsville, KY
William and Velda Clayton, Dandridge, TN
William Wood, Bryson City, NC
William Cleveland, Montrose, AL
William Dearing, Chattanooga, TN
William DeLoch
William Gazda, Bryson City, NC
William T. Moon, White Pine, TN
Wm. F. Walsh, Chattanooga, TN
Woody Chastain, Athens, GA
Wooten, Beverly, Blairsville, GA
Worth Mason, Blairsville, GA

Bill Frisbey, Blairsville, GA
Bill Parker, Blairsville, GA
Syndney Y. Cole
Mike Priven
Jill Henderson
Wynn Beidleman, Piney Flats, TN
Justin Broadway
Mary Ones
Eugene Henderson
Charles R. Perry

RESPONSE TO COMMENTS

Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels on a number of reservoirs under median conditions. The results of these evaluations are discussed in the EIS.

Proposed Combination/Modification of Alternatives

Summary of Comments

Most individuals who made comments on modifications to the alternatives addressed in detail in the DEIS suggested combining or modifying the alternatives to reduce adverse effects (e.g., flooding) or to focus on specific priorities (e.g., recreation and/or environmental improvements). Eleven individuals suggested combining one or more of the recreation alternatives (Reservoir Recreation Alternatives A or B, or Tailwater Recreation Alternative) with the Commercial Navigation Alternative in an effort to offset the adverse environmental impacts of those alternatives. A number of individuals recognized the complexity of the reservoir system and suggested a "test" or "pilot program" to evaluate the real-world impacts of the selected alternative. Other comments addressed optimizing individual reservoirs, being more equitable in drawing down pool levels, and studying how Federal Energy Regulatory Commission (FERC) rules would affect operations of the reservoir system.

Hybrid of Base Case

- Minimize impacts and provides more enhancement.
- Tweak reservoir operations to better benefit flood control, hydropower, and navigation – the real purposes of why the projects were built in the first place.

Hybrid of Reservoir Recreation A Alternative

- Provide some benefit to Boone Reservoir (e.g., extend summer pool level to October 1).
- Allow winter pool levels to be dropped on Cherokee and Douglas Reservoirs to their current winter pool levels.
- Provide 1.5 feet (18 to 24 inches) more water at winter pool on Kentucky Reservoir.

Hybrid of Reservoir Recreation B Alternative

- Modify to extend tributary summer pool to October 1 and restrict drawdown until October 1.

Hybrid of Tailwater Recreation Alternative

- Provide range of recreation flows that balances beneficial uses while providing ecological functions.

Hybrid of Tailwater Habitat Alternative

- Modify to achieve objectives and mitigate environmental consequences.

Blend of Alternatives Considered

- Blend Base Case and Commercial Navigation Alternative.
- Blend Reservoir Recreation A and Commercial Navigation Alternatives.
- Blend Reservoir Recreation Alternative B and Commercial Navigation Alternative.
- Blend Tailwater Recreation and Equalized Summer/Winter Flood Risk Alternatives to bring reservoir up slower in spring in order to reduce the likelihood of spring flooding and to hold summer pools longer to improve recreation.

Modified to Accomplish Designated Purposes

- Modify to optimize environmental improvements.
- Review possibility of special flushing releases during major rain events, when extended minimum flows are in effect in order to remove deposited sediment.
- Blend alternatives with flood control and protection of the environment (including water supply and quality) as highest priorities, followed by navigation and recreation (note that the relative priority of these will vary with location).
- Optimize navigation and water quality.
- Manage water levels to benefit fish and wildlife.
- Modify to hold water levels more stable during spawning season.
- Manipulate water levels to enhance sport fisheries and overall fish community.
- Modify 2-foot increase in winter pool to reduce impacts on flood control; try 1-foot increase to help winter recreation and aid navigation.
- Consider two or three plans of action, depending on the actual water levels and conditions; design alternatives that are triggered when certain rain and water level conditions are met.

Other Alternatives

- Begin with a commitment to keep flood levels the same as Base Case, then determine what winter levels should be and then summer levels.
- Consider alternatives with the least impact on the aquatic resources of the Tennessee Valley system and substantially increase recreational opportunities.
- Develop an alternative designed to protect aquatic habitat and species.
- Consider alternatives that would decrease flooding potential for Pickwick and Kentucky Reservoirs.

Optimize Individual Reservoir

- Maximize each reservoir for residents/users of it, provided it does not substantially and negatively affect other users or other systems.

- Use Reservoir Recreation Alternative A for Cherokee Reservoir and differing alternatives for other reservoirs to produce best overall system-wide results.
- Manage each reservoir for its own unique situation rather than a standard procedure for the whole reservoir system.
- Consider the highest and best use of each lake in the system. For some, it may be flood control, but navigation shouldn't be as high as it is now.
- Reservoirs such as Fontana, Nottely, and Watauga could be managed to optimize recreation, tourism, and/or water supply, while downstream reservoirs could be managed under other more profitable guidelines.
- Try a softer approach on a per-reservoir basis.

Pilot Test

- Try a more conservative approach for a season or two before implementing a more aggressive alternative.
- Suggest a “trial" or “pilot program” for one of the alternatives outlined in the study; could extend study now in progress.

Fill and Drawdown

- Use a more balanced approach for raising and lowering tributary reservoirs.
- Address additional winter pool drawdown options.
- Reduce period of draining and filling reservoirs.
- Average the drawdown between reservoirs, so that they are all taken down the same amount.
- Keep all reservoirs at relatively the same pool levels for the same duration, as nature and flood control allow. Do not have certain lakes absorb all fluctuation while preferred lakes are kept stable.
- Lower pool levels consistently and on the same time frame across reservoirs. One of the biggest areas of concern over the past has been the varying degrees of draws between the surrounding tributaries. Nottely has had a lower level much earlier than Lake Chatuge and Lake Blue Ridge.
- Appears study was written to justify Base Case.
- As an alternative, study how following FERC rules would affect the system.

Commenters

April Hall, Alabama Rivers Alliance, Birmingham, AL
Austin Carroll, Hopkinsville, KY
Barbara A. Walton, Oak Ridge, TN
Bob Russum, Piney Flats, TN
Brian E. Eeister, Bethalto, IL
Brian Geisel, Golden Pond, KY
Crystal Brown, Decatur, AL
Dale Whitman, Bristol, TN
Dana J. Mullins, Hillsboro, AL
Dave Cooper, Morristown, TN
Dennis Mack, Huntsville, AL
Don Waldon, Columbus, MS
Doug Triestram, Blairsville, GA
Forrest Liles, New Concord, KY
Kerry Grissett, Decatur, AL
Kevin M. McCarthy, Peachtree City, GA
K. Pritchard, Decatur, AL
Lamar Paris, Sole Commissioner, Union County, GA
Larry Mancini, Blairsville, GA
Lynn Fowler, Mayor, City of Decatur, Decatur, AL Malcolm P. Cotton, Dandridge, TN
Marti Steffen, Dandridge, TN
Margaret H. Schramke, Blairsville, TN
Mary Pat
Norman K. Owen, Murphy, NC
Peter Low
Ray Murphy, Dandridge, TN
Richard Simms, Chattanooga, TN

Frank McGinley, Savannah, TN
Gloria Dahlberg, Dandridge, TN
Greg Batts, Cadiz, KY
Guy Larry Osborne, Jefferson City, TN
Harold Andrews, Hiawassee, GA
H. B. McCowan, Clinch River Chapter, Trout Unlimited, Lake City, TN
J. C. Goodwin, Tuscaloosa, AL
Jim Wood, Hiawassee, GA
Joe Brang, Dandridge, TN
John Honey, Dandridge, TN
John S. McClellan, Dandridge, TN
Karen Adamson, Blairsville, GA
William H. Dyer, Paducah, KY
Richard Wagner, Blairsville, GA
Roger Gant, Corinth, Ms
Ron Krammes, Dandridge, TN
Stefan Prada, Morristown, TN
Gunnar F. Wilson

Richard C. "Dick" Crawford, President & CEO, TVPPA, Chattanooga, TN
Sarah A. Francisco and Richard A. Parrish, Southern Environmental Law Center, Charlottesville, VA
Stefan A. Prada, Morristown, TN
Wayne and Sigrid Burge, Athens, AL
William Gazda, Bryson City, NC

RESPONSE TO COMMENTS

Comment noted. TVA appreciates the suggestions of how alternatives could be modified or combined to increase their value and reduce adverse impacts. Those individuals who suggested TVA combine one or more of the recreation alternatives with commercial navigation to reduce adverse environmental consequence overlooked the issue that most of the adverse impacts of the recreation alternatives result primarily from higher and extended pool levels. The Preferred Alternative is a hybrid or blended alternative that was formulated to accomplish many of the changes suggested in these comments.

In response to the suggestion that TVA consider FERC rules, both FERC and TVA rely on the basic elements of the National Environmental Policy Act, specifically consideration of environmental impacts and public participation to incorporate stewardship considerations into their decision-making processes. Section 4(e) of the Federal Power Act requires FERC to give recreation, environment, fish and wildlife, and non-power values the same or “equal” consideration as it does to power and development objectives. By contrast, the TVA Act requires TVA to regulate stream flows primarily for certain non-power objectives: navigation and flood control and, consistent with those purposes, power generation. In addition, TVA must carry out its responsibilities for achieving these three system benefits in the context of its overall regional development mission and the demands of good stewardship, including water quality, water supply, and recreation.

TVA evaluated holding pool levels higher over a range of possible dates as it formulated the alternatives analyzed in detail in the EIS. Dates extending higher pool levels beyond Labor Day into fall resulted in unacceptable levels of increased flood damage and significant impacts on water quality.

In reference to the suggestions to run pilot tests, TVA has long employed an adaptive management approach to the operation of its reservoir system and intends to continue to do this, regardless of which alternative is selected. This involves extensive monitoring of a number of different reservoir and ecological parameters, and flexible application of reservoir operating guidelines that takes into account monitoring results. See Section 3.4 and Chapter 7.

Proposed Project Modifications

Summary of Comments

Most individuals who made comments that recommended modifications to projects mentioned specific summer or winter pool elevations. A few individuals proposed alternatives to the rate and amount to which certain reservoirs are drawn down. These and other proposed changes are listed below. Several of the agencies acknowledged that this EIS is programmatic in nature, but asked that TVA consider as part of the EIS or in subsequent studies various reservoir-specific issues or needs.

Blue Ridge

- Hold summer pool levels at elevation 1,690.

Boone

- Modify Reservoir Recreation Alternative A to provide some improvement on Boone Reservoir.
- Hold reservoir up longer.

Chatuge

- Maintain minimum pool no less than elevation 1,920 beginning in 2003.

Cherokee

- Maintain full summer pool at elevation 1,073.

Douglas

- Maintain minimum winter pool at elevation 960 (2).
- Maintain winter level at 970 to 980.
- Maintain minimum winter pool from elevation 955 to 958.
- Leave winter pool 10 to 30 feet higher (3); drawdown of 40 to 50 feet is excessive; 30 feet should allow for enough flood control.
- Increase winter pool about 10 feet higher than under Reservoir Recreation Alternative B.
- Maintain summer pool levels at least at elevation 990 or above between Memorial Day and Labor Day.
- Limit drawdown to elevation 985 August 1 to September 1, then a minimum of 975 until October 1.
- Limit drawdown to 980 feet from August 1 until Labor Day, then 970 feet until October 1.
- Maintain two-thirds full or less for duck hunting.

Great Falls

- Maintain summer pool at elevation 800 from May 30 through Labor Day.
- Increase winter pool elevation to 795.

Kentucky Reservoir

- Increase winter pool a few inches and more gradually fill and draw down the reservoir, starting when it is normally started, so that reservoir is filled later in spring and reaches winter pool later in fall.
- Begin drawdown from summer pool earlier than the existing Base Case and operate Pickwick and Kentucky Dams in tandem to maximize Kentucky Reservoir's riverine character and maintain biological health of this highly important resource.
- Hold winter level at elevation 356; elevations below 354 create hazards for reservoir users.
- Hold winter pool higher than elevation 354.3.
- Hold winter pool at elevation 356.
- Hold winter pool at least at 357.
- Hold summer pool of 359 and extend it past Labor Day.
- Raise winter pool a few inches; fill to summer pool more gradually, reach summer pool a little later in spring; maintain summer pool about same time; and draw it down gradually to reach slightly higher winter pool. No drastic changes.
- Maintain pool level in January and February at 354; from March to April 1 increase to 356; from April 1 to May 1 increase to 359; stay at that level until Labor Day; from Labor Day until November 1, go down to 356; then from November 1 through December go down to the 354; and back to January and February at 354.

Melton Hill

- Maintain water levels at 794 during the day for boater access.

Norris

- Don't go above elevation 1,020 during boating season because of bank erosion.

Nottely

- Leave at or near full pool (elevation 1,777 to 1,779) until Labor Day.
- Maintain summer levels above elevation 1,775.
- Maintain above 1,775 through Labor Day.
- Extend pool levels at least 6 weeks.

South Holston

- Increase winter pool to 1,702 or higher.
- Keep winter pool level at 1,713 (4).
- Do not drop winter pool level below elevation 1,716.
- Raise summer pool from 1,721 to 1,729.
- Increase summer pool between elevations 1,725 and 1,728.
- Keep pool elevations at 1,720 until Labor Day.
- Limit volume discharged to what is coming in.

Watauga

- Keep Labor Day pool level above elevation 1,949.

Wheeler

- Raise minimum flood guide level to elevation 552.
- Maintain pool levels above elevation 553 for water quality.

Wilson

- Provide additional 3 feet of water at winter pool below Wilson Dam.
- Provide minimum flows.

Commenters

Al Caudell, Marietta, GA
Anonymous
Bill Beutjer, Athens, AL
Bill Faber (Sportsmans Marina), Abingdon, VA
Bob Garrison, Blairsville, GA
Carole Kovich, Benton, KY
Colman B. Woodhall, Johnson City, TN
Dale Hartsell, Newport, TN
Dennis Yates, Baneberry, TN
Garland Wyatt, Benton, KY.
Gary Connaughty, Hiawassee, GA
George A. Gantte, Dandridge, TN
George Chaney, Knoxville, TN
George Cherry, Hiawassee, GA
Gloria Dahlberg, Dandridge, TN
Gordon B. Livingston, Clinton, TN
Greg Robinson, Abingdon, VA
J. Cavagnini, Dandridge, TN
Jackie F and Brenda Sise, Dandridge, TN
Jay and Libby Wise, Johnson City, TN
Jerry Stephens, Bluff City, TN
John Harper, Sikeston, MO
Larry and Karen Clevinger, Dandridge, TN
Mark Fredrick, Murray, KY
Michael Guffey, Seymour, TN.
Michael R. Adamson, Blairsville, GA
Michael Sylva, Del Rio, TN
Michael Sylva Sledjeski, Del Rio, TN
Paul Morris, Benton, KY
Peter Brunson, Killen, AL
Ralph Sheets, Abingdon, VA
Rex Mallory, Bristol, VA
Richard N. Douglas, Benton, KY
Roger Helton, Honaker, VA
Steven L Grubb, Knoxville, TN
Thomas Hodge, Dandridge, TN
Ulf Rheborg, Marietta, GA
Wayne Goodwin, Bristol, TN
Wilbur Neil, Gilbertsville, KY
William E. Hixson, Newport, TN
William T. Moon, White Pine, TN

RESPONSE TO COMMENTS

Although the focus of this programmatic EIS was to conduct detailed analysis on system-wide issues, reservoir specific recommendations that were received from scoping through the DEIS were considered in constructing all of the policy alternatives evaluated in this EIS, including the Preferred Alternative. Due to the infinite number of policy alternatives that could be developed from combinations of these recommendations, not all of the suggestions could be specifically included in the detailed analysis, but the nature of the suggestions was addressed within the context of broader programmatic issues. For example, under the Preferred Alternative, winter flood guides would be raised on Boone, Chatuge, Cherokee, Douglas, Norris, Nottely, South Holston, and Watauga Reservoirs. Also, the duration of the restricted summer drawdown would be extended on Blue Ridge, Chatuge, Cherokee, Douglas, Great Falls, Norris, Nottely, South Holston, Watauga, and Wheeler Reservoirs.

F2.3 Resource Areas

Water Levels for Fish Spawning

Summary of Comments

Most individuals who commented on fish spawning were concerned about the effect of water level fluctuations on fish reproductive success. Most people were critical of TVA's existing reservoir operations, particularly how water levels are drawn down during the spring spawning season. In addition to individual comments, TVA received a petition signed by 4,602 fishermen on Cherokee Reservoir, requesting that TVA stabilize reservoir levels during spring spawn to increase fish populations in all reservoirs in east Tennessee. Several individuals recommended that TVA cooperate with state fisheries agencies to improve fish spawning success. Major issues identified by those commenting on water levels for fish spawning are listed below:

- Stable water levels are critical during spring for fish to spawn.
- A substantial reduction in fish populations is due primarily to drawdown during spawning.
- Water level fluctuations have hurt fish reproduction; the generations of bass, crappie, and other species are lost year after year when water levels are dropped either during or just after spawn.
- Filling reservoirs early and holding them steady would enhance crappie and bass sport fisheries and benefit the overall fish community.
- Tax revenue would be lost because of no fish to catch.
- Decreasing standing stocks of sport fish, such as white and black crappie and largemouth bass, hurts the local economy; visitation of fishermen to the area during the months of March through May and September through November can make or break a resort's business for the year.
- Reduction of shoreline scrub/shrub wetland habitat or buttonbush habitat because of longer periods of full pool levels on Kentucky Reservoir, as well as other mainstem reservoirs, would substantially affect spawning success of white and black crappie and largemouth bass (7).
- Cooperate with the state agencies (e.g., Virginia Department of Game and Inland Fisheries and Tennessee Wildlife Resources Agency) on improving fish spawn (6).
- Petition signed by 4,602 fishermen on Cherokee Lake indicates that changing water levels during spawning time may be destroying eggs and requests stable water levels during fish spawn to increase fish populations in all reservoirs in east Tennessee.
- Request that water levels not be lowered on South Holston during fish spawn (8).
- Ecology of Cherokee and Douglas Reservoirs is suffering as evidenced by a substantial reduction of fish populations.

Commenters

Al Westlake, Athens, AL
Alan Mitchell, Abingdon, VA
Angela Yates, Abingdon, VA
Ann R. Warner, Memphis, TN
Anonymous (2)
Larraine Nobes, Murfreesboro, TN
Larry Akers, Abingdon, VA
Larry Whaley, Dandridge, TN
Lowell Smith, Raven, VA
Martha Atkins, Morristown TN

Ben Sharrett, Abingdon, VA
Bernard Johnson, Dandridge, TN
Bill Coward, New Market, TN
Chris Perkins, Florence, AL
Christine M. Robinson, Abingdon, VA
Don A. Brown, Greeneville, TN
Doug Triestram, Blairsville, GA
Edward Stricklin, Murfreesboro, TN
G. L. and Billie Bowman, Dandridge, TN
Gary D. Jenkins, Buchanan, TN
George A. Gantte, Dandridge, TN
Gilbert Moebes, Decatur, AL
H. R. Nichelson, Cherokee, AL
James Blankenship, Cedar Bluff, VA
James E. Barker, Kodak, TN
James W. McCabe, Dandridge, TN
J. D. Smith, Doran, VA
Jeff Blankenship, Cedar Bluff, VA
Jerri Mitchell, Abingdon, VA
Jimmy and Amy Owens, Dandridge, TN
John Ashe, Hayesville, NC
John Taylor, Springville, TN
Kerry Grissett, Decatur, AL
Mike Harriss, Knoxville, TN
Martha L. Atkins, Morristown, TN
Norman Owen, Murphy, NC
Paul Howell, Selmer, TN
Petition signed by 4,602 concerned fisherman
Ralph Duff, Saltville, VA
Richard L. King, Dandridge, TN
Richard Simms, Chattanooga, TN
Robert Browning, Hayesville, NC
Roger Dixon, Greeneville, TN
Roger Gant, Corinth, MS
Ron Witkowski
S. Dean Yates, Abingdon, VA
Sandy Robinson, Abingdon, VA
Sharon L. McCabe, Dandridge, TN
Steve McAdams, Paris, TN
Sue King, Dandridge, TN
Theresa Toney, Cedar Bluff, VA
Tom A. Yates, Bristol, VA
Vincent L. and June D. Greaves, Blairsville, GA
Wayne K. King, Dandridge, TN
William McIntsosh, Blairsville, GA

RESPONSE TO COMMENTS

As discussed in Section 4.7.2, TVA has a program to stabilize water levels as the water temperature at a depth of 5 feet reaches 65 ºF. Attempts are made to minimize water level fluctuations (maintain level within 1 foot per week, either higher or lower) for a 2-week period. TVA proposes to adjust this routine, beginning in 2004, to stabilize levels at 60 ºF in order to better include spawning for crappie, smallmouth bass, and early largemouth and spotted bass. Minimizing water level fluctuations is only one part of the fish spawning issue. Other environmental characteristics are also important in determining the numbers of larvae and juvenile fish produced. Factors after spawning, such as the amount of food and cover available for much of the initial growing season, are also critical to determining the number of catchable fish. TVA cannot limit fluctuations during the entire spawning season because of unacceptable impacts on flood risk and achieving other operating objectives for the TVA system.

Migratory Shorebirds

Summary of Comments

Most individuals whose comments related to migratory shorebirds expressed concern about changes in TVA's drawdown policy to reduce or eliminate flats and other critical habitats for migratory shorebirds, as well as herons, egrets, bald eagles, peregrine falcons, waterfowl, and other species. Accordingly, most were opposed to any changes in TVA's existing policy, (i.e., they supported the Base Case). They recommended that if the existing policy is changed, TVA should conduct additional evaluations of baseline conditions and potential impacts of alternatives, document the results in the FEIS, and mitigate any loss by providing a comparable or greater amount of habitat elsewhere across the reservoir system. The primary concerns of these commenters are listed below:

- Flats on Douglas (Rankin Wildlife Management Area), Chickamauga (Hiwassee Wildlife Refuge) Wheeler (Wheeler National Wildlife Refuge) and Kentucky (Tennessee National Wildlife Refuge) Reservoirs are important stopovers for wading birds, shorebirds, and waterfowl during migration.
- Changes in the existing policy to extend water levels through Labor Day will greatly reduce or potentially eliminate flats and other critical feeding and resting habitats for migratory species during peak migration.
- Late summer shallows are important for juvenile and adult wading birds that breed in the area.
- TVA does not have comprehensive survey or inventory data. If an alternative other than the Base Case is selected and implemented, TVA should compile all known data on species occurrence, numbers, alternative sites, and alternative site utilization for the project area, and also assess the potential for reservoir habitat loss and shorebird use for each alternative.
- TVA should evaluate the potential to avoid impacts on certain high-quality areas and nominate these areas as Important Bird Areas.
- Mitigate loss through creation of other suitable habitat; there should be no net loss of these areas in any modified river system operations plan.
- Evaluate (research if necessary) the use of areas and impact of habitat loss to shorebird energetics during migration.
- Consider the economic benefits from birders.

Commenters

Anonymous
Barabara G. McMahan, Chattanooga, TN
Benny Thatcher, Knoxville, TN
Bettie Mason, Knoxville, TN
Charles Musde, Maryville, TN
Charlotte E. Lackey, for WNC Group, NC Chapter, Sierra Club, Asheville, NC
Christine Liberto,
Clayton Ferrell, New Johnsonville, TN
Dan Feathers, Nashville, TN
David A. Aborn, Ph.D, Chattanooga, TN
David Vogt, Chattanooga, TN
Dr. K. Dean Edwards, Knoxville, TN
Dwight Cooley, Athens, TN
Elizabeth Wilkinson-Singley, Kingston, TN
Gary D. Jenkins, Buchanan, TN
Gaynell Thomas, Del Rio, TN
James K. Luce, M.D., Amarillo, TX
Jay Desgrosellier, Nashville, TN
J. Don Burgess, Killen, AL
Charles Muise
Jerry Hadder, Oak Ridge, TN
Jim Garner, Madison, MS
Kelly, Knoxville, TN
Kevin Calhoon, Chattanooga, TN
John Taylor, Springville, TN
Leslie J. Gibbens, Del Rio, TN
Linda Wright, Cosby, TN
Marian Fitzgerald, Maryville, TN
Mary Stevens, Jackson Audubon Society, Jackson, MS
Michael A. McMahan, Chattanooga, TN
Michael Smith, Gallatin, TN
Michael Sylva Sledjeski, Del Rio, TN
Michael Todd, McKenzie, TN
Robert Wheat, Paris, TN
Ruth Pullen
Shirley Cunningham
Steve McCadams, Paris, TN
Thomas and Marian Fitzgerald
Wayne Patterson, Shannon, MS
Noreen Kenny

RESPONSE TO COMMENTS

As noted in Section 5.10, most of the identified alternatives would affect flats and other habitats used by migratory shorebirds and other wildlife. Concerns for impacts on migratory species were considered in developing the Preferred Alternative. The Preferred Alternative would eliminate most of the proposed increases in winter pool levels on mainstem reservoirs, including Kentucky Reservoir. Accordingly, the Preferred Alternative would result in fewer impacts on flats and other critical habitats of migratory shorebirds. The FEIS includes additional analysis and information to address the issue. Issues regarding surveys and data gatherings are addressed in the Terrestrial Ecology section in Appendix F3.

Shoreline Erosion

Summary of Comments

Most individuals who expressed general concern about soil erosion indicated that higher and more constant water levels could reduce erosion, especially during the peak of the boating season. Their concerns included loss of land, loss of shoreline vegetation, bank slumping, and sedimentation that could occur due to wind- and boat-generated waves, fluctuating reservoir levels, and exposure of soil in winter months under TVA's existing operations policy. These and other concerns are listed below:

- Reservoirs should be maintained at constant level to prevent erosion.
- Shoreline is lost every year as lakes are lowered; shoreline erosion goes unabated.
- Change in water levels during boating season subjects the entire shoreline to erosion.
- Trees and other native vegetation are being lost due to bank slumping from undercutting of the banks.
- When water levels are held high during the boating seasons, erosion occurs mostly at a single point with little if any "undercutting."
- Higher lake levels in winter covers flats and reduces erosion and sedimentation.
- On Douglas Reservoir, banks are eroding at a very fast rate due to extreme drawdown.
- Boat traffic is a major contributor to shoreline erosion on Lake Nottely; it appears that there is more erosion when the lake levels are below full pool, than at full pool.
- High water is ruining the shoreline on Lake Blue Ridge; shoreline is eroding and trees are collapsing into the water.
- As a lakefront homeowner, I am very concerned about the amount of erosion we have experienced in the past several years.
- If the levels were left at more consistent levels or at full pool, property owners could better control the erosion of their individual properties.
- TVA should provide information and assistance to residents on how to stop erosion.

Commenters

Anonymous (2)
Bill Dearing, Ooltewah, TN
Charles Butler, Powder Springs, GA
Chuck Kinard, Morristown, TN
Colman B. Woodhall, Johnson City, TN
David and Marylin Miles, Dandridge , TN
Doug Triestram, Blairsville, GA
Freda Wycoff, Abingdon, VA
Howard Lowden, Rome, GA
Jack Miller, Hiawassee, GA
James F. Smith, Ringgold, GA
Jane Chinnici, Hiawassee, GA
John Taylor, Springville, TN
Joe Depew, Kodak,TN
Larry Mancini, Blairsville, GA
George Latham
Lee S. Horne, Lebanon, VA
Mark Patterson, Brentwood, TN
Michael A. O'Brien, Kennesaw, GA
Mr. and Mrs. D. C. Wenberg, Blairsville, GA
Robert Taylor, Dandridge, TN
Susan Goodman, Dandridge, TN
Patti Grubb, Knoxville, TN
Paul Howell, Selmer, TN
Roger W. Hill, Jr., Blairsville, GA
Sally Bobo, Hiawassee, GA
Sharon L McCabe, Dandridge, TN
Steve McCadams, Paris, TN
Thomas G. Sandvick, Morganton, GA
Thomas L. Parker, Murphy, NC
Tony E. Branan, Hiawassee, GA

RESPONSE TO COMMENTS

Comment noted. Shoreline erosion is an unavoidable consequence of changing water elevations, wind- and boat-generated waves, and freezing and thawing of exposed shore lands. Although there is a slight water quality impact from this erosion, it is small compared to the sediment contributions from the watershed. Because TVA's Preferred Alternative would result in higher winter flood guides, erosion is likely to decrease in the most sensitive, low-lying areas because less area would be exposed. The text in Section 5.16 has been changed to clarify this.

Additionally, TVA has an ongoing program to assess, prioritize, and repair eroding TVA-owned shoreline. TVA Watershed Teams work with local communities and property owners to address problem areas on tailwater banks. Watershed Teams provide technical support and help with obtaining funding. In addition to traditional riprap, TVA supports the use of bioengineering and natural channel design techniques to enhance habitat and aesthetics, while stabilizing shoreline and channels. These efforts are ongoing and might be expanded if the alternative chosen is shown to increase erosion rates.

Economic Analysis and Adverse Effects on Jobs and Local Economy

Summary of Comments

A number of individuals questioned the credibility of the economic analysis. They rejected the determination that increasing recreational opportunities by extending summer pool levels would result in negative impacts on the economy and a net loss of jobs. On the contrary, most indicated that higher and longer reservoir levels would expand tourism and development in their local communities and, as a result, create additional jobs and increase revenue for the local economy. Typical comments provided by those critical of the economic analysis are listed below:

- I disagree with the adverse effects on jobs.
- Can't imagine how an economist would conclude that jobs would be less with longer recreational periods.
- The economic analysis showing a net economic loss under plan A or B is not credible.
- I don't understand the negative impact on jobs that are indicated in the study.
- I think you have vastly underestimated the effects of jobs, as I think it would create a very positive job market, not negative.
- Leaving lake levels up for longer periods of time would not have a negative economic impact.
- Contrary to your study, the greater number of users on and around the lake shorelines, the greater number of jobs would be created for the people in these rural areas.
- Contrary to what your economists have stated, the retaining of more consistent lake levels would be an economic boon to the area.

Commenters

Anonymous
Charles Butler, Powder Springs, GA
Chuck Kinard, Morristown, TN
Colman B. Woodhall, Johnson City, TN
David and Marylin Miles, Dandridge , TN
Doug Triestram, Blairsville, GA
Freda Wycoff, Abingdon, VA
Howard Lowden, Rome, GA
Jack Miller, Hiawassee, GA
James F. Smith, Ringgold, GA
Jane Chinnici, Hiawassee, GA
John Taylor, Springville, TN
Joe Depew, Kodak, TN
Larry Mancini, Blairsville, GA
Lee S. Horne, Lebanon, VA
Mark Patterson, Brentwood, TN
Michael A. O'Brien, Kennesaw, GA
Mr. and Mrs. D. C. Wenberg, Blairsville, GA
Robert Taylor, Dandridge, TN
Susan Goodman, Dandridge, TN
Patti Grubb, Knoxville, TN
Paul Howell, Selmer, TN
Roger W. Hill, Jr., Blairsville, GA
Sally Bobo, Hiawassee, GA
Sharon L McCabe, Dandridge, TN
Steve McCadams, Paris, TN
Thomas G. Sandvick, Morganton, GA
Thomas L. Parker, Murphy, NC
Tony E. Branan, Hiawassee, GA

RESPONSE TO COMMENTS

There is no doubt that an extended recreation season on tributary reservoirs would result in job creation in the areas around those reservoirs, particularly in the recreation and tourism industry and retail sales. However, the TVA region as a whole would be negatively affected by Reservoir Recreation Alternatives A and B, because a loss of hydropower generation would increase power costs. These increased costs drive up the cost of doing business in the Tennessee Valley, the result of which would be jobs lost, either through plant relocation, job reduction, or slower job growth (as compared to the Base Case).

While coal-fired and nuclear plants provide the base load of TVA's power production capabilities, hydropower is used to meet peak demands. The water that turns turbines at tributary dams continues to generate electricity at each location downstream. If that hydropower capability is reduced as a result of holding tributary pool levels up longer, TVA must replace that power by either generating it using other means (typically gas turbines) or buying it off the national grid at market rates. Either proposition is more expensive than hydropower generation, especially in August when annual demand is at its greatest. TVA costs are paid for by its power consumers. Increased power costs are passed along to customers.

Although the percentage is small, the actual change in the cost of doing business for industrial customers purchasing hundreds of thousands of dollars of electricity every day could be millions annually. These industries compete with others outside the region, so they might, in turn reduce their workforce, add fewer jobs than would occur under the Base Case, or relocate in order to remain competitive. Consequently, extending summer pool levels would increase the number of lower-wage, seasonal jobs in areas around the tributary reservoirs but decrease the number of higher-wage, permanent manufacturing jobs elsewhere in the TVA region. From a regional perspective, the economic losses would outweigh the economic benefits.

F2.4 Out of Scope

Logs and Debris

Summary of Comments

Several individuals expressed concerns regarding the large amounts of floating logs and debris when pool levels are raised and their accumulation along shorelines when pool levels are lowered. They commented on how the amount of trash and debris continues to grow, creating increasing hazards for boaters and night fishermen. Several indicated that the problem was too large for a few concerned citizen groups and property owners, and suggested that TVA and other agencies should address the problem. Suggestions to address the problem are listed below:

- Provide revenue to address the problem.
- Create jobs so that someone is constantly working on the problem.
- Use prison inmates to cleanup the shoreline.
- Work with other agencies, such as the Corps, to remove logs and debris, especially big logs and large objects in the water, which are dangerous to boaters.

Commenters

Anonymous (2)
Clarence R. Bailey, Dandridge, TN
Jeff Cabe, Robbinsville, NC
Sharon Chilson, Bryson City, NC
Don Cross, Bluff City, TN
Laurie Danko, Dandridge, TN
Louis Duval, Dandridge, TN
Fred Frazier, Bluff City, TN
Mike Harriss, Knoxville, TN
Alice Jane Jesseel, Abingdon, VA
Jerri Mitchell, Abingdon, VA
Dianna Mullins, Bristol, TN
Karen Niehaus, Cadiz, KY
Norman Owen, Murphy, NC
Jean Prater, Athens, AL
Mrs. Jean Roberts, Morristown, TN
Mark Wiggins, Cordova, TN
Jay Wise, Johnson City, TN

RESPONSE TO COMMENTS

TVA agrees that the presence of floating logs, trash, and debris on TVA reservoirs and shorelines is a serious problem, particularly after heavy rains and sudden increases in water levels. Most of the debris originates on land and enters the rivers and streams due to erosion, rainfall runoff, and improper disposal practices. Effective combative measures require a concerted effort by the general public, reservoir users, TVA, and other organizations to conduct cleanup projects and public education campaigns, and to enforce laws related to littering and dumping trash. To help address this problem, TVA actively works in partnership with reservoir users, other citizen groups, and local agencies to plan and implement cleanup of shorelines before the reservoir level rises each spring. It is commendable when property owners take the time and effort to clean up the shoreline in front of their lots. Reservoirs by nature contain hazards that may not be visible to all users. While TVA tries to identify and mark permanent hazards that could affect a large number of users, use of TVA reservoirs by the public is at the risk of individual boaters.

Boater Safety

Summary of Comments

Three individuals expressed concern regarding snags, stumps, and other submerged objects posing safety hazards for boaters if pool levels are changed, especially in small inlets and backwater areas. They noted that adding 2 feet of water to winter levels will have serious consequences to boaters, as stumps that normally are out of the water in winter pool, or deeper in summer pool, become just out of site, but within the draft of a boat. They recommended that backwater areas laced with stumps be marked in some way, or that the stumps be physically removed to protect recreational boaters from the hazards associated with travel in those areas. One individual suggested that TVA come out in favor of age restrictions for boats and other powered watercraft.

Commenters

Mark Cole, Athens, AL
Candy Cox Ellis, Bristol, VA
H. Lee Fleshood, Nashville, TN
John Gustafson, Decatur, AL
Chip Miller, Hixson, TN
Larraine Nobes, Murfreesboro, TN
James D. Wheeler, M.D., Dandridge, TN

RESPONSE TO COMMENTS

TVA recognizes that when the reservoir levels are raised or drawn down on certain reservoirs, submerged hazards may become more problematic to boating safety. This occurs at a time when the majority of the recreating public has reduced their use. There are inherent risks in recreation activity. TVA makes an effort to mark particularly hazardous underwater obstructions; however, use of TVA reservoirs by the public is at the risk of individual boaters. State agencies are primarily responsible for regulating usage and safety of watercraft and should be contacted about setting age restrictions on watercraft use.

Jet Skis

Summary of Comments

Several individuals expressed concern and frustration regarding jet ski operators. Concerns focused on operators having no regard for property owners who live on the lake, shoreline damage and safety hazards they cause, possibly restricting them to certain areas on lakes, and operators being under age.

Commenters

Tony E. Branan, Hiawassee, GA
Barbara Phillips, Lexington, KY
Frank Stahlkuppe, Hiawassee, TN
Earl L. Card
D. C. Wenberg, Blairsville, GA
Joanne Wenberg, Blairsville, GA
Roger W. Dixon, Young Harris, GA

RESPONSE TO COMMENTS

Comment noted. State agencies, not TVA, regulate watercraft operations on TVA reservoirs.

Water Pollution

Summary of Comments

Water pollution concerns were raised by several individuals around Boone, South Holston, Hiwassee, and Chatuge Reservoirs, and elsewhere. Sewer outfalls and runoff from hog and cattle farms were mentioned as particular problems. A few commenters asked whether TVA has a role in addressing these issues; others requested that TVA take a more active role in monitoring and policing lakes for violators.

Commenters

Anonymous
Angela Boyda, Abingdon, VA
Louis Duval, Dandridge, TN
H. Lee Fleshood, Nashville, TN
Fred Frazier, Bluff City, TN
Jeff Garner, Florence, AL
Barbara Garrow, Dandridge, TN
Brian Mazzei, Abingdon, VA
Steven J. Milcheck, Mooresburg, TN
Larraine Nobes, Murfreesboro, TN
Jean Prater, Athens, AL
K. Pindzola, Johnson City, TN
Alice Russell, Hayesville, NC
[I] Tolly G. Shelton, Decatur, AL

RESPONSE TO COMMENTS

This EIS focuses on the reservoir system operations policy, not issues of the type identified by those commenting on water pollution. However, TVA is aware that both failing septic systems and runoff from cattle operations can adversely affect water quality. Through its Clean Water Initiative, TVA is developing partnerships with regulatory agencies, the general public, local officials, industries, and other others to enhance water quality in the Tennessee Valley.

Appendix F3

Response to Specific Public Comments

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Table of Contents

List of Acronyms

cfs	cubic feet per second
Corps/USACE	U.S. Army Corps of Engineers
DEIS	Draft Environmental Impact Statement
DO	dissolved oxygen
USEPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
ROS	Reservoir Operations Study
SMI	Shoreline Management Initiative
TVA	Tennessee Valley Authority
TWRA	State of Tennessee Wildlife Resources Agency
USFWS	U.S. Fish and Wildlife Service

F3 Response to Specific Public Comments

This section contains specific individual comments followed by TVA's response. Comments are arranged by alternatives and study areas. Each comment identifies the author and original comment by number. TVA staff has provided a response related to every substantive comment, either individually or by clusters of clearly related comments.

F3.1 Alternatives

Base Case

1. The Base Case presented does not provide enough info to tell us what the current operating policies are. "Target dates and target elevations" don't tell us anything. I do not see how anyone can make an intelligent comment when the Base Case is not presented. The Alternatives can not be properly evaluated unless we know what the current operating policies are. **Bill Beutjer, 2554**

Response to Comment 1: The Base Case operations policy is described in Chapter 2 of the DEIS, and Appendix C contains detailed tabular and box plot data that show probable elevations for the Base Case and each alternative. In response to public comments, flood guide curves that show probable elevations for the Base Case and TVA's Preferred Alternative have been added to Appendix C.8.

2. It was difficult, indeed impossible, to select an alternative, or even two or three alternatives. Choosing an alternative to enhance one area of the environment almost always adversely affected another when straying from the Base Case. The most logical solution would be Adaptive Management. We don't know the outcome in some of the cases. Let us try for a period of time to see what works best. I hope you will take these comments seriously. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3108**

Response to Comment 2: TVA has long used an adaptive management approach to the operation of its reservoir system and intends to continue to do this, regardless of which alternative is selected. This involves extensive monitoring of a number of different reservoir and ecological parameters, and flexible application of reservoir operating guidelines that takes into account monitoring results. See Section 3.4 and Chapter 7.

3 My overall observation is that none of the 8 alternatives evaluated in detail stand out as a definite enhancement over how TVA operates the system currently. If that is the case, i.e., if the current policy cannot be improved upon and there is consensus that it was a fair and balanced assessment, as I believe it is, will TVA's critics and the TVA board be willing to accept "no action" as the preferred alternative for the FEIS? **Gary Hauser, 68**

Response to Comment 3: All eight alternatives identified in the DEIS and the Preferred Alternative identified in the FEIS were evaluated in detail to determine whether they met the criterion of increasing the overall public value.

4. This [Base] Case calls for a very low drawdown of the tributary lakes (November - December) when flood risk is negligible and peak power production is the least needed. Summer levels are acceptable to reduce electrical rates, as long as drawdowns are somewhat limited prior to Labor Day. **Greg Worley, 1346**

Response to Comment 4: TVA's Preferred Alternative strives to increase recreational opportunities on a number of reservoirs by restricting drawdowns through Labor Day and allowing higher winter flood guide elevations, as determined by the flood risk analysis.

Reservoir Recreation Alternative A

1. This comment is submitted on behalf of The United Company, a privately held corporation located in Bristol, Virginia, which owns Camp Sequoya, a girl's camp located on 50 acres of lakefront property at South Fork Holston River Mile 64. Camp Sequoya was established more than 75 years ago by Sullins College as a private camp where young girls and young women would be allowed to flourish in a safe, nurturing environment.

Throughout its history, Camp Sequoya has attracted generations of campers from across the United States, and many foreign countries. One of the strengths of the camp is the diversity of the backgrounds of its campers, each of whom returns to their respective homes at the end of each summer as an ambassador for the beauty of South Holston Lake and the surrounding area. The camp is the only facility of its kind on South Holston, and to our knowledge, is unique in its proximity and access to the TVA waterways.

Throughout the years, Camp Sequoya has managed its operations in relative harmony with the TVA's operations of its South Holston Reservoir. Much of the Camp lies within the TVA easement below the 1747 foot elevation mark, which accommodation was reached when the TVA approved the construction of certain camp facilities in its easement.

The camp, which is in the peak of its operations during the summer season when schools are out of session, is affected dramatically when the elevation of South Holston approaches the 1729 level. At this elevation, the camp's swimming pool is rendered nearly unusable, as the pump equipment is at this elevation. At 1732 elevation, the camp pool, which is one of its primary attractions, is underwater. At this higher lake level, access to the isthmus portion of the camp property is also cut off as the access road is likewise underwater. Consistently higher pool levels in the summer season will threaten the economic viability of the camp.

For these reasons, The United Company and Camp Sequoya are concerned about the ROS alternatives that project higher levels for the summer pool in South Holston. For example, Recreation Alternative A would increase the number of days that the camp pool would be underwater during June, July and August. Under the Base Case, the South Holston summer pool level peaks in late May and early June, which generally has minimal impact on camp operations.

We certainly recognize that by virtue of the easement agreement between the TVA and the Camp, complaining about the impact of reservoir levels on camp operations may not be compelling. However, we wished for the TVA to understand that Camp Sequoya campers and their families who visit the area to drop off campers and pick them up, are just the type of visitors that this area needs -- people who appreciate the natural beauty of the lakes and mountains, and choose this area over scores of others, to send their daughters to learn about teamwork, fellowship, nature, self-sufficiency, self-image and themselves.

In concluding, we believe that the Base Case Alternative, which has been the manner in which the South Holston Reservoir has been managed very well for more than a decade, is the best alternative to pursue. We therefore wish to add our voice to those who oppose raising the summer pool levels in the manner contemplated by Reservoir Recreation Alternatives A & B, the tailwater recreation and habitat alternatives, and the Equalized Risk alternative. **Brian Sullivan, 3120**

Response to Comment 1: Under the Preferred Alternative, the flood guide for South Holston Reservoir in late spring and summer has not been modified from the existing operation.

2. I do not fully understand the differences between the Reservpor Recreation Alternatives A and B. I would like to communicate that as a homeowner, small business owner, and permanent resident of Towns County, I would like to see Lake Chatuge stay at the highest water level possible throughout the year. This would benefit the businesses of Towns County in many ways, make the lake recreational year round, and increase the look of the area. I would tend to think that Plan B would accomplish these things, but as I stated earlier, I do not understand the report enough to draw that conclusion. I want the plan that would keep the lake level up year round. Please take my comments into consideration when making a decision about Lake Chatuge. **Denise N. Gladfelter, 518**

Response to Comment 2: The major difference between Reservoir Recreation Alternatives A and B regarding summer pool levels on Chatuge is that Reservoir Recreation Alternative B would provide a higher median pool elevation on Labor Day than Reservoir Recreation Alternative A. TVA did evaluate holding reservoir levels higher year-round; however, this would result in unacceptable flood risks.

3. Allowing the TVA lake and river levels to remain high in summer and winter would greatly increase their recreational value and use. Property values and development would increase around them as a result. This would help the economies of the surrounding areas.

I work for Georgia Power and Southern Company. I have seen what the Georgia Power lakes such as Burton and Rabun have meant to the economies of the counties around them. I can only assume that this would happen for TVA's lakes if recreation is made a primary purpose also

I realize that when the dams and lakes that make up the TVA system were created, flood control, navigation and power generation were the primary purposes for the system.

It is my opinion that due to the tremendous population growth the south has seen in the past 50 years, recreation will have a much higher priority than in the past. The mountains and lakes of Appalachia are where the people of the South choose to play.

The political pressure to make recreation a primary purpose for the TVA lakes and rivers will only increase in the future.

I call upon you - the leaders of TVA to be proactive and make that change today!

Michael P. Van Winkle, 680

Response to Comment 3: TVA developed its Preferred Alternative in an effort to enhance recreational opportunities on its reservoirs and the associated economic benefits, while lessening the potential impacts on other important values and benefits associated with alternatives in the DEIS—such as water quality and flood risk reduction. The primary purposes for which the TVA reservoir system is operated were established by the TVA Act.

4. Under my study of 2002 that I sent to TVA, this plan would fall with in my predictions for Douglas Reservoir. I live on Douglas at river mile 61 left. **Philip Davis, 716**

Response to Comment 4: Comment noted.

5. The possibility of Alternative A is the best news we in the navigation business have gotten from TVA in over 40 years. There are innumerable reasons for an additional 2 feet of water at minimum winter pool levels and no apparent reasons not to change the minimum levels. Some of the advantages to navigation, and the river's other users as well, are**:**

The 2 feet additional depth would eliminate all the choke points on the main river, i.e., below Pickwick Dam, Florence cut and the canal below Wilson Dam, the rock reach below Guntersville Dam, problems below Nickajack, and all the low water problems between Chattanooga and Knoxville. The choke points limit an otherwise 10' plus useable channel. It seems wasteful to let choke points adding up to less than 50 miles of river dictate the usability of the remaining 600 miles of the Tennessee River. Actually, the load draft is limited all the way from origin.

The 2 feet additional depth will mean that barges will not have to "lite load" for the Tennessee River, thereby putting Tennessee River users at an automatic rate disadvantage. (TVA coal will probably be the single biggest benefactor).

The 2 feet additional depth will enable more tonnage to transit our congested locks in the same number of lockages, i.e., a 15-barge tow that is held to 9' draft rather than 10' draft is sacrificing 17 ½ feet of cargo handling capability or over 1 ¾ extra barge loads equaling over 12%. This would mean an automatic 12% decrease in lockages required to move the same tonnage, saving our equipment time, wear and tear on old locks and dams, saving wasted lockage water, etc.

The 2 feet additional depth would make the Tennessee River much safer. The Tennessee River is a major hazardous liquid material artery. More water would vastly increase the safety factor in handling these hazardous barges.

The 2 feet additional depth would be a significant safety factor for our towboats themselves. Since there are no midstream fuelers on the Tennessee River, the towboats going to the Tennessee must take on at least 10 days of fuel prior to entering the river. This means that for the first few days of a trip during “winter low pools” our towboats are drafting deeper than their tow of barges. This is certainly not desirable now “best practices.” It is usually much more serious when the towboat is disabled or holed than when a barge(s) is grounded.

The additional 2 feet of water at minimum pool would be a great help to all of our river dock customers and would greatly lessen the need for dredging, thereby appealing to environmental concerns.

The fact that the Tennessee River is known as a “lite load river” undoubtedly has cost the area some industry. If everything else is equal, a plant on the Ohio or Illinois rivers has an advantage of heavier draft and thereby lower transportation costs. There is no appreciable difference in our boats costs shoving a 9’ draft tow and a 10’ draft tow if there is enough water. **Tennessee Valley Towing, Inc., Bill Dyer, 3717**

Response to Comment 5: The purpose of increasing channel depth in the winter pool time frame was to provide added benefits to navigation on the Tennessee River. However, detailed flood risk analyses indicated that raising the mainstem reservoirs by 2 feet in winter would result in an unacceptable flood risk. The Preferred Alternative provides for a 1-foot increase in channel depth at Kentucky Tailwater to elevation 301 feet by controlling releases at Kentucky Dam and raising the minimum winter pool depth at Wheeler by 6 inches.

Reservoir Recreation Alternative B

1. The actual resulting Water Level Elevations would be a very important clarification when presenting the alternatives. I.e. - Great Falls Dam Reservoir Summer Pool Level of 800 ft. would be extended to June 1 through Labor Day of each year ... and the winter pool MINIMUM water elevation would be increased from 785 ft. to 795 ft. ... suggest this be applied throughout the Alternatives discussing the TVA Great Falls Dam Reservoir at least. You folks have been doing an excellent job in this "Milestone" Project. Would accept Reservoir Recreation Alternative B with these discussed changes. **Dan Fairfax, Representative of Rock Island Shores Property Owners, 1982**

Response to Comment 1: Under the Preferred Alternative presented in the FEIS, Great Falls would have a planned operating level of 800 feet from Memorial Day through the end of September, and the winter minimums would be set at elevation 785. Due to hydrologic characteristics of the reservoir and contributing watershed area, however, much of the time the reservoir levels would be substantially higher than 785 feet. Allowing the pool to be lowered to 785 feet by hydroelectric generation as often as possible during this period provides additional benefits to TVA power consumers during a time of the year when recreation is less critical.

2. The lake elevations are very important to my family. The extended summer elevations through labor day will add value to my property and allow me to use my lake front property for a longer period. I would like to have the following charts shown during one of the presentations for Wheeler lake**:**

- Flow chart for options A & B base
- Elevation charts for options A& B& Base
- Generation capacity for option A & B & Base

I would like to get the above charts for the main stem lakes combined also **Gail Spurgeon, 2305**

Response to Comment 2: Probability elevation plots along the flood guide curves for the tributary reservoirs and the operating guide curves for the mainstem reservoirs have been included in Appendix C for both the Base Case and the Preferred Alternative.

Equalized Summer/Winter Flood Risk Alternative

1. Was the original intent and origination of TVA to control waters to prevent flooding along with the opportunities of commercial navigation and power supply? If this is true, and the original goal of TVA, there is only one alternative that reduces the risk of flooding, (Equalized winter/summer flood risk), with minimal increase or decrease for optional benefits. **Lane Marte, 2354**

Response to Comment 1: Section 9a of the TVA Act establishes the priorities for operation of the TVA reservoir system. The primary priorities are navigation, flood control, and the generation of power. Consistent with meeting those priorities, TVA also operates the system to meet other goals, such as water quality and recreation. Under the Preferred Alternative, potential damages from flood events with less than a 500-year frequency are lower than under the other action alternatives, and essentially the same as under the Base Case.

2. When did TVA go to a 500-year inflow? What is the variance when comparing the 500-year inflow, and the 100 year inflow? Since Blue Ridge lake is only 73 years old, where did tva get statistics from 500 years ago. To me it sounds like TVA did this, to have as large a "cushion" as possible for justification when it decides on lake levels.

The description of "lower summer pools" and "higher winter pools" is totally vague. I believe all users of Blue Ridge lake as well as the other TVA lakes would welcome fairly stable lake levels as long as those levels would not make land owners and public-use areas non-navigable to recreation boats and docks. **Thomas G. Sandvick, 2655**

Response to Comment 2: TVA selected the 500-year flood level as an objective means of comparing the flood damages associated with large flood events. A 100-year continuous period flow record was established from historical stream gage data, and then analyzed using standard hydrologic statistical techniques to estimate flood inflow volumes. Using the 500-year flood inflow is appropriate, in light of the direction in the TVA Act to operate the reservoir system primarily for flood control (as well as for navigation and power generation). Reservoir levels vary for many reasons such as heavy rainfall and runoff, power demands, and meeting downstream minimum flow targets and navigation needs.

Commercial Navigation Alternative

1. Do the numbers in the EIS include navigation levels for Kentucky? Very difficult to determine from text. Assume Corps did not allow Kentucky to be included. Would make report more straight forward to say 2 feet increase Ft. Loudoun through Pickwick. **Arland Whitlock, 565**

Response to Comment 1: Seasonal levels for all projects, including Kentucky, for all alternatives are shown in Appendix C. Several agencies, including the Corps and other individuals, objected to changing levels on Kentucky Reservoir. TVA's Preferred Alternative would not change operating guide curves on Kentucky.

2. It is extremely disturbing to discover the fact that TVA did not broaden the scope of their study, which they are currently performing, for other adverse affects downstream of Savannah. Increased water flow into the Tennessee River, which in turns increases water flow on the Ohio River which in turns increases water flow on the Lower Mississippi River. During high water months, navigation on the Lower Mississippi River becomes extremely difficult due to increased water flows. Towing companies are unable to efficiently move barges up and down stream on the Mississippi River during high water conditions. During normal water conditions, a 20 barge tow can be pushed with a 4,000 horsepower towboat (approximately 200 horsepower/barge). However in high water conditions, the same 20 barge tow can only be pushed with a 5,000 horsepower towboat (approximately 250 horsepower/barge). Many towing companies are unable to offer such an option of increased horsepower so they have to limit the size of their tows or they will add a helper boat to the tow in order to gain the needed horsepower to move the 20 barge tow. The increased water flows also greatly escalates the risk for a tow to collide with bridge piers on the Ohio and Lower Mississippi Rivers. **Eddie Adams, 3033**

Response to Comment 2: As explained in Section 5.22, TVA's analysis did extend downstream of Savannah, Tennessee. The Corps expressed concerns about changing operations on Kentucky Reservoir because of the potential effect on the lower Ohio and Mississippi Rivers. Its position is that any proposed changes that would involve reduction in flood storage capacity would need to be evaluated within the context of the entire lower Ohio/Mississippi River system. Flow changes, if any, from Kentucky Reservoir and/or Barkley during high-flow periods are expected to be minor and should not impede navigation. TVA did not include changes to the operating guide curve for Kentucky Reservoir as an element of its Preferred Alternative.

3. Commercial benefits seem somewhat obsolete despite all of the supporting information. We do not believe river commercial navigation is either economical or practical considering the impending scarcity of water. Wasting water on navigation is somewhat scurrilous. **George Pisciotta, 1871**

Response to Comment 3: See Section 4.21 for a discussion of commercial navigation benefits. Water used to support navigation serves a number of different objectives, including maintaining water quality.

4. The way that I understand this Alternative, Kentucky Lake reservoir elevation would be 356' during the winter months and the drawdown from summer pool would be much later than the base case. If that is the case, I would be in favor of this Alternative. **John De Freitas, 3082**

Response to Comment 4: TVA's Preferred Alternative does not include changes to the operating guide curve for Kentucky Reservoir.

5. If the pool level could be maintained at a higher level, barge traffic in the Guntersville pool would be improved. My company, USG, Bridgeport, Al. is adversely affected when low water pool levels are experienced. We receive 100 % of our raw material, synthetic gypsum by barge. We experience difficulties in maintaining barge deliveries when the water pool level falls below 594 MSL. In addition during power generation peak periods, we experience rather severe water level fluctuations on an hourly basis. This not only interferes with barge delivery schedules but also creates safety issues for barge handling personnel. **Larry Pawlosky, 2197**

Response to Comment 5: None of the alternatives analyzed in detail, including the Preferred Alternative, would change elevations for Guntersville Reservoir headwater because of the limited flood storage available. Steady water releases, such as those that would occur under the Tailwater Habitat Alternative, were found to result in an unacceptable cost to power and power system reliability. Dredging at the dock to ensure adequate depth and provision of adequate and safe mooring facilities are the responsibilities of the dock owner.

6. 1) One of the things that is causing this [shoreline erosion] to come up is barge traffic. Barges don't operate in the sloughs even in the summer, and the channel stays at a relatively fixed level. Increasing water levels in the reservoir will only fix the problem for a short time - until the channel fills again. It is likely that the increased washing on the shore will advance the rate of sedimentation or silting. The channel should be deepened by dredging, not by changing the ecology of the river. **Mark Cole, 2077**

Response to Comment 6: Wave action from barges does contribute to shoreline erosion. However, barges produce a smaller wake than large V-hulled recreational boats because they have a flat bottom and travel at slower speeds. Other factors contributing to erosion and sedimentation are addressed in Sections 4.16 and 5.16. The Corps dredges the channels periodically, but resource limitations preclude the use of dredging throughout the reservoir system with sufficient frequency to "fix the problem." Dredging also results in a number of adverse environmental impacts, including re-suspension of sediments and disruption of channel bottom ecosystems.

7. As an employee with Marine Terminals of Alabama, I am very concerned that lower water levels will adversely affect our company. One of our main sources of income derives from unloading steel scrap from barges off the river. A lower water level will inhibit the ability for scrap to arrive at our port and therefore not provide the revenue to sustain our current job level and limit the potential for growth. Increased cost would also adversely affect the ability of NUCOR Steel to make a profit and again negatively impact the employment situation of our facility. **Ray Hancock, 2333**

Response to Comment 7: Comment noted.

8. We need an additional 2 feet of water at "winter pool." The Tennessee River is being severely affected by a 9' restriction when the whole US River System is at their higher winter pools with "at least" 10' loadings. **William H. Dyer, 3506**

Response to Comment 8: The Preferred Alternative would allow 1 foot of additional channel depth through controlled releases below Kentucky Dam. Increasing winter pool elevations resulted in an unacceptable increase in flood risk; therefore, it was not included in the Preferred Alternative.

9. My main concern is operation of the gates at Normandy Dam during flooding. I think there needs to be a study on when to open them and close them in order to release -- in releasing the water to help in the flooding downstream. The big question -- I know when the lake gets full, it has to be released, but maybe a study that it could start releasing -- when you see the radar that the weather is coming, maybe the lake could be lowered prior to all the rain when it gets here, then be cut back. That is my main concern. Operating it by computer from Knoxville, I think that's the way it's operated, it's questionable whether you could open the gates properly or know when to open and close them. That's basically it. I mean, that's my main concern is the flood. You know, I know there's concern with fishermen and boaters, but Normandy Dam was built for flood control and not for boating and recreation; that's as only a second. And this flooding here this time has cost me somewhere around probably 18 to 20,000 dollars. Even though I have flood insurance, you still lose the deductibles and things. Then last January, I was also flooded in my shop due to two gates being opened after the river had already crested, and it brought 26 inches in my shop; didn't quite reach my home. And this is my main concern, the opening and closing the gates. There needs to be more study done on them to maybe help us downstream. **Donald R. Carpenter, 2324**

Response to Comment 9: No changes are proposed in the operations policy for Normandy Reservoir as part of the ROS. To address some of the specific concerns you have regarding the existing operations policy at Normandy, we offer the following comments:

Normandy Reservoir is operated as part of the TVA integrated water control system. Releases from Normandy Dam are scheduled and implemented from TVA's River Forecast Center in Knoxville, Tennessee. Normandy is monitored 24 hours a day in the Forecast Center for observed rainfall, predicted rainfall, downstream flows, and the existing and projected reservoir pool elevations. When heavy rainfall occurs in the Normandy and Shelbyville area, if adequate pool storage is available at Normandy, Normandy releases are generally reduced to low amounts until the flooding that occurs due to natural runoff below Normandy Dam has crested. Releases are then increased at Normandy, but not to the extent that flooding is increased beyond that which occurred due to the local runoff downstream of the dam. Because Normandy Dam has limited flood storage, if the reservoir fills to the top before downstream flooding has crested, TVA must begin releasing water earlier than desired.

Although weather radar is a valuable tool in helping plan and monitor the system, the advance warning provided by radar is not sufficient to lower the reservoir in order to gain any substantial additional flood storage. In fact, in many events, lowering the pool level while heavy rainfall is occurring downstream would increase flooding.

10. I would be interested in knowing how much increase in navigation tonnage would be realized by the extra 2ft of water. I would like to know if there is a preferred plan at this time. **Rick Saucer, 1296**

Response to Comment 10: The ROS project looked at the increased efficiency to existing Tennessee Valley shippers with the extra 2 feet of year-round navigable channel. No measurement of induced tonnage was made; however, a traffic forecast growth factor was included for the existing shippers. During the comment period for the DEIS, TVA had not selected a preferred alternative. After review of comments on the draft and further analyses, TVA formulated a Preferred Alternative, which is addressed in Chapter 3 of the FEIS.

Tailwater Recreation Alternative

1. Please continue to provide regular releases on from Ocoee #2 and #3 and also from the Apalachia Dam. I am pleased that Ocoee #3's releases will augment from 20 in 2003 to 54 in 2004. River releases are critical to the economy and in essence to the survival of Polk County and its neighbors. Thanks for reclassifying the Upper Ocoee into the bracket (community/economic development rather than power generation) in which it belongs. **Anonymous, 2100**

Response to Comment 1: TVA's Preferred Alternative includes increased flows through the Apalachia Dam and scheduled releases at a number of locations for which this has not been previously done. This should enhance opportunities for tailwater recreation, including rafting and boating. As stated in the EIS, recreational releases from Ocoee #2 and #3 are not within the scope of this EIS. In addition, the Upper Ocoee has not been reclassified; TVA still requires full-cost recovery for lost power revenues that result from Upper Ocoee recreational releases.

2. As a whitewater paddler, I request that reservoir releases be planned in advance whenever possible and that current release data be available online or by telephone for as many navigable waterways as possible. I request that fall draw-down releases be conducted during daylight hours and with flows suitable for recreational uses. I appreciate the variation of these releases as this creates a more natural river environment than one sustained level at all times. Please consider the importance of recreational information and releases on the Ocoee, Nantahala, Tallulah, Pigeon and Dries, Great Falls Hydrostation, and other popular whitewater streams that make the Southeast such a great place for paddlers to live, work, and play. **Cay Wright, 666**

Response to Comment 2: To respond to this and similar comments, TVA's Preferred Alternative includes a number of scheduled releases from dams. TVA will continue to provide a daily water release schedule on its web site and toll-free public lake information telephone line.

3. The Ocoee is a world-class whitewater paddling resource, as emphasized by the construction of the 1996 Olympic Whitewater facilities. Nothing in the ROS should be done to interfere with the 74 release days recommended for the Upper Ocoee in the earlier NEPA document pertaining to that issue; nor should the ROS adversely affect the whitewater releases on the Middle Ocoee. **David M. Ashley, 2098**

Response to Comment 3: TVA's Preferred Alternative would not adversely affect scheduled releases on the Ocoee.

4. I'm with Edge of the World Rafting Company in Banner Elk, North Carolina, and we are concerned with the release of the water from Watauga Lake out of Wilbur Dam back into the Watauga River because that's where we raft.

And what we would like to see ideally happen for our rafting business and the other rafting businesses over there is to begin scheduled releases Memorial weekend and to end the scheduled releases Labor Day weekend, plus have Saturdays through September, plus add Sunday of Memorial weekend and Sunday of Labor Day weekend. And the amount of water we would find ideal to release would be one unit from 11:00 to 12:00, two units from 12:00 to 4:00 and one unit from 4:00 to 5:00 Monday through Saturday; no release on Sundays. **Greg Barrow, 4355**

Response to Comment 4: TVA has developed a Preferred Alternative that includes a release schedule for Watauga operations for recreation flows below Wilbur Dam. See Appendix B for details.

5. Two generators daily Memorial Day through Labor Day 9:00 am to 7 pm minimum and two generators 11:00 am-3:00 pm every Saturday of year at Apalachia --Hiwassee River. **J. Harold Webb, 2196**

Response to Comment 5: TVA's Preferred Alternative includes an expanded release schedule for below Apalachia Dam. See Appendix B for schedule and timing of recreation flows below Apalachia Dam.

6. I think the Ocoee #2 and #3 tailwaters should be considered in the recreation and economic and environmental studies also. And consider same for all other significant (i.e., where is a significant user base of desire for more tailwater flow) tailwaters upstream of the tailwaters you did study. Even though Ocoee #2 has a contract for water, it will be up for negotiation in the near future, about 5 to 7 years from now. So considering it now in your ROS would be helpful. The economic benefits of Ocoee #2 are great now to the region. Helping improve use of Ocoee #3 would further help the region economically, especially since so much money was invested in the Olympic section. **John Hubbard, 2255**

Response to Comment 6: Recreational flows for Ocoee #2 and Ocoee #3 were the subject of two separate EISs that included decisions concerning recreational releases to the Ocoee River. See Response to Comment 2.

7. An unrestricted drawdown would seemingly be beneficial for tailwater recreation on dams like Apalachia where water release coincides with power generation. However the statement that "no tailwater releases would be made for recreation"seems to imply that TVA would release the water whenever demand spiked. According to TVA's statements issued to Ocoee outfitters, power demand remains level on weekends as compared to weekdays, making the release of water into the Ocoee riverbed on weekends detrimental to the price of hydropower. However, TVA often cites lower weekend power demands as the reason for a lack of water on Saturdays and Sundays in the Hiwassee riverbed. Since Apalachia Powerhouse produces more electricity than Ocoees #2 and #3 combined, it seems that this alternative could work for that region if TVA opted to generate from Apalachia at the same times that they release water into the Ocoee for recreation. This would also produce a guaranteed release schedule for Hiwassee recreation, and the amount of cold water in the Hiwassee tailwater during the summer months would effectively protect the coldwater fishery habitat found there. **Mary Shirley, 42**

Response to Comment 7: TVA's Preferred Alternative includes scheduled releases from Apalachia Dam. See Appendix B for the schedule. Regardless of whether power demand is high or low, when water is spilled at Ocoee, revenues are lost.

8. Great job pitting lake interests against those downstream. I am CERTAIN that there is a balance that can provide adequate water for both of these groups, but the language employed in the summary of this plan should make for great fireworks at the Blairsville meeting.

I'm not sure that I understand this alternative correctly, but it seems that TVA would maintain lake levels until Labor Day -- delaying the fall drawdown by about a month. Would lake levels be maintained at lower levels than in the Base Case? I don't understand how a lengthened summer pool season can provide priority to downstream recreation over lake recreation -- at first glance it seems like a good compromise for both groups. **Mary Shirley, 45**

Response to Comment 8: Appendix C shows a comparison of reservoir levels at various times of the year for all alternatives. TVA's Preferred Alternative attempts to balance many competing demands, such as reservoir and tailwater recreation. Under this alternative, tailwater releases would have a higher priority at selected locations. See Appendix B for details.

9. Why does tailwater recreation have a higher priority over reservoir water level and recreation??? Is this because a group of Tennessee politicians forced the TVA to supply water to the Ocoee River for rafting?? **Thomas G. Sandvick, 2667**

Response to Comment 9: The Tailwater Recreation Alternative placed a higher priority on tailwater recreation compared to reservoir recreation, just as other alternatives placed higher priorities on other operating objectives. See Response to Comment 8.

10. I am concerned about this alternative, because I disagree with the notion that tailwater recreation at South Holston is more valuable (higher priority) than reservoir recreation. I would like to see more information regarding how this decision was made. The graph of model simulations for this alternative suggested that reservoir elevation would be higher under this alternative than in the Base Case scenario. Under median conditions, can flow be increased while maintaining the lake at higher elevations? **Tom Hampton, 262**

Response to Comment 10: Under median conditions both reservoir and tailwater recreation would benefit under this alternative. Under the Preferred Alternative, minimum flows at South Holston would be increased from April 1 through October 31 for the downstream fishery. See Response to Comment 9.

11. Tailwater recreation. Has this approach in other parts of the country or world caused any severe consequences? **Richard Wagner, 2101**

Response to Comment 11: A number of adverse effects were identified for the Tailwater Recreation Alternative assessed in this EIS. The nature and severity of these effects depend on site-specific factors. Under TVA's Preferred Alternative, releases would be scheduled from a number of TVA dams to support tailwater recreation.

Tailwater Habitat Alternative

1. This seems to be the best option to mimic the natural flow of the river. The adverse predictions about flood risk appear to be related to the decision to set pool levels at 75% of maximum. A better plan would start with deciding to keep flood risk equal and then set seasonal pool levels accordingly.

This criticism seems to apply to other alternatives as well, such as Reservoir Recreation Alternative A and B. That is, the increased flooding risk is an artifact of deciding to set winter pool levels such that there will be an increased risk of flooding.

A more honest alternative would be to start with a commitment to keep flood levels the same as the Base Case Alternative, and then determine what winter pool levels should be and develop the rest of the alternative from there. **Guy Larry Osborne, 1207**

Response to Comment 1: TVA designed the alternatives to evaluate the broad set of issues and suggested operational changes identified during the scoping phase of the study. TVA performed the flood risk analysis to determine which of the changes evaluated could be made without unacceptably increasing flood risk at any critical location. TVA developed its Preferred Alternative to maintain flood risk at acceptable levels while preserving desirable characteristics that were associated with the alternatives that were evaluated in detail.

2. This option would not appear to help the Apalachia tailwater habitat at all. The best way to maintain the coldwater fishery habitat in the Apalachia tailwater corresponds to practices for maximum tailwater recreation there and the installation of a continuous low-flow alternative to average the "one-hour-on/three-hours-off"amount of discharge currently practiced. **Mary Shirley, 54**

Response to Comment 2: The Tailwater Habitat Alternative was developed to improve biodiversity and aquatic habitat for native warm-water species that live in this cool-to-warm tailwater. TVA's Preferred Alternative contains increased recreational flows from the Apalachia powerhouse. See Appendix B for details.

3. Contrary to its stated purpose, the Tailwater Habitat Alternative does not always improve overall aquatic habitat in tailwaters. In fact, the DEIS characterizes this alternative, one of the two worst alternatives for water quality because it would reduce instream flow during the summer. DEIS at 3-26. We are puzzled by this. Could you please explain why mean Summer and August-September flow will decrease in almost all tributary tailwaters under the Tailwater Habitat alternative, when this alternative was intended to improve water quality and aquatic habitat by increasing and stabilizing instream flow? DEIS at 3- 18; DEIS at Table 5.7-04, Table 5.7-05. **Southern Environmental Law Center, 4229**

Response to Comment 3: The Tailwater Habitat Alternative was developed in response to requests to better mimic natural seasonal variation of flows—high flow during winter and early spring, and low flow during late summer and early fall. This was accomplished by reducing hydro peaking and releasing a portion of the natural inflow on a continuous basis. Reducing hydropower peaking stabilizes the flow on a weekly basis. These lower flows would adversely affect water quality. The benefits provided by the reservoir system to augment lower flows in late summer with water held in storage would not be realized under this alternative.

4. I raise the question of state prejudice when the TN located Ocoee River has priority over the Georgia located Blue Ridge Lake **Thomas G. Sandvick, 2668**

Response to Comment 4: TVA is not proposing to change recreational flows on the Ocoee as part of the ROS and this EIS. Those flows and their associated effects were the subject of two earlier EISs; decisions to provide recreational flows on the Ocoee were made earlier, after those EISs were completed.

5. As stated in Section 5.7.10, the Tailwater Habitat alternative "would increase the weeks at full pool levels and increase winter pool levels." Model results of reservoir levels for five dates through the year (Appendix C) show that the Tailwater Habitat Alternative has either the highest water levels or among the highest water levels of the modeled reservoirs. There are not adequate data presented to determine why this occurs, but it is likely to be due to releases of only 25% of inflow or less. **Wendy Smith, Executive Director, World Wildlife Fund, Southeast Rivers and Stream Project, 4182**

Response to Comment 5: This is correct. Under the Tailwater Habitat Alternative, reservoir releases are limited to 25 percent of the inflows, or the minimum flows—whichever is greater—and are drawn down only in late fall in order to remain below flood guide levels and maintain flood storage capacity.

F3.2 Study Areas

Air Resources

1. From our property the haze and air pollution is all too pervasive -- there are more days when the park land across Fontana Lake is shrouded in dirty air than there are clear days. The rising incidence of asthma in our young people, the number of days it is unsafe to be outside if one is elderly, young or has respiratory problems is increasing. Plant and animal life in the [Great Smoky Mountains National Park] GSMNP is endangered by pollution and acid rain. TVA's responsibility for much of this pollution is a national shame and recent efforts to clean up the pollution spewing energy plants is way overdue. Continued efforts should be addressed immediately and should be ongoing. **Bonnie Ragland, 2461**

Response to Comment 1: As part of continuing efforts to address this problem, TVA has begun a major additional reduction program for air pollutants. The program focuses on reducing sulfur dioxide and nitrogen oxides emissions, which contribute to haze. TVA has spent almost $4 billion to reduce emissions from its coal-fired power plants, resulting in reductions to sulfur dioxide emissions of over 75 percent and reductions in nitrogen oxide emissions of over 60 percent. TVA is in the process of spending another $1.8 billion through the end of this decade on additional reductions. By the end of the decade, TVA will have reduced sulfur dioxide emissions by 85 percent and nitrogen oxide emissions by 75 percent during the ozone season. Impacts related to emissions under the Preferred Alternative range from no change to a slight increase compared to the Base Case because of a reduction in hydropower generation and its replacement with fossil-fuel generation.

2. It will cause TVA to burn more coal in a place that already has highly polluted air. This will cause further damage to the most valuable asset in Tennessee - Great Smoky Mountains National Park. **Charles, 2654**

Response to Comment 2: While some alternatives would result in slightly more fossil-fuel generation and others less, as described in Section 5.2, TVA does not believe that these relatively small differences would result in meaningful air quality changes. TVA's ongoing emissions control programs for both nitrogen oxides and sulfur dioxide would continue to reduce TVA's contribution to air pollution. See Response to Comment 1.

3. Would like to see improvements in air emissions. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3084**

Response to Comment 3: See Responses to Comments 1 and 2.

4. Do we need more air pollution when the area already ranks nationally as one of the top five in poor air quality? **Drew Danko, 1022**

Response to Comment 4: See Response to Comment 1. Contrary to media reports, air quality in the Tennessee Valley region has been steadily improving. The USEPA's decision to make its ozone- and particle-related national standards more stringent will now result in additional emission reductions, ensuring that air quality will continue to improve.

5. As a non-smoking Tennessee resident facing lung surgery for a tumor, I have a strong interest in establishment and enforcement of the most stringent air pollution regulations. Release of small quantities of carcinogens is NOT acceptable. It is better to prevent introduction of hazardous chemicals into our air and water supply than to enact laws to filter them out later. **Larraine Nobes, 18**

Response to Comment 5: TVA has conducted health risk assessments of toxic releases from its coal-fired power plants. Those assessments, which indicate that the releases do not substantially add to the risk of cancer incidences, have been reviewed by an independent third party. See the discussion of hazardous air pollution in Section 4.2.

6. Air quality would suffer if drawdown were to be postponed, as in the recreational alternatives. The loss of hydropower would be compensated by fossil fuel combustion in the worst period for air pollution. TVA should be making every effort to improve air quality. **Michael Sledjeski, 2968**

Response to Comment 6: See Responses to Comments 1 and 2.

7. Both recreation alternatives would result in increased fossil-fuel emissions during the period of highest air pollution. TVA power plants are presently the chief cause of air pollution in the area, resulting in conspicuous degradation of plant life, and visibility and a less obvious, but just as real adverse impact on human health. **Michael Sylva, 2124**

Response to Comment 7: See Responses to Comments 1 and 5.

8. Maximize all clean air potential for coal plants ASAP, please. **Pr. John Freitag, 983**

Response to Comment 8: Comment noted.

Climate

1. Climate is important. Our scientists tell us global warming is real. We know there is a much higher incidence of asthma in children than in the past. This may be related to air quality and climate. For the sake of our children and for the future of the planet, please protect the air resources. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3107**

Response to Comment 1: TVA actions to mitigate emissions of carbon dioxide include expansion of green power sources, increased use of generation that emits fewer or no greenhouse gas emissions, and support of carbon emission reduction programs.

Water Quality

1. Important to me, but not to such an extreme that other areas are severely affected. **Anonymous, 3072**

Response to Comment 1: TVA developed a Preferred Alternative that enhances recreational opportunities on a number of reservoirs and tailwaters, while reducing the potential for adverse water quality effects that was associated with a number of the alternatives identified in the DEIS.

2. Improved navigation and improved water quality seem to go together. **Anonymous, 3074**

Response to Comment 2: Comment noted.

3. Water Quality - Only 7 out of the 35 reservoirs were modeled for changes in water quality. The water quality parameters should have been modeled for all reservoirs considered in the EIS so that impacts could be analyzed for each reservoir. The proposed changes in TVA's operations should not be based on only a small portion of the system.

Although the change in reservoir retention time and change in volume of low DO water is presented for the reservoirs modeled, the number of days of low DO water is not presented in the same tables (Appendix D). An increase in low DO volume may only include lower elevations, which typically may not even impact aquatic habitat or compliance with water quality standards. The significance of the increase or decrease in the volume of low DO water is not described in the water quality sections. **Alabama Rivers Alliance, April Hall, Watershed Restoration Specialist, 3735**

Response to Comment 3: This is a programmatic EIS and use of representative reservoirs is an appropriate approach for a Valley-wide evaluation. A total of 26 reservoirs and 10 tailwaters were modeled and model outputs were examined during preparation of the EIS. Representative reservoirs were chosen from these results for more in-depth analysis. Based on comments on the DEIS and the operations policy of the Preferred Alternative described in the FEIS, model results from two additional representative reservoirs were included in the final evaluation and presentation of water quality information.

4. Reports on water quality for Lake Chatuge reflect fair to good and medical people in the area state that to swim in the lake can have adverse effects, involving ear infections and skin eruptions. As recent residents to the area, we hear about homes along the tributaries and on the lake frontage that have sewage flowing directly into the water system. Is this a Clay County in North Carolina and Towns County in Georgia issue or does TVA have any clout in cleaning up problem areas? **Alice Russell, 642**

Response to Comment 4: Other federal and state agencies have primary regulatory authority over water quality and sewage disposal facilities. However, TVA is concerned about water quality in its reservoirs and works cooperatively with other agencies, businesses, and landowners to encourage actions to improve water quality.

5. There have been septic systems that have been allowed to be put into flowage easement areas, and my concern is that the septic is going to be entering into the water. And this high water has not been a consideration to land management in the past, and how are they going to handle the roads and the septic systems that have been allowed to put in the easement areas when they do hold the water up higher? **Angela Boyda, 4368**

Response to Comment 5: See Response to Comment 4. The June 1 flood guide levels would not be higher than they were in the past under the Preferred Alternative. Some roads and septic systems located in flowage easements would be subject to more—but still infrequent—inundation under the Preferred Alternative.

6. Please try some how to try and clean up South Holston lake. It is filthy and am ashamed of it. **Anonymous, 139**

Response to Comment 6: See Response to Comment 4.

7. I'm concerned that this objective only considered water quality of reservoirs, not those in tail waters. Could these two objectives be split into 2? **Anonymous, 20**

Response to Comment 7: Water quality in 10 tailwaters was modeled for the Base Case and alternatives identified in the EIS. Tailwater quality was an important metric in the threatened and endangered species analysis. Temperature, dissolved oxygen (DO), and water surface elevation were evaluated for the tailwaters.

Additionally, some of the reservoir metrics were chosen due to their potential impact on tailwater quality. For example, the Base Case and alternatives were compared for their potential to form anoxic (very low DO) conditions at the bottom of the reservoir. Under these conditions, manganese and iron in the bottom sediments may dissolve into the water. When this water is discharged into the tailwater, brown stains may appear on the rocks and shoreline downstream. Therefore, an alternative with better DO in the reservoir would result in better conditions in the tailwater.

Regardless of the alternative chosen, TVA is committed to maintaining the existing DO targets in the tailwaters. This may lead to adding aeration capacity at some sites. TVA's cost of additional aeration was included in the cost analysis.

8. I am seriously concerned that no alternative was included that optimized water quality on the reservoir system. The Navigation alternative helps water quality the most, but I'm concerned about the by products effects on water supply and purity. **Anthony Morris, 2715**

Response to Comment 8: Water quality improvement was an important consideration in the formulation of all of the alternatives. Because the alternatives considered span a reasonable range of alternative operations policy, water quality effects or consequences varied. There are many demands placed on the Tennessee River system, all of which TVA considers and integrates when making decisions about use of available water. Water quality is one of those considerations. For example, TVA operates the river system to provide minimum flows at numerous locations specifically for water quality. Water quality played a very important role in the development of the Preferred Alternative. One of the fundamental changes proposed in the Preferred Alternative is to manage reservoir operations to achieve certain flows, rather than certain levels in summer, June 1 through Labor Day. This is expected to improve water quality in low-flow years in the latter part of summer.

9. How is DO effected by alternatives in mg/ltr. No graphs or tables to indicate how close or how much deviation from TVA's commitments in base case. **Arland Whitlock, 566**

Response to Comment 9: Section 5.4 provides a variety of data and graphics relating to DO. More detailed information is contained in the Water Quality Technical Report. This report is in TVA's administrative files.

10. Water quality and water supply are my next biggest concerns and should be managed as the second highest priorities. **Betty M. Fulwood, 2292**

Response to Comment 10: Protecting water quality and managing to ensure adequate water supply are also goals of TVA. Chapter 3 of the FEIS includes a description and the reasoning behind the formulation of TVA's Preferred Alternative and indicates the roles of water quality and water supply in this alternative.

11. Water quality and water supply with higher lake levels, how can that be adversely affected also, I'm asking, for the fact that water is there, and not a dwindling supply of it, away from the tributary lakes. **Carroll and Gail Johnson, 4403**

Response to Comment 11: There are two components to water supply: (1) the cost of extracting water from reservoirs, which is decreased (a beneficial impact) by higher reservoir levels and (2) the quality aspect of the raw water in the reservoir. When reservoir levels are held up, flows through the system are generally decreased, water can stagnate, and water quality in the reservoir can deteriorate, which leaves the water more difficult to treat (an adverse impact). See Sections 4.4, 4.5, 5.4, and 5.5.

12. That is one of the first things I look for. I'm afraid we have way too much runoff in our rivers. This ends up in our reservoirs (such as TVA) and sits there with its load of pollutants. Nasty stuff. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3105**

Response to Comment 12: See Sections 4.5, 4.16, 5.5, and 5.16 and Response to Comment 4.

13. Continuation of the liquid oxygen injection system currently in use is encouraged. This is important to support the fishing opportunities in the tailwaters. This also assists in the aquatic insect population to insure adequate food production for the species in the river. We suggest that there be continued research in this area. As new technology and techniques become available it would be advantageous to implement them to insure the water quality of the lake at Blue Ridge and the Toccoa River. **Jacquelyn O'Connell, 3801**

Response to Comment 13: TVA is committed to maintaining these DO targets, regardless of any changes that may result from this review of TVA's reservoir system operations policy. To ensure effective and efficient operation, TVA continually researches products and techniques as they become available. When innovations appear promising, TVA conducts either bench-scale or pilot tests to evaluate potential application within the Tennessee Valley region.

14. There are significant water quality issues in the Elk River. There is amply evidence to suggest that there is untreated sewage–including some very obvious above-ground septic systems that are right on the river bank that have not been dealt with. **Jean Prater, 1373**

Response to Comment 14: Other federal and state agencies have primary regulatory authority over water quality and sewage disposal facilities. However, TVA is concerned about water quality in its reservoirs and works cooperatively with other agencies, businesses, and landowners to encourage actions to improve water quality.

15. There are many natural lakes without a drawdown that have better water quality than the TVA reservoirs. I don't believe that keeping the water up through the 1st of November would create a problem. **Joe Brang, 863**

Response to Comment 15: Reservoirs differ from natural lakes in many ways. Some of the more important differences are:

- *Water temperature*. TVA's reservoirs are warmer than most natural lakes. The warmer water helps more algae grow, which can deplete DO that aquatic life need.
- *Drainage basin*. The land area draining into a natural lake is usually small in comparison to the lake area. The land area draining into a reservoir is usually large compared to the reservoir area. This means there is more opportunity for nutrients and pollutants to rinse into the reservoir.
- *Inflow.* Runoff usually flows into natural lakes via small streams and often through wetlands before reaching the lake. These wetlands reduce the nutrient and pollutant load to the lake. Most inflow to reservoirs enters via high flow streams, directed along old riverbed valleys, where there is less opportunity for the nutrients to be reduced. Increased nutrient loads contribute to more algal growth.
- *Outflow*. Outflow is relatively constant from natural lakes and water flows out from the surface of the lake. Reservoir outflows are irregular, and withdrawals are typically from the bottom of the reservoir.
- Many reservoirs have been built to promote economic development.

Maintaining reservoir levels longer in fall requires releasing letting less water from the reservoir. Data and model results indicate that these lower flows affect water quality. Maintaining constant levels through November 1 would also result in unacceptable impacts on flood risk.

16. [Under the Tailwater Alternative] with levels remaining constant, I think that TVA could look at alternatives when discussing Water Quality and Aquatic Resources. Many of our northern neighbors have taken drastic steps in their older still water lakes. They have actually flown in large aerators to draw oxygen depleted bottom waters and thrust it into the air somewhat improving the quality. This would serve in much the same way as weir dams do in the tailwaters of rivers below dams. This also would allow natural regeneration of aquatic plant life to return thus renewing the process of replenishing the natural nutrients needed for healthy macroinvertibra. **Joe Payne, 60**

Response to Comment 16: TVA uses a wide range of methods to improve DO concentrations in tailwaters. As the commenter indicated, one way is through aerating weirs (small dams designed to add oxygen to the water as it plunges over the top of the weir walls). Another method is turbine venting. TVA has developed a technique for this method using hub baffles and bypass piping to draw air into hydroturbines and mix it with water as power is generated. Air compressors and blowers are used at other sites to force air into the water flowing through the turbine.

Two other methods are used by TVA to improve tailwater conditions, each of which add oxygen to the reservoir immediately upstream of the dam. Hydroturbine intakes typically draw water from deep levels in the reservoir, creating low-oxygen conditions downstream of the dam. One of these methods is the use of surface-water pumps, which resemble large ceiling fans. These pumps push warm, oxygen-rich surface water downward, where it is mixed with low-oxygen bottom water and then drawn in by the turbines during generation. The other method TVA uses in the reservoirs is the use of oxygen injection systems. The system consists of an oxygen tank and evaporators on the bank that are connected to diffusers, perforated hoses suspended above the reservoir bottom upstream of the dam. All these methods are used to improve conditions in the tailwaters. Theoretically, the oxygen injection system could be used to aerate an entire reservoir. However, due to the volume of TVA's large reservoirs, this would be infeasible, both in terms of cost and the ability to obtain and diffuse the volume of oxygen needed. The method of drawing bottom water and thrusting it into the air, as the commenter suggested, is frequently used at wastewater treatment plants to aerate sewage. On a large scale, such as on the reservoirs, pollution prevention and reservoir operation are much more effective and practical than treatment.

17. In the video presentation, a somewhat negative impact on . . . water quality was indicated, however this was based on computer modeling, which, while an approximation of reality, is subject to question. I am interested in how the data was gathered, and whether the current TVA baseline is really a true median for all the factors at stake. So many things are affected by any change in the system, but I have to assume the overall benefit to the public is the eventual goal. **Margaret H. Schramke, 1436**

Response to Comment 17: The baseline, or existing conditions, as described in Section 4.4, was based on TVA's extensive Vital Signs Monitoring Program, which examines biological, chemical, and physical conditions in most TVA reservoirs. The program is in its 14th year and provides a very good representation of existing conditions. Water quality models were successfully calibrated against existing baseline conditions in order to ensure the validity of predicted results, and used to predict conditions that do not yet exist and for which there is no available data. TVA's objective in the ROS is to identify changes to TVA's reservoir system operations policy that will improve the overall public value of the system.

18. We also are concerned about water quality and would agree with exceptions to this plan in years when water quality is significantly affected by low inflow or other factors. **Michael and Evelyn Fink, 430**

Response to Comment 18: During drought conditions, TVA strives to continue to meet water quality and water supply commitments, and uses the flexibility in its reservoir operations policy to maintain other minimum levels of benefits to the extent possible. As discussed in Section 3.4, TVA is considering developing a formal drought management plan that would supplement its reservoir system operations policy.

19. I would like to see water quality monitored more than it is at this time. **Mrs. Jean Roberts, 1919**

Response to Comment 19: TVA has an extensive monitoring program, Vital Signs Monitoring, which provides extensive amounts of data from locations throughout the Tennessee Valley region. This program was started in 1990 and is expected to continue into the future. Other federal and state agencies also monitor water quality conditions.

20. Water needs to be tested regular and be enforced to keep clean water for fishing and over wildlife, also people health. **Paul Howell, 4024**

Response to Comment 20: See Response to Comment 19.

21. In addition to concerns about flood control, I would also like to minimize any adverse effects on the water quality of the system. This puts a double whammy on alternatives 3C, 5A, 7C, and 8A. **Robert A. Lamm, 2920**

Response to Comment 21: Comment noted.

22. With the standards in Virginia getting tougher every year our health department is protecting our water quality in an upgrade on a yearly basis. This quality is elevated on a yearly basis. Development in our area is strict. Of the highest standards and tradesmanship ability we protect our water quality to send it to the Tenn. River System in the highest quality that they can get the most benefits from it. **Taulbee Lester, 2987**

Response to Comment 22: Comment noted.

23. I would like to see this a top priority of concern in conjunction with affiliated agencies who oversee and enforce industrial waste and farmland waste. My school students think the green color of the water is the natural color and have no idea how beautiful clean water can be. **Terry Sisk, 577**

Response to Comment 23: Other federal and state agencies have primary regulatory authority over water quality and sewage disposal facilities. However, TVA is concerned about water quality in its reservoirs and works cooperatively with other agencies, businesses, and landowners to encourage actions to improve water quality.

24. TVPPA supports environmental stewardship in the Tennessee Valley. We believe that its citizens have a basic right to clean water. Thus, TVPPA supports a balanced sensitivity that incorporates environmental quality improvements in the overall reservoir operations policy decisions. **TVPPA, Richard C. "Dick" Crawford, President & CEO, 4237**

Response to Comment 24: Protecting water quality was an important consideration in the formulation of TVA's Preferred Alternative. Although there could be some negative impact on water quality if the Preferred Alternative is implemented, compared to other alternatives that would enhance recreation, the expected effects would be less.

25. My house is on South Holston Lake and we have to have a septic system, sewer lines are not available for hookup. I don't believe this situation provides for optimal water quality. Are there any plans concerning this situation? Brian Mazzei, 134

Response to Comment 25: While it is true from the perspective of water quality that septic systems are less desirable than a sewer system connected to a wastewater treatment plant, a well-designed, properly installed, and periodically maintained septic system can effectively treat household wastewater. This EIS examines issues associated with possible changes to TVA's reservoir system operations policy. The resolution of site-specific problems, such as those identified in this comment, is addressed in other forums.

26. I think the winter water level should be maintained through the months of March, April and May because we have experienced our severest floods during those months in Decatur. When the pool is kept close to 553 heavy rains in those months cause the drainage system of Decatur to become slack water and our sewerage system seems to back up. **ITolly G. Shelton, 2428**

Response to Comment 26: Wheeler Reservoir is commonly filled during the period from March 15 to April 15 to full pool at elevation 555.75 feet. While holding Wheeler Reservoir levels low might relieve some of the backup on the sewage system, this comment suggests that the sewage system suffers from excessive infiltration and inflow or cross connections from the storm drain system. This is a design or operating problem. The sewage system should function without backup when Wheeler Reservoir is at full pool. After an extensive flood risk analysis, TVA is not proposing to change the spring fill period on Wheeler Reservoir under its Preferred Alternative.

Water Supply

1. It would be wonderful and helpful, and even critical if the data information in your publications contained easily readable 'x-y graphs' covering the ' 30 year water and population projection period' this study suppose to be covering within the Tennessee River Watershed. These graphs would contain on the 'y' axis the population increase over 30 years. The 30 years would be on the 'x-axis.' Also there would be similar separate or overlay graphs showing the increase of water consumption with increasing population over the 30 year projection. Separate increased water uses over the 30 year period would be on either separate graphs or overlays. The water uses would include as your report indicates: drinking (residential), industrial, recreation, and etc. The water quantity would be related to satisfy the water quality needed for the uses. The water uses would take into account the water quantity needed to maintain the water quality for human/aquatic/biological/ecology criteria. The average water quantity and related quality would also include 'drought' and 'global warming' variables over the 30 year projection. The drought variable (based on historical water history) would decrease total available water. The 'global warming' variable will either increase or decrease the water quantity in this geographical region over the next 30 years. I assume the impact of 'global warming' and the 'drought variables' would be averaged into the total water quantity over the 30 year projection. Your 'Summary of Policy Alternative' tables are technically very wonderful, but visually for the ordinary citizens I do not believe are very readable for understanding the related impacts.

All of the above would indicate the decreasing amount of available water for inter-basin transfer from the Tennessee River Watershed to other regions over the next 30 years.
Frank DePinto, 3965

Response to Comment 1: TVA's FEIS uses a variety of similar techniques to provide data in tabular formats. Among other things, summary material provided in the text of the EIS is typically expanded on in the appendices of the EIS, where readers can find more detailed information.

2. I. General
A. Yearly Projected Percentages of Growth for**:** Population/Business/ Industry/Commercial/Recreation and related water volume demands.

1. What is the yearly percentage increase (10%, 12% population growth) TVA will be using for the six state area for the 30 year projected period?
   a. also the yearly projected percentage growth for Business, Industrial and Commercial sectors?
2. What is the coinciding yearly increase of water increase for each of the above sectors?

B. The average inches per yearly rainfall statistic which will be used for the study? (80 inches/year, etc)

1. Does this include a global warming factor?

C. Drought occurrences.

1. The number drought occurrences within a 30 year time frame which will be used?
2. What are the parameters of these drought occurrences?
   a. Number of days, months, years of drought?
   b. The yearly reduction of water availability due to projected drought conditions.
   Frank DePinto, 3968

Response to Comment 2: Population is forecasted to increase from less than 10 percent in some parts of the watershed to more than 100 percent in other areas over the 30-year period. Likewise, business, industrial and commercial growth is expected to be slight in some areas of the watershed and extensive in others. Overall, population is expected to grow by about 31 percent over the watershed. Other growth factors in the next 30 years include:

- Public supply and commercial water use – 31 percent;
- Industrial use – 25 percent;
- Irrigation – about 37 percent;
- Cooling water for coal and nuclear power generation – about11 percent; and,
- Total water use – about 14 percent.

Average rainfall in the Tennessee River Watershed is presented in Section 4.3.3.

Potential global warming was not considered in the detailed modeling analysis of water quality and water supply effects because there are no reliable projections specific for the Tennessee River Watershed. In the water quality analysis, 8 years of varying meteorological conditions were considered. This included a record drought year, a very wet year, and a very warm year. The climate variability likely to occur in global climate change would be within the range of the variability illustrated during the 8-year simulation. Climate change and global warming are discussed in Sections 4.3 and 5.3.

The Base Case and each alternative were analyzed for the last 99 years of hydrologic record—the entire hydrologic record for the Tennessee River Watershed. This record includes both wet and drought conditions. Mean annual rainfall during this period varied from 35 to 65 inches per year, as explained in Chapter 2.

3. II. Priority/Allocation

A. Will each state know how much 'projected water' they will be getting for each of the 30 projected years so that they can plan growth/no growth?

B. Will there be any stipulations for water conservation programs in each state, and states where there is interbasin water transfer (a stipulation for inter-basin transfer)?

C. How will each state be allocation the quantity of volume of water per year? Will this be determined by the amount/percentage of area each state has in the watershed/waterstudy area? Or will it be determined by population number in the watershed/waterstudy area?

1. An example**:** say the State of Tennessee occupies 35% of the waterstudy area, so it will be able to obtain 35% of the water. Or**:** there are 1 million Tennesseans in the watershed/water study area so Tennessee will be able to obtain that amount of water for drinking, business, commercial and recreation uses. If Mississippi is only 6% of watershed/water study they will get 6% of the water flow.

   a. Scenario**:** Would Georgia (say 5% of the watershed/water study area) be able to siphon off as much water from Tennessee as they want and transfer it to Atlanta?

   b. Scenario**:** Will north Alabama which is in the watershed/waterstudy area be able to siphon off as much water as they want to send to South Alabama which is not in the watershed/waterstudy area?

3. Who/What type of committee/authorities will make the above decisions i.e. TVA, state agencies, federal agencies, etc. **Frank DePinto, 3969**

Response to Comment 3: Sections 4.5 and 5.5 address water supply issues. TVA's final reservoir operations policy and the analyses of it in this EIS will provide a framework for making the types of decisions identified in this comment. TVA has had over several years of dialogue with Valley states about water supply issues and the management of water supplies in order to meet the needs of the region now, and in the future, and that dialogue is ongoing. TVA is not, as part of the ROS or possible changes to its reservoir operations policy, proposing to establish a water allocation policy for the region. There are important and complex economic, environmental, and political considerations associated with developing such a policy that extend well beyond TVA's role as manager and steward of the water resources of the Tennessee River system.

4. III. Contractual- Inter-Basin Water Transfer-Droughts

A. Will there be stipulations that during droughts the amount of water originally contracted for Interbasin water transfers will be proportionally reduced during drought periods. **Frank DePinto, 3970**

Response to Comment 4: Net inter-basin transfers into and out of the Tennessee River watershed currently are only about 6 million gallons per day. All the transfers that account for this are the result of utility districts selling water to their neighbors. Some of this water is diverted above TVA reservoirs, where streamflow cannot be augmented in dry conditions by reservoir releases. Therefore, some of these utility districts might not have enough water during dry conditions. Contracts for the sale of such water generally carry provisions for what will happen when the seller has no water to supply the buyer. TVA is not involved in the provision of such contracts, and nothing in the ROS addresses what these utilities would do if flow in their unregulated streams declines.

Appendix D9 provides information about inter-basin transfers. The largest existing inter-basin transfer is 200 million gallons per day through the Tennessee Tombigbee Waterway. It is likely that this amount will not grow more than to about 300–400 million gallons per day over the next 30 years. The ROS, however, has conservatively assumed that the Waterway would operate at its design flow of 800 million gallons per day in 2030. TVA's analysis suggests that TVA's reservoir system could handle a diversion of this amount with limited effects, depending on where the diversions occur. As discussed in Section 3.4, TVA is considering developing a formal drought management plan that would supplement its reservoir system operations policy.

5. III. Contractual- Inter-Basin Water Transfer-Droughts

A. Will there be stipulations that during droughts the amount of water originally contracted for Interbasin water transfers will be proportionally reduced during drought periods. **Frank DePinto, 3971**

Response to Comment 5: See Response to Comment 4.

6. IV. Legal Strategies to Protect Water Study Area.

A. What type of legal strategies have the State of Tennessee and other states within the Waterstudy Area devised to protect its water supply in anticipation of law suits from other states such as Georgia/Atlanta for more water than TVA would allocate?

B. What legal protections do the citizen/state of Tennessee, etc. have that TVA will not sell its water to another state (outside the watershed/water study are) for greater profit i.e. if Atlanta is willing to pay more for water than the state of Tennessee or other states within the Water study areas?

C. What legal protection does the state of Tennessee have from the federal government stipulating that water is a southern regional item (Tennessee, Georgia, Alabama, Florida etc.) and not a local watershed/waterstudy (Tennessee, Alabama, Kentucky, Mississippi) item. With such an interpretation and water allocations would be based on a total regional framework and the areas with more population would get the most water. Thus, Georgia and Atlanta would not only get its own water, but would be eligible for water in Tennessee. **Frank DePinto, 3973**

Response to Comment 6: See Response to Comment 4. Tennessee has a law that requires a permit for transfers of water from one river basin to another. Should Georgia seek to divert water from Tennessee to Atlanta, Tennessee would have to agree to this action.

7. V. Aesthetic Attractive River Elevations.

A. Chattanooga

2. The city of Chattanooga's economy depends on tourism to a large extent. The attraction for tourists in Chattanooga is the Tennessee River. If drought occurs in the waterstudy area, the Tennessee River might be lowered for water transfer to other states thus leaving the water at lower than 'aesthetic attractive' level in Chattanooga, thus effecting tourism.

3. It would be pretty awful during a drought period for Atlanta to be getting Chattanooga's water that is now only 5 ft. above river bed and not a pretty site for tourists, thus demising tourism in Chattanooga. **Frank DePinto, 3981**

Response to Comment 7: See Response to Comment 4. None of the ROS alternatives would lower the elevation of Nickajack Reservoir. There are currently no proposals to withdraw water from Nickajack Reservoir for Atlanta. In fact, by Georgia state law, the solution to Atlanta's water problem must be found without considering inter-basin transfers of water. If this law changed in the future and a proposal was made to withdraw a large amount of water from the Tennessee River at Chattanooga, the proposal would be thoroughly evaluated to determine its effect under all hydrologic conditions and would require approval by the State of Tennessee.

8. VI. 30 Years of Soil Erosion. (Water Study projection)

A. "Water is like money in the bank. The bigger the bank one has the more money can be put in it."

1. It might be cost effective to dredge lakes, dam areas and rivers so more water can be stored.
2. It might be cost effective along with the Water Study to initiate a 'soil erosion protection plan' for the Water Study area using air and satellite photos. This could be part of a water conservation plan for all states in Study area and inter-basin transfer states. **Frank DePinto, 3985**

Response to Comment 8: Reservoir dredging and sediment control for the purposes of increasing reservoir storage were not included in the ROS as elements of an alternative operations policy. TVA has examined reservoir dredging at several locations and found it to be ineffective or too expensive to implement. TVA has implemented extensive soil erosion protection projects in the past (e.g., the reclamation of Copper Basin) and continues to look for opportunities for such projects particularly in cooperation with others. See Sections 4.16 and 5.16, where erosion is addressed.

9. I live on Lake Chatuge. My property is near the town's county water treatment plant. The area is very flat by mountain lake standards. A draw down of 4-5 feet exposes 15-20 feet of mud and red dirt.

I have wondered just how far out into the lake the supply pipe is that provides the county water. **Harold Andrews, 2423**

Response to Comment 9: The Clay County Water Service District—which serves Hayesville—is a groundwater system and is unaffected by Chatuge Reservoir levels. Hiawassee, Georgia, has a surface water intake on Chatuge, which can pull water from as low as 1,895 feet.

10. Flood Control on the Duck was conceived as a two dam river. Columbia didn't get theirs and Shelbyville should not suffer additional flood risk to benefit Columbia's water supply. There are more prudent solutions for Columbia; namely, its ability to provide for drinking water by building a smaller lake on a tributary of the Duck.

To conclude, I would strongly oppose any solution that would increase flow on the Duck. Should Normandy Dam be raised, increased flood control should be one of the benefits.

If the City of Columbia has involved itself in these discussions and that involvement has not made it into the record, I would be disappointed. **Harold Segroves, 3**

Response to Comment 10: None of the alternatives considered for the ROS would change the configuration of Normandy Reservoir, the operation of Normandy Dam and Reservoir, or the flow in the Duck River. The Duck River would not be affected by the Preferred Alternative.

11. In regard to Normandy Dam and its management, it is my opinion that nothing should be done that might increase average flows on the Duck River. It is my understanding that one solution the City of Columbia has to combat its own water quality problem would be to have Normandy Dam increase its release into the Duck. I also understand it might be possible to raise the dam at Normandy to help accomplish Columbia's needs.

I am concerned that Columbia's water needs have been a subtext of this TVA study. I can find some verbal proof that this is the case but can find nothing in the study indicating this as an issue. **Harold Segroves, 1**

Response to Comment 11: See Response to Comment 10.

12. In the late 1970s, Tupelo was forced to switch from ground aquifers to surface water. The aquifers were being drawn down so far that communities within 25 miles were affected by reduced water levels in their wells. The switch to surface water was essential for human consumption and economic development purposes.

Tupelo, through the Northeast Mississippi Regional Water Supply District, constructed an 18-mile pipeline, water treatment plant and pickup point on the Tombigbee River. A water withdrawal permit was granted for up to 30 million gallons per day. This system is being paid for by a 25-cent sales tax collected in Tupelo.

The Northeast Mississippi Regional Water Supply District services Tupelo, Baldwyn, Saltillo, Verona, Turner Industrial Park, Tupelo-Lee Industrial Park and North Lee Industrial Park. Fulton has just joined the system and has a main water line under the Tennessee Tombigbee Waterway. The system is truly a regional system at the present time.

Future needs are additional water allocation as the system grows and matures. Current use is in the 60 percent of withdrawal limits. This growth indicates that additional needs for water will be necessary within the next several years.

The future needs will be with the small rural systems that need to connect to a dependable water supply. This is critical for rural systems because of the financial stabilities they face. **Mayor Larry Otis, 4348**

Response to Comment 12: Sections 4.5 and 5.5 address water supply issues. Appendix D9 presents an analysis of potential effects from inter-basin transfers, including operation of the Tennessee–Tombigbee Waterway.

Groundwater Resources

1. High priority to protecting ground water from depletion and from contamination. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3088**

Response to Comment 1: Sections 4.6 and 5.6 address groundwater.

Aquatic Resources

1. In Chapters- 4.7 and 5.7, TV A acknowledges that only the currently existing species and habitats were considered during analysis of the alternatives. However, the EIS should place more importance on native habitat and species, especially those that are rare or imperiled. The Board of Directors should be aware that certain negative impacts on aquatic resources are not as significant as other negative impacts. For instance, a reduction in species or habitat for a non-native, hardy species found in reservoirs may not be considered as significant as the same reduction to a native riverine species. So an overall negative impact to aquatic resources (as illustrated in the Executive Summary) does not necessarily mean a significant change in important native habitat **Alabama Rivers Alliance, April Hall, Watershed Restoration Specialist, 3736**

Response to Comment 1: We recognize the importance of protecting native species, especially those that are threatened or endangered. However, TVA also realizes that several non-native species are highly managed to provide for sport fisheries. Sections 4.7, 5.7, 4.11, 5.11, 4.13, and 5.13 address aquatic resources, invasive species, and threatened and endangered species, including non-native species. Metrics developed to evaluate aquatic resource impacts included aspects important to native species, such as flow, water temperature, and DO concentrations. A metric was directed at reservoir habitat for cool-water fish species—both native and introduced.

2. The value clean, healthy water and aquatic habitats is not included in the economic model. While we understand that a numerical value would be difficult to determine, the TVA Board of Directors should be aware that these values were not considered. We would like to point out however, that the public places a great deal of value on the protection of the environment, as determined, during TVA's scoping process. **Alabama Rivers Alliance, April Hall, Watershed Restoration Specialist, 3737**

Response to Comment 2: The importance of and potential impacts on these resources are fully addressed in the FEIS. TVA chose not assign monetary values to these resources; rather, to discuss them in terms of natural metrics, such as concentrations of DO as an indicator of water quality.

3. I would like to see the number and status of native flora and fauna improved even if it means that sport fishing opportunities decrease. **Anonymous, 9**

Response to Comment 3: Comment noted.

4. The lower levels and early pulls has an adverse effect on the biotic community. Does the TVA really care?? Or is power generation their main goal? **Bill Frisbey, 1445**

Response to Comment 4: Power generation is only one of several goals of the operation of the TVA reservoir system. Chapter 2 of the EIS describes in detail the reasons why TVA reservoirs are drawn down each year. Reservoirs are drawn down to maintain flood storage necessary to minimize flood risk, to generate hydropower, to provide minimum flows for aquatic resources, and to meet downstream water requirements, such as providing cooling water for nuclear and coal-fired power plants, processing water for industry, or flow for navigation. See Section 5.7 for a discussion of the potential effects on aquatic resources.

5. Do not want to see the aquatic resources harmed. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3087**

Response to Comment 5: See Section 5.7 for a discussion of the potential effects on aquatic resources.

6. Would like to see commercial musselling banned in all TVA reservoirs. **Chris Perkins, 3830**

Response to Comment 6: State fisheries agencies are responsible for regulating commercial mussel harvest in TVA reservoirs.

7. I also support maintenance of instream flows below TVA reservoirs to support healthy aquatic ecosystems; however, these measures should be enacted only after site-specific instream flow studies that will accurately quantify habitat needs and therefore minimize the amount of hydropower losses to the reservoir projects. In particular, there is no need for minimum releases on the Ocoee #3 and #2 projects because of the highly impaired nature of the river ecosystems from years of pollution in the Copper Basin upstream and from existing hydropower operations. **David M. Ashley, 2096**

Response to Comment 7: While it is true that aquatic resources in the Ocoee River have been devastated by acidic releases from Copper Basin activities for many years, conditions have improved considerably. Tennessee has been successful with acid neutralization at one Copper Basin stream and may eventually be able to treat other streams enough to improve conditions for aquatic life in the Ocoee River. Although minimum flows may not be helpful at Ocoee #2 and #3 presently, they could be in the future. Minimum flows are beneficial for the Toccoa/Ocoee River below Blue Ridge Dam and Ocoee #1 Dam.

8. We need to broaden the discussion to take into account the environmental health of the river system. **Guy Larry Osborne, 1267**

Response to Comment 8: The purpose of much of the FEIS is to discuss factors potentially influencing the environmental health of the river system. These discussions were broken down into individual aspects of the environment that were most likely to be affected by various policy alternatives. Discussion of some specific aspects have been enhanced. For example, the FEIS contains additional discussion of factors that could influence fish spawning success and determination of year class strength (i.e., numbers of fish that attain sizes large enough for capture by traditional sport fishing techniques). It also describes factors that could influence waterfowl and shorebird numbers, if water levels were held high longer into summer and early fall.

9. I am concerned that the quantity and quality of our aquatic habitat is being compromised and our children's children will not have the option of fishing on our waters. **Larraine Nobes, 12**

Response to Comment 9: Aquatic resources and habitats are addressed in a number of EIS sections including, primarily, Sections 4.7 and 5.7.

10. I own a farm at the head waters of South Holston Lake, the South and Middle Fork rivers. My water level has dropped nearly three feet this week. I have noticed for ten years now at the number of fish that are lost to the water level dropping so rapidly. The farm in mention has over 4,000 feet of water frontage. **Larry Akers, 162**

Response to Comment 10: Tributary reservoirs play an important role in flood control; after heavy rainfall and associated runoff, reservoirs must be lowered to regain the flood storage space. Efforts to recover flood storage are made in accordance with prescribed policies that balance the need for recovering flood storage, reducing flood damage downstream, and minimizing environmental impacts in the reservoir. In the specific instance mentioned, the reservoir was lowered to flood guide level within the prescribed policies.

11. Every effort should be made to improve tailwater habitat regardless of which alternative is chosen. **Richard Simms, 2388**

Response to Comment 11: Regardless of the alternative, TVA is committed to maintaining existing tailwater conditions first established in the Lake Improvement Plan.

12. Limitations of the "Tailwater Habitat Alternative"

The Nature Conservancy's primary concern with the draft PEIS is that the management alternative intended to benefit these same aquatic habitats, the "Tailwater Habitat

Alternative," is interpreted as having either adverse or, at best, no effect on either warm-tailwater biodiversity in general or protected species in particular. We believe the problems with this alternative are twofold; the first being the manner in which different species groups were lumped during the impact interpretation, and the second being in the parameters of the alternative itself

In Section 4.7.5, Tailwater biodiversity, cool-water and warm-water tailwater aquatic communities are described separately. However, the discussion of the "Tailwater Habitat Alternative" in Section 5.7.10 lumps these habitat types under one category, "Tailwaters," and concludes that "results suggest no change to biodiversity under this alternative." Native warm- water fauna and introduced cool or cold water species generally have conflicting temperature requirements. Therefore, when these species are combined under the umbrella of" general biodiversity" to interpret effects of the various ROS alternatives, these conflicting requirements may cancel one another out and disguise otherwise beneficial effects for native warm-water species. For example, Section 5.13 - Threatened and Endangered Species, indicates that in warm, free-flowing tailwaters substantial benefits to fauna are seen in many instances under the Tailwater Habitat Alternative. **Scott Davis, Executive Director, Tennessee Chapter of The Nature Conservancy, 3743**

Response to Comment 12: Cool-water and warm-water fish species were combined for the purposes of describing potential impacts on biodiversity. This was done because fish species in both of these groups typically are not restricted in warm- to cool-water habitats (except for high water temperatures that could limit cool-water species; however, these conditions would not occur in tailwaters under any policy alternative). Cold-water habitats on the other hand typically have low biodiversity (see Section 5.7.1). Any alternative that would warm tailwater releases was considered to result in beneficial impacts on aquatic biodiversity. As noted in Section 5.7.2, metrics used to evaluate impacts on biodiversity included several directed at changes in water temperature (some comparing water temperatures during the summer and August-September periods, and another addressing hours with a water temperature less than 16 ^{o}C). As noted in Table 5.7-06, temperature conditions in warm and cool-to-warm tailwaters would not differ from the Base Case, except for the Cherokee Tailwater, which would have lower temperatures that would adversely affect biodiversity in that particular tailwater.

13. Shoreline habitat is vital to fish spawning and here on Kentucky reservoir we have seen severe shoreline habitat loss due to barge traffic, large pleasure boats, and higher lake levels. **Steve McCadams, 3171**

Response to Comment 13: Under the Preferred Alternative, the Kentucky Reservoir operating guide curve would not change from the Base Case.

14. The World Wildlife Fund comments are focused primarily on the aquatic biodiversity aspects of the PEIS.

Section 4.7, Aquatic Resources, [recognizes] "the construction of the TVA reservoir system significantly altered both the water quality and physical environment of the Tennessee River, with little regard at the time for aquatic resources." The reservoir system has indeed created "local extinctions," particularly of native mollusks and fish. However, the compound effect of "local extinctions" in reservoir pools and tailwaters multiplied across the entire Tennessee Valley also resulted in severe habitat fragmentation for our native aquatic fauna. In spite of all this, the remnants of the native Tennessee Valley aquatic fauna still rank among the most diverse on the planet. In fact, World Wildlife Fund, the Nature Conservancy and others recognize the aquatic systems of the Tennessee Basin as some of the most significant freshwater systems in the world. As a result, we feel that TVA must place a strong emphasis on protecting and managing specific reaches of free-flowing river habitat in the Valley in order to minimize the risk of further species extinctions. **Wendy Smith, Executive Director, World Wildlife Fund, Southeast Rivers and Stream Project, 3545**

Response to Comment 14: As indicated in Section 3.4.1, TVA is aware of the wide diversity and the biological importance of several mainstem and tributary stream reaches within the Tennessee River basin. TVA has evaluated—and will continue to evaluate—project-specific activities that could enhance or improve recovery of endangered and other native aquatic species in these areas. TVA made a commitment in the 1990 Lake Improvement Plan to provide minimum flows below TVA projects. No alternative formulated for the ROS would reduce that commitment.

15. Limitations of the “Tailwater Habitat Alternative”

World Wildlife Fund agrees with The Nature Conservancy’s primary concern with the draft PEIS which is: that the management alternative intended to benefit these same aquatic habitats, “Tailwater Habitat Alternative,” is interpreted as having either adverse, or at best, no effect on either warm-tailwater biodiversity in general or protected species in particular. WE believe the problems with this alternative are twofold: the first being the manner in which different species groups were lumped during the impact interpretation, and the second being the parameters of the alternative itself.

In Section 4.7.5, Tailwater biodiversity, cool-water and warm-water tailwater aquatic communities are described separately. However, the discussion of the “Tailwater Habitat Alternative” in Section 5.7.10 lumps these habitat types under one category, “Tailwaters,” and concludes that “results suggest no change to biodiversity under this alternative.” Native warm-water fauna and introduced cool or cold-water species generally have conflicting temperature requirements. Therefore, when these species are combined under the umbrella of “general biodiversity” to interpret effects of the various ROS alternatives, these conflicting requirements may cancel one another out and disguise otherwise beneficial effects for native warm-water species. For example, Section 5.13—Threatened and Endangered Species, indicates that in warm, free-flowing tailwaters, substantial benefits to fauna are seen in many instances under the Tailwater Habitat Alternative. **Wendy Smith, Executive Director, World Wildlife Fund, Southeast Rivers and Stream Project, 3546**

Response to Comment 15: See Response to Comment 12.

16. The general framework of the Tailwater Habitat Alternative, given the constraints imposed by deep reservoir distributed throughout the system, limits TVA’s ability to maintain adequate DO levels in both reservoirs and tailwaters. As evidenced by the success of the Reservoir Release Improvement Program, we believe that TVA can manage reservoir releases to the benefit of the native aquatic fauna. The Tailwater Habitat Alternative as designed does not meet water quality objectives due to reservoir levels that may be excessively high. **Wendy Smith, Executive Director, World Wildlife Fund, Southeast Rivers and Stream Project, 4183**

Response to Comment 16: See Responses to Comments 12 and 14. Although water depth is a contributing factor to low DO concentrations in many reservoirs, citing it alone as a major contributor without acknowledging the complexities of oxygen depletion in the hypolimnion of reservoirs can be misleading. There are numerous examples in the Tennessee Valley region where deep reservoirs exhibit much less oxygen depletion than shallower reservoirs.

Other preliminary alternatives that passed between 50 and 75 percent of the inflow were evaluated in the screening process but were determined to result in substantial adverse impacts on several other operating objectives.

17. As is clearly described in Section 4.4, deep water is a major contributor to low DO levels. Larger releases from reservoirs would allow for water levels to meet other project objectives, reduce residence time, and improve quality of reservoirs and tailwaters. Better quality water and higher tailwater flows would be beneficial to native aquatic fauna. In addition, lower winter reservoir levels would reduce the adverse impact of this alternative on flood storage. Justification should be given for releases of only 25% of inflows or a new alternative should be designed with higher flows. **Wendy Smith, Executive Director, World Wildlife Fund, Southeast Rivers and Stream Project, 3871**

Response to Comment 17: See Response to Comment 16.

Fishing

1. I like fishing **Anonymous, 3174**

Response to Comment 1: Comment noted.

2. You can't fish the banks of the reservoir when lake is full for limbs hanging over – especially true on South Holston and Boone Reservoirs. **Alan Mitchell, 705**

Response to Comment 2: Comment noted.

3. Would like to do what's possible to enhance and preserve fishing. Critical for preserving wildlife. **Ben Robinson, 3977**

Response to Comment 3: State fisheries agencies are responsible for management of the fisheries resources in TVA reservoirs. TVA does work in concert with these agencies when possible to enhance environmental conditions.

4. As a South Holston tailwater fisherman I am concerned about water temperatures stressing trout during the month of August. We have experienced temperatures in excess of 70 degrees Fahrenheit. in May when you are releasing (2) one hour pulses a day in an attempt to bring the lake level to full pool by May 31. **Bob Cheers, 269**

Response to Comment 4: Retention of water in reservoirs such as South Holston enhances tailwater trout fisheries by creating a larger body of cold water. By retaining the water and releasing it at intervals, summer and early-fall water temperatures in the tailwater can actually be decreased (which is better for trout). Section 5.7.11 of the EIS provides additional explanation. In addition, the Preferred Alternative includes increased minimum flow releases from South Holston Reservoir from April 1 through October 31, which would result in colder tailwater temperatures for the downstream fishery.

5. Fishing is a wonderful pastime for many people. Native fish species should be encouraged. Commercial fishing should be monitored and controlled when it threatens to reduce the fish populations. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3104**

Response to Comment 5: See Response to Comment 3.

6. The reduction of the shoreline scrub/shrub wetland habitat will have a significant impact on the spawning success of crappie and largemouth bass on Kentucky Reservoir, as well as other mainstem reservoirs. With significantly reduced spawning success, these species could suffer population declines, which would significantly reduce fishing success.

This loss has the very real potential of decreasing standing stocks of sport fish such as white and black crappie and largemouth bass. If indeed this does occur, the economy of this region will suffer significantly. As it stands now, the summer season finds most resorts filled to near capacity with folks who come to the lake for water-related sports such as boating and swimming. However, most resort owners will tell you that these three months are not what is critical to the success of their business. It is the visitation of fishermen to this area in the months of March through May and September through November that make or break the resort's business for the year. If fishing success suffers as a result of reduced fish spawning and nursery habitat from mortality inflicted by longer periods of full pool water levels, visitation to the resorts will suffer significant declines during the "off-season" time frames previously mentioned. **Gary D. Jenkins, 2110**

Response to Comment 6: TVA's Preferred Alternative would not change the operating guide curve for Kentucky Reservoir, thereby avoiding potential impacts on fish spawning and nursery habitat.

7. In my opinion, the fishery of TVA's mainstem reservoirs could possibly be severely and significantly affected by any alternative which would cause extension of full pool elevation any longer than currently being implemented. **Gary D. Jenkins, 2105**

Response to Comment 7: As discussed in Section 5.7.2, extending the time that reservoirs are kept at full pool would, over a period of successive years, decrease available habitat. Reservoir bottom areas would not be dewatered for sufficient time to allow adequate growing conditions for redeveloping the desirable vegetative growth that provides the nutrient boost, good spawning, and nursery habitat for the fishery.

8. On behalf of Clinch River Chapter of Trout Unlimited. Concerned with summer hydropower alternative could significantly increase number of days of warm water releases that can stress both trout and intvertebrates. Concerned that Recreation Alts A and B could lead to increases in deposited sediment due to increase in periods of minimum flow during summer. We recommend that TVA review possibility of special flushing releases during major rain events when extended minimum flows are in effect. We believe these would not be needed often and cost would be minimum. Second, recommend that TVA look for ways to increase minimum flows above 200 cfs on Norris. **H. B. McCowan, 3944**

Response to Comment 8: Under TVA's Preferred Alternative, these problems would largely be avoided. TVA considers peaking flows to be flushing flows and does this when water is available. Most of the year, the daily average minimum flow from Norris Reservoir is greater than 200 cubic feet per second (cfs). See Appendix A for these flows. These have been included in the Base Case, as well as in each alternative analyzed.

9. Can you explain why fishing has been so bad in the last few years? **James and Lavada Mansfield, 3823**

Response to Comment 9: Numbers of fish typically fluctuate annually, based on numerous environmental conditions and management options. State agencies are responsible for the management of sport fish.

10. More fishing time. **Jerome Alton Connor Jr., 2064**

Response to Comment 10: Comment noted.

11. I think that the Ocoee (upper and middle) needs to have consideration of its fish river habitats like you give to the Hiwassee. The waters going into the Ocoee are being cleaned up in the Copperhill area and the river should be able to support for fish life. But the lack of any but absolute bare minimums except for flood control releases and recreational releases seems to me to preclude much life support in the river sections. **John Hubbard, 2389**

Response to Comment 11: Aquatic resources and habitats are addressed in a number of EIS sections including, primarily, Sections 4.7 and 5.7.

12. TVA does not do a good job of regulating the lakes for fishing... I feel income in the area is probably decreasing rather than increasing due to water control by TVA. **Karen Niehaus, 3853**

Response to Comment 12: See Response to Comment 3.

13. Crappie fishing should get the highest priority in this area. **Kathy Mesmer, 465**

Response to Comment 13: Comment noted.

14. No Sea Bass brought in. They have ruined my crappie fishing. **Marlin Seaton, 2735**

Response to Comment 14: Comment noted.

15. The way that TVA operates the generators affects our ability to put commercial fishing nets in the water. If the flow is high, we cannot work. It's very important that we continue to be able to get the generation schedule off the computer that TVA now provides on their website. It's also important that we be able to get the daily schedule off of the recorded telephone line at Pickwick Dam. **Mike Kelley, 4524**

Response to Comment 15: The recorded flow information systems would not be changed under any of the alternatives.

16. One of the recommended alternatives, and I think it was the navigation alternative, where the flow would be continuously an increase flow would severely affect about 400 commercial fishermen and mussel drivers on the Kentucky Reservoir, from Pickwick Dam down to Kentucky Dam. Again I repeat, when the flow is high, we cannot work. To put it in real numbers, when it is in excess of 30,000 CFS. **Mike Kelley, 4525**

Response to Comment 16: Under the Preferred Alternative, the flow regime at Pickwick is not expected to change materially on a daily basis.

17. Our fish should be managed in the right way. **Paul Howell, 4027**

Response to Comment 17: See Response to Comment 3.

18. Plan A would help fish population along with a TWRA ban on fishing during spawning. **Phillip Davis, 2377**

Response to Comment 18: Comment noted.

19. The list below is people who like fishing in South Holston lake. Mr.& Mrs. Johnny Holmes, Mr.& Mrs. Charles Eastridge, Mark Ford, Mr.& Mrs. Lawrence Eastridge, Rev. Dennis Banks, Mr.& Mrs.Jonathan Duff, Mr.& Mrs. Robert Buchanan,Brian & Richard Duff, Troy Terry, Mr.& Mrs. Ralph Duff. We appreciate you keeping the lake at full stages thank you very much. **Ralph Duff, 306**

Response to Comment 19: Comment noted.

20. Management efforts should be conducted to enhance and improve fisheries resources. **Richard Simms, 2236**

Response to Comment 20: See Response to Comment 3.

21. I will make my comments on fishing here. I have a fishing license, so I fish in addition to boat. I hope that your ultimate operational decisions are not based on lobby from BASS. If fishermen can't catch fish with the electronics that are available to them in today's market, they need to pick another sport. **Suzie Reed, 43**

Response to Comment 21: Comment noted.

22. East Lake here in Morgan County just below west of the railroad bridge, normally here we call it the Flat Areas, a stumpy grass area, I would like to present a restocking area of large-mouthed bass because this area hosts the Bassmasters, other tournaments, revenue for this area.

I have an idea for restocking. They are small concrete octagons with holes in them to hold fish, to put a string of large-mouthed bass and other big bass that would draw revenue tournaments here, but they have to grow, be restocked, no fishing for a couple of years to hold in these grassy areas.

The issue about commercial fishing in the brochure and what I've seen today, I don't believe it was met or nothing was done. Could you look into it and TVA write – give me a letter, call, set up another meeting? **Tim Stewart, 4345**

Response to Comment 22: See Response to Comment 3.

23. Issue of a fish attractor, I am going to pursue it, seek a permit and we'll go with that, see how we do on that. That's for areas for the Bass Pro tournaments, environmental or how y'all list it as – this category would be under Aquatic Fishing, I believe. There's a section here under Sports Fishing and Commercial Fishing. That is what these fish attractors would do, bring revenue, and help the environment, fishing in this area. **Tim Stewart, 4346**

Response to Comment 23: There are guidelines pertaining to the placement of fish attractors on TVA reservoirs. Those guidelines, as well as permits for attractor placement, can be obtained from the appropriate TVA Watershed Team.

24. Would like to see the level of Douglas lake maintained at 2/3 full OR LESS. Duck hunting and fishing seem to be best when the lake levels are kept lower than they are now. Some really big fish were caught from Douglas Lake during the 60s and 70s. No more. **William E. Hixson, 923**

Response to Comment 24: Comment noted.

25. This plan would give the boaters more recreational time in the summer and fall. And also would benefit the fisherman also. **Windel Lester, 125**

Response to Comment 25: Comment noted.

Wetlands

1. Protect the wetlands which help water quality. Even the tailwater habitat increases pooling stability and thus doesn't aid water quality. Address a water quality option. **Anthony Morris, 2716**

Response to Comment 1: Sections 4.4, 5.4, 4.8, and 5.8 address water quality and wetlands. Water quality improvement was an important consideration in the formulation of all the alternatives. Because the alternatives considered span a reasonable range of operations policy, water quality effects or consequences varied. Many demands are placed on the Tennessee River system, all of which TVA considers and integrates when making decisions about the use of available water. Water quality is one of those considerations. For example, TVA operates the river system to provide minimum flows at numerous locations specifically for water quality. Water quality played a very important role in the development of TVA's Preferred Alternative. One of the fundamental changes proposed in the Preferred Alternative is to manage reservoir operations in such a way to achieve certain flows—rather than certain levels—in summer (June 1 through Labor Day). This is expected to improve water quality in low-flow years during the latter part of summer.

2. The emphasis on wetlands is absurd. The protection of so called wetlands is often illogical. Like most matters or causes, extremists seem to rule. **Bill Dearing, 2186**

Response to Comment 2: Wetlands perform a number of very important water quality and ecological functions. Under the Clean Water Act, certain wetlands are protected. In addition, Executive Order No. 11990 establishes a policy under which federal agencies are to avoid construction activities in wetlands and minimize adverse effects on wetlands. As a federal agency, TVA is committed to protection and stewardship of wetlands. Sections 4.8 and 5.8 address wetlands.

3. Preserve existing wetlands and nurture potential wetlands. Do not destroy existing wetlands. They are one of our greatest natural resources. I won't list all their contributions. Constructed wetlands are nice if they are not replacing a natural wetland which was lost through "development." **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3097**

Response to Comment 3: See Response to Comment 2.

4. Wetlands are important to strong ecosystem. **Chris Perkins, 3828**

Response to Comment 4: Wetlands are addressed in Sections 4.8 and 5.8.

5. As indicated in the study, scrub/shrub wetlands on Kentucky Lake and other mainstem reservoirs will suffer significant impacts as a result of increased duration of full pool elevations. **Gary D. Jenkins, 2109**

Response to Comment 5: Potential effects on scrub/shrub wetlands and other types of wetlands are addressed in Section 5.8. Under TVA's Preferred Alternative, operating guide curves for Kentucky Reservoir would not be changed, and the wetlands and flats on that reservoir would not be affected.

6. On Kentucky Reservoir in particular, the shoreline scrub/shrub wetland vegetation was significantly reduced by the change in dates of beginning drawdown starting in the early 1980's. Prior to that change, water started being drawn from Kentucky Reservoir on June 15. The change was to start the drawdown on July 5. This additional two weeks of high water started increasing mortality of plants such as buttonbush, water willow, and black willow that at one time grew out as deep as the 357 contour on the lower portion of the reservoir. Now, one would be hard-pressed to find any of this vegetation thriving below the 357.5 contour, again on the lower portion of the reservoir. With an increased time of inundation of this vegetation as proposed in the current alternatives, it is highly probable this vegetation will suffer greater devastation. **Gary D. Jenkins, 2106**

Response to Comment 6: See Response to Comment 5.

7. I don't like bugs and snakes, but accept them as part of the outdoors. Too many communities are being built at the edge of our lakes and rivers and wiping out the very habitat that made the house on the lake so desirable.

TVA should consider stronger restrictions for homes and communities that build on or near aquatic areas. **Larraine Nobes, 22**

Response to Comment 7: TVA's Shoreline Management Initiative (SMI) (TVA November 1998) and resulting policy addressed this.

8. If TVA messes up in this area it will be a national disgrace. Many school programs talk about wetland communities and youth today are very aware of the need to preserve these areas. Be very careful to stay on the side of conservation rather than progress in management of wetland areas, because many eyes are watching. **Larraine Nobes, 32**

Response to Comment 8: TVA is committed to stewardship of wetlands on TVA reservoir lands. Potential changes to wetlands and other sensitive ecological resources throughout the region have been evaluated. See Sections 4.8 and 5.8.

9. The Base Case presents the least adverse effect on lowland areas and their plant and animal inhabitants. Migratory birds are at risk because of rampant habitat loss. The TVA water system provides a vital "lifeline"for these birds. Their future may very well depend on the flats that are created in the TVA tributary areas at drawdown. Any choice that raises or maintains higher water levels year round will eliminate the flats. Choices that maintain water levels for longer periods of time, miss the migratory time frame. Any of these choices adversely affect migratory birds. Tree species that currently survive with part of the year spent in the dry, would surely suffer under conditions that would keep them submerged year round. Loss of these species would have an adverse effect not only on the aesthetics of an area but also on animals and other plants that depend on them or relate to them in various ways. **Leslie J.Gibbens, 84**

Response to Comment 9: Shorebirds were identified as important resources in the EIS. As noted in Section 5.10, most of the identified alternatives would adversely affect shorebirds, as well as some species dependent on forested wetlands—mostly from the extension of summer pool levels on various reservoirs. TVA considered these impacts when developing the Preferred Alternative and has made changes where appropriate to accommodate this important resource.

10. Wetlands improvement is almost certain to result. **Mark Patterson, 2898**

Response to Comment 10: The wetland analyses conducted for this EIS indicate that holding reservoir levels higher longer would increase the period of inundation of wetlands and flats, and result in some adverse effects. See Sections 5.8 and 5.10.

11. A potential compromise**:** limit drawdown in Douglas Lake to 980 feet from Aug. 1 until Labor Day, then, say, 970 feet until Oct. 1. This would allow plenty of lake surface for recreation and esthetics, and permit power generation during the late summer period of high demand. Most importantly, the established wetland cycle would be preserved and the dependent wildlife species protected. **Michael Sylva Sledjeski, 78**

Response to Comment 11: TVA formulated a Preferred Alternative in an effort to enhance recreational opportunities on a number of reservoirs and tailwaters, while reducing the impacts associated with the alternatives identified in the DEIS. See Appendix C for elevation probability plots along with flood guide curves for tributary reservoirs, including Douglas, under the Preferred Alternative.

12. Wetland sites should be protected and enhanced in every way possible. TVA should not penalize groups who work to enhance wetland habitat through winter flooding. In other words, don't charge people for holding back water for wildlife development projects. **Richard Simms, 2247**

Response to Comment 12: Comment noted.

13. Most of the alternative will increase the flood risk to the managed wetlands on Kentucky and Wheeler Reservoirs. These wetlands provide valuable habitat for many species of fish and wildlife. They are also important areas for recreation activities such as hunting. If changes are made that increase the risk of flooding TVA should mitigate the risk. **Robert Wheat, 2813**

Response to Comment 13: Potential flood risk to managed wetlands and associated infrastructure are discussed in Sections 4.8 and 5.8. Under TVA's Preferred Alternative, operating guide curves for Kentucky Reservoir would not be changed and the important wetlands and flats on that reservoir would not be affected. Wheeler Reservoir minimum winter pool elevations would be raised by 0.5 foot under the Preferred Alternative. See Section 5.14.

Aquatic Plants (Including Invasive Aquatic Plants)

1. Aquatic Plants - Hooray for past programs to retard hydrella and other aquatic plants that choked reservoirs! Hooray! **Anonymous, 3244**

Response to Comment 1: Comment noted.

2. Public should be made more aware of the potential good or bad of plants and trees they may be placing on our shorelines so as not to damage the environment over the long term. **Anonymous, 605**

Response to Comment 2: TVA has an active program that provides information to landowners about beneficial native vegetation that can be used along shorelines.

3. Invasive aquatic plants are a problem and should be vigorously pursued with a goal toward elimination. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3086**

Response to Comment 3: Invasive aquatic plants such as Eurasian watermilfoil, hydrilla, and spinyleaf naiad—the most abundant invasive species in the TVA reservoir system—are so abundant and widespread that eradication is not feasible. Although these species are exotic, they provide benefits to fish and wildlife, and an eradication effort would likely be opposed by angler and waterfowl organizations, and some state resource agencies. TVA works with stakeholder groups to develop reservoir-specific management plans for controlling invasive and nuisance aquatic plants along areas of developed shoreline, where they hinder recreational use or restrict boating access. See Section 4.9.

4. The City of Guntersville is concerned about the impact of the policy changes and their effect on the aquatic weeds that we are dealing with on the Guntersville Reservoir. We have worked with TVA through the Stakeholders Group to manage and control these invasive aquatic plants. We are satisfied with the progress we have made together with TVA and would not support a policy that would hamper or hinder that process. We feel that the Base Plan is working for us. **City of Guntersville, Alabama, 2332**

Response to Comment 4: No reservoir operating guide curve changes are proposed for Guntersville Reservoir under the Preferred Alternative. TVA is appreciative of the support and accomplishments of the Guntersville Stakeholder Group in managing aquatic vegetation in Guntersville Reservoir.

5. I would hope that "Real" science would be used to control the invasive aquatic species of plants, i.e. milfoil and hydrilla. Too many sports fishermen continue to believe that the more plants there are then the more fish there are. Science refutes this and I hope that the TVA is not swayed by emotion put forth by uninformed fishermen. **Harold DeHart, 2132**

Response to Comment 5: Aquatic vegetation in moderate amounts is considered beneficial to the reservoir fishery. However, when aquatic plants become overabundant they can adversely affect fish growth and the structure of fish populations, and hinder angler access to "prime" fishing areas. Aquatic plant management plans are developed to promote balanced use of the resource—controlling aquatic plants in some areas and protecting aquatic plants in other areas as fish and wildlife habitat.

6. As I watched the video, I didn't see any discussion of aquatic plants and plant growth. And my property is on Wheeler Lake and I'm very concerned that we do not get aquatic plant growth similar to what they have on Guntersville Lake.

So I'm curious if these alternatives where we keep the water at a higher level throughout the year, in the wintertime particularly would in any way enhance the growth of these undesirable milfoil or other aquatic plants in the lake.

I like the idea of the lake levels being kept at a higher level in the winter as compared to where it is now, but if there's going to be any adverse affect of enhancing the aquatic plant growth, I would be very disappointed. **John Dumbacher, 4331**

Response to Comment 6: Higher winter levels on mainstem storage reservoirs, such as Wheeler, could favor the establishment and expansion of species such as Eurasian watermilfoil and hydrilla into the area of the drawdown zone that would no longer be dewatered during late fall and winter months. In many mainstem reservoirs, this portion of the drawdown zone with suitable substrate is already colonized—primarily by spinyleaf naiad and other plants that regrow from seed when flooding occurs during summer months. Therefore, higher winter levels could shift the composition of the plant community in the portion of the drawdown zone flooded by higher winter levels. The extension of summer pool levels could slightly decrease coverage of Eurasian watermilfoil and hydrilla colonies on the deep-water side due to a reduction in light penetration and slightly increase aquatic plant coverage in the drawdown zone. Regardless of the alternative, aquatic plants in mainstem reservoirs are expected to fluctuate widely in response to natural climatic and hydrologic events that are beyond the control of TVA. See Sections 4.9 and 5.9.

7. As a fisherman who has been on Kentucky Lake, Barkley, and Priest for several years, I find the lack of aquatic vegetation very disturbing. Years ago, it was possible to see and hear frogs and toads, now they can rarely be seen. I think this may be due to a loss of their habitat and food supply. Consideration needs to be given to bringing back vegetation to support the eco-system needed for reptiles and amphibians. **Larraine Nobes, 16**

Response to Comment 7: TVA recognizes that aquatic plants, including invasive species such as Eurasian watermilfoil and hydrilla, provide benefits to fish and wildlife. TVA also recognizes that an overabundance of aquatic plants impedes many types of recreational activities, restricts access to shoreline areas, and negatively affects the ecological balance within a reservoir. To achieve balanced use of the resource, TVA works with stakeholder groups representing a wide variety of user interests to develop reservoir-specific aquatic plant management plans that allow control in designated areas and protect aquatic plants in other areas for fish and wildlife habitat. Aquatic plants fluctuate widely primarily in response to hydrologic and climatic events that are beyond the control of TVA. Planting of native vegetation is very costly, and expected results are small in comparison to increases that occur during years with optimal growing conditions. See Section 4.9.

8. I am concerned with the growing presence of the aquatic plant Hydrilla that continues to plague Pickwick Lake and the Tennessee River. An aggressive plan to rid this plant of our waterways needs to be developed before it overtakes the regional waters. Last summer there was a sizeable "island"of the plant on the main body of the lake about 1 mile upstream from Pickwick Dam. It caused numerous incidents of damage to boats and PWC but fortunately no loss of life as in other recreational lakes such as Lake Austin in Texas, where uncontrolled neglect of the plant caused an eventual shutdown for a season to recreational boating resulting in major economic impact. **Mark Wiggins, 2275**

Response to Comment 8: See Response to Comment 3.

9. All seven policy changes note that they would have an adverse affect on the abundance and spread of aquatic weeds. This, of course, throws up a "red flag"to us on the Guntersville Reservoir. We would not support any policy that would increase the aquatic weed on our reservoir. **Milla M. Sachs, 2331**

Response to Comment 9: See Response to Comment 4.

10. I would also like to see if there is anything that can be done about water weed control. At one time it was sprayed for, but we have terrible problems with prop fouling. We know the anglers love it, but it causes tremendous problems for us. **Pat McAlister, 2352**

Response to Comment 10: An overabundance of aquatic plants can affect boating and restrict access to developed shoreline and other areas within reservoirs. All aquatic plant management activities within TVA reservoirs are guided by reservoir-specific plans developed by stakeholder groups that represent a wide variety of user interests. These plans promote a balanced approach to the use of the resource, by allowing control in designated areas while protecting aquatic plants in other areas for the benefit of fish and wildlife. See Section 4.9.

11. Aquatic plants good if keep clean **Paul Howell, 4030**

Response to Comment 11: See Response to Comment 3.

12. There should be recognition that some species once considered "invasive,"provide great benefits. Specifically Eurasion milfoil provides great benefits to fish and wildlife, especially waterfowl. **Richard Simms, 2239**

Response to Comment 12: See Response to Comment 3.

13. Management efforts should be conducted to improve and enhance aquatic vegetation in the reservoirs as they provide great benefits for fish and wildlife. **Richard Simms, 2235**

Response to Comment 13: See Response to Comment 3.

14. I would like to see the resource managed to INCREASE the number of aquatic vegetation to provide more habitat for fish and wildlife. **Richard Simms, 2219**

Response to Comment 14: See Response to Comment 3.

15. The plan should recognize that there can be benefits to certain species that some people might consider "invasive."Eurasion milfoil has long been considered "invasive,"yet provides great benefit to fisheries and wildlife. There must be an acceptance of the benefits of some of these invasive species. **Richard Simms, 2225**

Response to Comment 15: See Response to Comment 3.

16. Don't make any changes that will allow more millfoil and hydrilla to grow.
Rita Dumbacher, 3955

Response to Comment 16: Except for the Summer Hydropower Alternative and the Equalized Summer/Winter Flood Risk Alternative, which are expected to decrease coverage of submersed and floating-leaved aquatic plants, climatic and hydrologic events beyond the control of TVA are expected to override any potential changes in coverage associated with the other alternatives during most years (see Section 5.9). Aquatic plants in mainstem reservoirs are expected to continue to fluctuate widely in response to natural climatic and hydrologic events. Hydrilla is expected to continue to expand in TVA mainstem reservoirs under the Base Case or any of the other alternatives.

17. With respect to invasive aquatic plants, we encourage TVA to consider alternative means of controlling plant growth. Reducing nutrient-laden non-point source runoff and point source discharges of nutrients would retard the growth and spread of invasive plants without using herbicides. **Southern Environmental Law Center, 3615**

Response to Comment 17: TVA Watershed Teams currently work with stakeholder groups and local and state agencies throughout the Tennessee Valley region to reduce non-point pollution. TVA also works with stakeholder groups representing a wide variety of user interests to develop reservoir-specific plans for managing aquatic plants. The various options for managing aquatic plants are reviewed prior to development of the plans. Management methods in the plans primarily include the use of herbicides for controlling aquatic plants in near-shore areas of developed shoreline and mechanical harvesters for opening and maintaining boating access lanes.

18. The water levels this summer has reduced the amount of algae and weeds growing in my slough by a considerable amount. **Thomas H. Hollingsworth, 3521**

Response to Comment 18: Comment noted.

Terrestrial Ecology

1. If you chose an alternative plan that does reduce the amount of late summer / fall habitat, I urge you to mitigate this loss by providing a comparable or greater amount of habitat distributed elsewhere across the reservoir system. I would also urge you to commit to managing this replacement habitat in perpetuity. **Benny Thatcher, Graduate Research Assistant, Natural Resources Program, Department of Forestry, Wildlife and Fisheries, University of Tennessee, 2549**

Response to Comment 1: As noted in Section 5.10, most of the identified alternatives would affect flats habitats used by shorebirds and waterfowl. This issue ranked highly when TVA developed its Preferred Alternative. TVA considered potential impacts on threatened and endangered species and on resident and migratory wildlife. TVA's Preferred Alternative better addresses these issues than the alternatives identified in the DEIS, which were formulated to improve recreational opportunities by holding levels higher longer. The Preferred Alternative would result in fewer impacts on wildlife resources than the other action alternatives. For example, under the Preferred Alternative, TVA would not change the operating guide cuves for Kentucky Reservoir, which has flats that are important to migrating wildfowl. See Sections 4.10 and 5.10. Also see Chapter 7 for a discussion of mitigation.

2. Waiting until later to lower water level will cause an undue burden on a majority of people, so that a small minority of wealthy landowners and boat owners can play, and enjoy raised property value....

It will reduce the number of nature lovers who travel to places such as Rankin Bottoms — who spend money there. **Charles, 2653**

Response to Comment 2: Comment noted.

3. Improve the wildlands to support habitats to support as wide a variety of species as possible. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3093**

Response to Comment 3: Comment noted.

4. Particular attention to our R/T/E species habitat which is used year round, breeding habitat, or is an important migratory stop-over for some species. Please be sure that if any of their habitat is lost they will have another place to stop that is as rich as the one they are presently using. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 4181**

Response to Comment 4: See Response to Comment 1.

5. It is my understanding that, in the TVA Reservoir Management Study the Base Case (No-Action Alternative**:** current operating conditions), pool levels begin to drawdown around July 1 each summer by a few inches per day. This results in great habitat for shorebird migration. Regular utilization includes killdeer, plovers, yellowlegs, sandpipers, and dowitchers by the hundreds, perhaps thousands at many sites. However, the TVA does not have comprehensive survey or inventory data. Checking the TNWR bird checklist, 10 waders and bitterns, and over 30 shorebirds could be affected by a change in habitat availability.

If an alternative other than the Base Case is selected and implemented, pool levels will be significantly altered during the peak shorebird migration period, sometimes low, but most times too high to provide the kind of habitat available for them in most normal years. Either way, changes in the current operations will greatly reduce or potentially eliminate this habitat.

TVA should compile all known data on species occurrence, numbers, alternative sites, alternative site utilization, for the project area. Also, assess the potential for reservoir habitat loss and shorebird use with each alternative.

TVA should evaluate potential to avoid impact to certain high quality areas, and nominate these areas as Important Bird Areas. Mitigate loss through creation of other suitable habitat, purchase of other habitats (assuming purchase isn't a high priority habitat for other valuable resources).

Evaluate (research if necessary) use of areas and impact of habitat loss to shorebird energetics during migration. **Christine Liberto**, **2434**

Response to Comment 5: See Response to Comment 1.

6. Delaying of the drawdown will likely cause continued decline of buttonbush as did the delay that occurred in the 80's. This buttonbush habitat is very important for brood rearing habitat for wood ducks. This could cause decline in the wood duck population. Crappie lay their eggs in buttonbush and this is also important habitat for fish fry. Loss of the buttonbush could be damaging to fisheries on Kentucky Lake as well as others. Loss of this habitat will also speed erosion of islands and the shoreline. This buttonbush habitat is also used by breeding prothonotary warblers as well as migrant warblers. This loss could hurt these populations. Presently flats on the lake are important for fall shorebird migration which begins in early July. Delaying the drawdown will reduce this habitat. Pace Point on the Big

Sandy Unit of the Tennessee National Wildlife Refuge used to be the most important migration stopover for shorebirds in the state. The delay that occurred in the 80's significantly hurt this area for shorebirds and another delay will be even more detrimental. Another concern is increased flood risk. Hurricanes and tropical storms from the Gulf Coast often dump very heavy rains on this area in late summer. Flooding at this time could ruin the waterfowl foods on the WMA's and Refuges significantly hurting wintering waterfowl populations and hunting. I feel this change will be very detrimental to habitat and wildlife populations in this area. **Clayton Ferrell, 2498**

Response to Comment 6: See Response to Comment 1.

7. I am concerned about potential adverse impact on breeding and migrating birdlife (and other aquatic life). It is my sincere hope that TVA place a high value on the ecological results of any changes in reservoir operations. It is my understanding that ANY of the changes being considered will harm waterfowl. If this is the case, I would encourage TVA to reject any of the changes.

I realize that this is a complicated and confusing issue, so I would appreciate any additional information (or sources of information) — if a human reads this and can indeed email me. **Dan Feather, 2685**

Response to Comment 7: Your request for additional information has been forwarded to our Resource Stewardship staff for a response. See Response to Comment 1.

8. Finally, the loss of flats would negatively impact shorebirds. Of the 74 species of shorebirds in North America, over one-third are exhibiting population declines, and 22 are considered conservation priorities. Many shorebirds make extremely long migration, some flying from the Alaskan tundra all the way down to the beaches of Argentina. These flights require a tremendous amount of energy, and all feeding sites along the way are critical to the survival of these species. The loss of flats would reduce the chances of survival for many shorebird species. **David A. Aborn, Ph.D., 2091**

Response to Comment 8: See Response to Comment 1.

9. All of your proposed alternatives would increase water levels on the Hiwassee River during the fall and winter, the time when the cranes are here. This would cause the loss of flats and sandbars which the cranes rely on for roosting and feeding. The loss of roosting/feeding sites would result in one of two possible detrimental effects.

The second possibility would be that the cranes stayed in the area, but would begin utilizing off-refuge fields and farm ponds for roosting and feeding. This would result in the cranes being viewed as a nuisance, and could lead to people poaching them or calling for a hunting season on the cranes. **David A. Aborn, Ph.D., 2089**

Response to Comment 9: The mouth of the Hiwassee River is an important area for migrating sandhill cranes. Under TVA's Preferred Alternative, the reservoir operating guide curves would be similar to the Base Case during late fall and winter. Consequently, the flats still would be available to the cranes under this alternative, and potential impacts on sandhill cranes should be minimal.

10. In addition to the sandhill cranes, Hiwassee Wildlife Refuge figures mainly in the efforts to restore endangered Whooping Cranes to the eastern United States. For the past 2 years, ultralight aircraft have been leading flocks of juvenile Whooping Cranes on a migration from Wisconsin to Florida. Hiwassee is one of the places the planes land and the flock spends several days there. The US Fish and Wildlife Service hopes that Hiwassee will be one of the main resting areas for the cranes when they begin migrating on their own. Last year, several of the birds from the previous years' flights did indeed stop at Hiwassee for several days to rest and feed before continuing their migration. The loss of roosting and feeding areas would seriously impair the efforts to restore an endangered species. **David A. Aborn, Ph.D., 2090**

Response to Comment 10: See Response to Comment 9.

11. Serious concerns. All your proposed alternatives would increase water levels on Hiwassee during fall and winter, the time when cranes are here. Causing loss of roosting/ feeding sites, resulting in detrimental effects. **David A. Aborn, Ph.D., 4060**

Response to Comment 11: See Response to Comment 9.

12. One of the most disturbing things about changing the river operating plan is the effects the various alternatives will have upon Rankin Wildlife Management Area on Douglas Lake in Cocke County, I. During the fall, Rankin Bottoms is a crucial migrations stop-over for thousands of shorebirds as well as large waders such as herons and egrets, Bald Eagles, Peregrine Falcons and waterfowl.

Shorebird migration begins in late June and continues until October or even November; however, the peak of this migration occurs from late July through early September. First-year birds (born the previous summer) and non-successful breeders are the first to trickle back through in late June. Early July the males of many species begin to return from the Arctic breeding grounds leaving the females to brood and raise the young. In late July and early August, the females pass through, having left the fledged young to fend for themselves. The juveniles are typically the last to pass through beginning in early August throughout the remainder of the season with peak numbers in late August. The juveniles have a high mortality rate to begin with and depend highly upon reliable migration stop-overs on their long trip south.

In addition to shorebirds, Rankin WMA is important to large wading birds such as Great Blue Heron, Black-crowned Night-Heron, Green Heron, Cattle Egret, Great Egret, Little Blue Heron, Snowy Egret, and White Ibis. The first four species mentioned are known to breed at Rankin; the last four disperse from their breeding colonies further south and come to Rankin specifically to take advantage of the easy feeding opportunities as fish are trapped in ponds as the water level drops. In late August, over 300-400 waders can often be found feeding and roosting at Rankin making the area look more like the Everglades than East I. Local breeding and dispersion into the area are timed to coincide with the lake drawdown.

Bald Eagles also come to Rankin at this time for the easy fishing. Migrating Peregrine Falcons follow the flocks of shorebirds and ducks and can often be seen preying on them at Rankin.

The current operating plan with drawdown beginning on 1 August provides excellent habitat for shorebirds and waders in late August right at the crucial time, during the peak of shorebird migration and during post-breeding dispersal of the large waders. That is why they have learned to come here. Delaying the drawdown until 1 September would mean that suitable habitat at Rankin would not be exposed until late September or even early October, well past the peak migration period for shorebirds, eagles and Peregrine Falcons and after many of the waders will have headed back south **Dr. K. Dean Edwards, 2726**

Response to Comment 12: Most of the proposed alternatives in the DEIS affected waterfowl and shorebirds in varying degrees. Some alternatives reduced the amount of flats habitats by extending summer pool or raising winter pool levels. TVA's Preferred Alternative better addresses these issues than other alternatives that seek to enhance recreational opportunities. See Response to Comment 1.

13. [If you choose to deviate from the Base Case] I urge TVA in the strongest terms to ... to (1) mitigate the loss [of critical habitat for migrating shorebird, herons and egrets] by providing a comparable or greater amount of habitat distributed across the reservoir system, and (2) commit to properly manage this replacement habitat in perpetuity. **Elizabeth Wilkinson-Singley, 2571**

Response to Comment 13: See Response to Comment 1.

14. Additionally, several species of wildlife could be adversely affected by such an action. Many species of birds such as Prothonatary warblers, red-winged blackbirds, utilize this habitat for nesting. Wood ducks use these areas for feeding, resting and fro brood protection. Many species of water snakes and turtles inhabit these habitats. With the loss of this habitat, significant impacts on these species can be expected. **Gary D. Jenkins, 2111**

Response to Comment 14: Comment noted.

15. Raising winter level and not exposing river mud bars would completely do away with waterflow watering at refuges and hunting along the river and at management areas. My lifetime observation show the present policy is working well. **J. Don Burgess, 4164**

Response to Comment 15: The proposed changes under the Preferred Alternative would not result in substantial changes that would affect dewatering activities at associated wildlife refuges and management areas.

16. Reservoir Recreation Alternative A would have an adverse impact on migratory shore birds. This would be beneficial to Chatuge since we have too many Canada Geese that have ceased to migrate. **James B. and Elizabeth F. Eppes, 4014**

Response to Comment 16: Comment noted.

17. We (Candace Myers, PhD and I) are writing a guide to birding sites along Interstate 40. One of our best sites is Rankin Bottoms, particularly for wading and shore birds. Delaying the late summer Water drawdown would eliminate critical habitat for shorebirds, herons, egrets, etc for Tennessee. There are a limited number of migrating flats for these birds in Tennessee. While the drawdown delay might benefit waterfowl such as ducks, geese and swan there are plenty of lakes to accommodate these birds. **James K. Luce, MD, 2513**

Response to Comment 17: See Response to Comment 5.

18. I strongly object to any plan that destroys or endangers bird and other wildlife habitat. Such plans diminish the quality of life in the Tennessee Valley. If TVA chooses an alternative that destroys important bird habitat, I urge TVA to mitigate the loss by providing a comparable or greater amount of habitat distributed across the reservoir system, and that TVA commit to properly manage this replacement habitat in perpetuity. **Jerry Hadder, 2505**

Response to Comment 18: See Response to Comment 1.

19. It is my understanding that there is a proposal to change the time frame the water levels will be increased or decreased. In doing so it endangers the feeding and wading areas of many shorebirds that have built in migratory cycles. I watched a documentary on Yellowstone National Park and how badly it was devastated in the 1920's and through the 1950's all the get the dollars from tourism. Those that use the lakes will not suffer if the boating season is cut short will they? TVA has been an organization that for many years has been trying to balance nature and business and has done a very good job. I hope that you will consider the impact your plan my have on those migratory birds. I will also contact my congressman to let them know what I think as well. **Kelly, 3158**

Response to Comment 19: See Response to Comment 1.

20. The shrub/scrub community at the headwaters of Douglas Lake appears to be at the limits of tolerance to prolonged submersion, More black willows and buttonbushes die off during years of prolonged high lake levels. **Michael Sylva, 2126**

Response to Comment 20: Under the Preferred Alternative, the fall drawdown would be similar (albeit slightly slower) than the average drawdown observed under the Base Case. The changes for Douglas Reservoir are not expected to result in significant reductions of scrub/shrub plant communities.

21. During the winter months, the flats are very unpleasant to look at. Perhaps migratory birds do like flats somewhere but I have yet to see them here. **Michelle Maloney, 2421**

Response to Comment 21: Flats can be an important feeding and resting resource for many birds. See Sections 4.10 and 5.10.

22. The original primary purposes of your dam and reservoir system were power production and flood control. Once in full operation, secondary benefits appeared—some perhaps not anticipated by the planners. As currently operated the system provides excellent fishing year-round, as well as critical habitat for migrating shorebirds, herons, egrets, and other species. In Douglas Lake in particular [where we have for many years enjoyed the fishing and the birdlife], the long months of low water provide time for vegetation growth on the exposed flats. When the water level is raised in the spring, these areas become nurseries for many aquatic species, causing Douglas to be one of the most productive lakes around. And the flats at Rankin Bottoms and elsewhere have become important stopovers for migrating shore- and wading birds in August and September. We feel that delaying the late summer drawdown would be a big mistake. The numerous wildlife species that now call our TVA lakes home have adapted to the patterns of high/low in remarkable and delightful ways. Why can't the people who live on the lakes do likewise? **Thomas and Marian Fitzgerald, 3537**

Response to Comment 22: Comment noted.

23. I have enjoyed Douglas Lake as a fisherman and wildlife observer for many years. If drawdown schedule is changed, what will be the impact on aquatic species and migrating waterfowl that use the flats as they come through? For over 50 years TVA has maintained the same drawdown schedule and I know for a fact as a fisherman when they draw it down in late August, September, but the time you get to October, there are weeds sprouting and in the spring when it fills back up this provides a great place for baby fish who have been spawned. After all these years, when the aquatic and wildlife have attuned themselves, what is the impact? **Tom Fitzgerald, 3953**

Response to Comment 23: Flats must have adequate exposure to air for the annual vegetation to become established. This vegetation provides food for waterfowl, and the exposed flats become feeding areas for migrating shorebirds. See Sections 4.10 and 5.10.

24. It is apparent that many of the alternative reservoir management scenarios outlined in the ROS, would maintain higher water levels during the late summer, fall and winter months. This practice would lead to significant reductions of important habitat for migrating shorebirds, wading birds, and waterfowl, as well as some species of songbirds and raptors. Currently, a large portion of the shorebird foraging habitat available to migrating shorebirds during late summer, and early fall months found in the Tennessee Valley is located within the TVA reservoir system. Unfortunately, this habitat is not quantified. Nor does the study discuss the availability of alternative habitats of the proportion of shorebird, wading birds, and waterfowl in the Tennessee Valley that are dependent on this habitat. This information is critical to the development of measures to mitigate the adverse affect of higher water levels.

We have noted that a few important shore bird areas in mainstream reservoirs, including Pace Point on Kentucky Lake and Savannah Bay on Chickamauga Reservoir, no longer support the late summer/early fall shorebird populations that they did during the 1970s and 1980s (although these areas remain important habitats). This is probably a result of stabilized water levels introduced in the early 1990s, although we cannot determine from the very brief description of previous reservoir policy changes whether this is indeed the case. An explanation of the reduced shore bird numbers at these locations would help in further evaluating the effects of the currently proposed changes.

Among the species that would be adversely affected by increased lake levels are several species included on the US Fish and Wildlife Service 2002 List of Birds of Conservation Concern. These species include Little Blue Heron, Peregrine Falcon, Buff-breasted Sandpiper, Semipalmated Sandpiper, Short-billed Dowitcher, Prothonotary Warbler and Louisiana Waterthrush. Alternative lake management scenarios outlined in the ROS may also adversely affect foraging areas used by the Federally Threatened Piping Plover. We are concerned that the DEIS makes no mention of most of these species or the potential impact that increased lake levels may have on their populations.

We believe higher lake levels maintained during fall and winter months will be detrimental to wintering waterfowl population as well as to wintering sandhill cranes. The largest population of wintering sandhill cranes in the Southeastern US north of the Georgia-Florida border is found in the upper Chickamauga Reservoir. These birds require exposed flats for critical evening roosting sites and for foraging grounds.

We find it difficult to evaluate the birds in Appendix Table D6a-01 because there is no accompanying key in the "Reaches" column. This table lists the Swainson's Warbler (which is also on the USFWS 2002 List of Birds of Conservation Concern) as being potentially directly affected in upland habitats. This species also occurs in bottomland forests in the Kentucky Reservoir area (and potentially in similar habitats elsewhere). These populations could be affected by water level changes in the reservoir and are in fact, probably adversely affected by the current practice of periodic overfilling of the reservoir in the late spring. **Virginia B. Reynolds, President, Tennessee Ornithological Society, 3791**

Response to Comment 24: See Sections 4.10 and 5.10. More information about waterfowl has been added to these sections to respond to comments. Many of the impacts described in this comment are associated with Kentucky Reservoir. Under the Preferred Alternative, the operating guide curve would not be changed and there would be no impacts on the many biological resources that occur on Kentucky Reservoir. This would include species such as piping plovers and least terns that are discussed specifically in TVA's Biological Assessment submitted to the USFWS. The Preferred Alternative would extend some summer pool levels on select reservoirs. However, many of these reservoirs receive limited use by shorebirds (Guntersville) or are used by them as wintering sites (such as Pickwick) under present operations. TVA recognizes that the Preferred Alternative would delay the development of some flats habitats used by shorebirds by extending pools. We are looking at a variety of ways to mitigate or offset these impacts. Lastly, the sandhill and whooping crane resources at Chickamauga Reservoir are identified as important resources in the EIS. Most flats habitats on Chickamauga Reservoir are not available until mid-October. The weekly scheduling models for the Preferred Alternative indicate that reservoir levels would be similar to those of the Base Case by October 1, and would remain at Base Case levels through April 1. Therefore, TVA does not anticipate impacts on sandhill cranes or their habitat under the Preferred Alternative.

25. I am concerned over the loss of late summer/early fall habitat for shorebirds, herons, egrets, and other species, as well as the loss of winter flat habitat. These birds do not have much habitat left and they need our help. **Wayne Patterson, 2532**

Response to Comment 25: See Response to Comment 5.

Invasive Terrestrial and Aquatic Animals and Terrestrial Plants

1. Let's fight the invasives. **Anonymous, 3073**

Response to Comment 1: Sections 4.11 and 5.11 address invasive species.

2. Stop the spread of invasive plants and animals on land and in the water. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3089**

Response to Comment 2: Comment noted.

3. Invasives**:** our animals and fish should be protected from. **Paul Howell, 4031**

Response to Comment 3: Comment noted.

Vector Control (Mosquitoes)

1. Put up boxes for purple martins. **Anonymous, 3245**

Response to Comment 1: Comment noted.

2. In the 18 years I have been associated with the use of Lake Hiwassee, this is the first year I have seen mosquitoes to be a problem. Right now, not a severe problem, but this is the first year we have even seen problems. This might be studied as a potential problem keeping the water at full pool for too long, caused by the flooding conditions we have had this year **Anonymous, 624**

Response to Comment 2: This was studied as part of the FEIS. See Sections 4.12 and 5.12. Due to unusually heavy rainfall periods, there was an increase in the mosquito population because depressions in the floodplains were continually being filled by rain and high waters. TVA removed the high water as quickly as possible while reducing further flood damage. However, water remained in these pools to produce mosquitoes. The Preferred Alternative does create a potential for increased mosquito breeding habitat.

3. Do whatever it takes to reduce number of mosquitoes. **Bill Dearing, 2187**

Response to Comment 3: TVA fluctuates water levels on four mainstem reservoirs—Chickamauga, Guntersville, Wheeler, and Pickwick—for the suppression of mosquitoes and would continue to do so under all of the alternatives identified in the EIS. See Sections 4.12 and 5.12 for a discussion of vector (mosquito) conditions.

4. They used to have it and we would like it back. **Carolyn Ippisch, 3135**

Response to Comment 4: TVA no longer uses pesticides for the control of mosquitoes. The TVA mosquito program includes the fluctuations of four mainstem reservoirs for the suppression of mosquito populations. The program also conducts disease surveillance. When TVA has a positive mosquito sample for a virus the state health department is notified. See Sections 4.12 and 5.12 for a discussion of vector issues (mosquitoes) and Sections 4.11 and 5.11 for a discussion of invasive plant issues.

5. Is there habitat for the natural predators of mosquitoes? Bat/other insects eat many mosquitoes. Would like to see natural controls used. Are there particular seasons (such as we are experiencing in WNC) when the mosquitoes are worse? If so, then a flexible approach would be best. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3095**

Response to Comment 5: There is habitat for natural predators of mosquitoes. It is the same habitat as that for mosquitoes. These predators are small fish and dragonflies. Dragonflies are one of the most efficient predators of mosquitoes. According to many university studies, bats do not eat enough mosquitoes to reduce the abundance of mosquitoes. Spring is typically a worse time for mosquitoes; however, anytime there is an increase in rainfall, there will be an increase in mosquitoes. TVA fluctuates water levels on four mainstem reservoirs for the suppression of mosquitoes.

6. Would like to see mosquito control. **Chris Perkins, 3829**

Response to Comment 6: See Response to Comment 4.

7. I'm a resident of Lakeshore Campgrounds where I camp during the summer. The biggest problem we have over there is TVA lowering the lake so much. We get these ponds every time they lower it and mosquitoes are terrible over there because the water doesn't drain. It gets in there somehow but it won't drain until it evaporates. **Danny Matas, 4352**

Response to Comment 7: See Response to Comment 4.

8. You need to start spraying for mosquitoes. **David C. Johnigk, 4187**

Response to Comment 8: See Response to Comment 4.

9. If the users of Boone Lake can manage this [mosquito] problem with high lake levels in the summer, the users of South Holston Lake can also manage this potential problem with Alternative A. **Greg Robinson, 2976**

Response to Comment 9: Comment noted.

10. Obviously, this is an important issue, especially in light of the West Nile Virus. Continued [mosquito] control is of utmost importance. **Harold DeHart, 2134**

Response to Comment 10: See Response to Comment 4. West Nile Virus is transmitted by container-breeding mosquitoes (for example, mosquitoes that breed in tires, birdbaths, buckets, and clogged gutters). These types of mosquitoes are not affected by the operation of the reservoirs.

11. If the lake users on Boone Lake can manage this [mosquito] problem with high lake levels in the summer, the users of South Holston Lake can also manage this potential problem with Alternative A. **Joseph A. Robinson, Jr., 2619**

Response to Comment 11: Comment noted.

12. The lakes are left very high until mid-June and dropped too low by mid-August. Causes a definite mosquito problem. **Karen Niehaus, 3854**

Response to Comment 12: Comment noted. The drop in August actually decreases mosquito populations. During the summer pool levels in June, mosquito populations typically increase. During this increase, TVA monitors the mosquitoes for viruses.

13. Sanity needs to be part of this area – in the words of Benjamin Franklin, “Moderation in all things.”**Larraine Nobes, 27**

Response to Comment 13: Comment noted.

14. Mosquitoes and diseases associated with them is a major issue that should be addressed. It has become a major concern. If any change will cause more stagnant water to pool and cause mosquito populations growth that should be a concern. **Linda Coons, 2309**

Response to Comment 14: See Sections 4.12 and 5.12. The TVA mosquito program includes the fluctuations of four mainstem reservoirs for the suppression of mosquito populations. The program also conducts disease surveillance. When TVA has a positive mosquito sample for a virus, the state health department is notified.

15. Need to spray to reduce mosquitoes and milfoil. **Marvin and Lili Scott, 3987**

Response to Comment 15: See Response to Comment 4.

16. I think mosquito control should be reinstated. **Mrs. Jean Roberts, 1916**

Response to Comment 16: See Responses to Comments 4 and 10.

17. Mosquito Control, yes we need to control mosquitoes **Paul Howell, 4032**

Response to Comment 17: Comment noted.

18. The lower and raise policy for vector control should be maintained at all costs... there need to be people to use the resources and aside from health issues, there is a need to encourage recreational use and as such, less bugs=more fun. **Pr. John Freitag, 994**

Response to Comment 18: See Response to Comment 14.

19. Once upon a time, TVA had a mosquito control program. They would raise the lake level for a few days, giving the mosquito’s time to lay their eggs, then they would drop the lake level abruptly, killing the eggs. I don’t remember ever having a mosquito problem in those days. As it stands today, I can’t go outside without being eaten alive. This lake level control process did not require any chemicals or spraying and was very effective in controlling the mosquito population. **Suzie Reed, 47**

Response to Comment 19: See Response to Comment 4.

20. New viruses are found on mosquitoes. It is very important for TVA to start again spraying for mosquitoes before we all have West Nile. **Thomas Browning, 618**

Response to Comment 20: See Response to Comment 10.

21. The number of mosquitoes in my area has been drastically reduced since early June. Since we have had more rain than usual I can only attribute this drop to higher water levels. **Thomas H. Hollingsworth, 3522**

Response to Comment 21: The reduction of mosquitoes in the commenter's area is probably the result of two things: (1) mosquito populations naturally drop during summer, and (2) TVA fluctuates water levels on four mainstem reservoirs for the suppression of mosquitoes.

22. Improved efforts to control mosquitoes would be helpful, especially at our site, we now use two (2) LP gas fired Deleto units to control our sites exterior areas and will provide screened porch at addition. **Thomas L. Parker, 3992**

Response to Comment 22: See Response to Comment 4.

23. I think mosquito control should be reinstated and be a high priority **Vernon Roberts, 1921**

Response to Comment 23: See Response to Comment 4.

Threatened and Endangered Species

1. I would like to suggest that on lands adjacent to TVA holdings that contain cultural resource that TVA advise the local jurisdictions of the significance of these resources and ways they may be protected. The same should be done for other sensitive resources such as Threatened and Endangered Species, etc. **Barbara Garrow, 471**

Response to Comment 1: With regard to endangered species, the Tennessee Valley region supports a large number of species that are protected at either the federal or state level. Whenever it is involved with a project, TVA works with local entities to avoid or mitigate adverse effects on protected species in the area. However, identification of specific sites of sensitive resources may not always improve their protection, especially cultural resources.

2. [I am] for protecting T&E species **Ben Robinson, 3978**

Response to Comment 2: Sections 4.13 and 5.13 address threatened and endangered species.

3. In the area of threatened/endangered species, it appears extremists are calling the shots. **Bill Dearing, 2188**

Response to Comment 3: Comment noted.

4. This is one area that we feel TVA has been largely successful with--we would however, encourage TVA to expand it's programs in this area and encourage it. **Jean Prater, 1381**

Response to Comment 4: Comment noted.

5. The Tennessee River system is home to what is undoubtedly the most important community of freshwater mussels in the world. Protection of this globally valuable resource should be a very high priority, especially in tailwaters of Pickwick, Wheeler and Guntersville dams. One specific situation which should receive consideration is in Wilson Dam tailwaters. There are at least four and probably five federally endangered mussels in the riverine reach downstream of the dam. With no flow from the dam when power is not being generated or water spilled for flood control (which is an almost daily occurrence) treated wastewater from the Florence sewage treatment plant accumulates until the daily start of generation (late morning). Minimum flows from Wilson Dam (enough to keep the wastewater flushed) would likely be very beneficial to that mussel community. Several species in that river reach will likely be lost over the next decade due to very low recruitment. Mitigation of this problem with minimum flows could prevent their loss. **Jeff Garner, 2842**

Response to Comment 5: Information provided by the Alabama Division of Wildlife and Freshwater Fisheries has helped TVA stay aware of the importance of the fresh-water mussel stocks in northern Alabama, including the presence of endangered mussel species. TVA has met with state regulatory agencies to discuss possible causes and solutions for the reported stresses to mussel stocks downstream from Wilson Dam. At present, the identification and resolution of those problems appear to be state water quality matters instead of issues that TVA should attempt to identify and address—particularly in the context of evaluating alternative operations policy that are system-wide and not location specific.

6. These practices [?] have not only been very harmful to habitat, but have left the streams almost destitute of freshwater mussels and probably some other aquatic groups as well. An excellent remnant population of freshwater mussels, including two federally endangered and several other sensitive species, is located in the lower reaches of Bear Creek, just above the reach influenced by Pickwick Reservoir. Should the flow regime from the Bear Creek dams be adjusted, and instability problems mitigated, mussels from that population would likely expand upstream to repopulate the system. **Jeff Garner, 2844**

Response to Comment 6: As indicated in Section 3.4.1, TVA is not proposing changes in operation of the Bear Creek Projects as a part of the ROS.

7. There appears to be very little justification for this [Tailwater Habitat] plan, except in limited areas such as the Apalachia Bypass. It appears to me that the Apalachia Bypass is unique enough to be an exception to the general plan. **Michael A. McMahan, 2387**

Response to Comment 7: As indicated in Section 3.3.8, this alternative was included in the evaluation to specifically look at ways the reservoir system might be managed that would benefit tailwater aquatic habitats. With regard to the flow augmentation through the Apalachia Bypass, as indicated in Section 3.4.1, that proposal would be implemented under any of the identified alternatives.

8. T&E: Should be protected, there are too many people sport fishing and hunting. They kill and leave laying. My daddy told me don't take what you don't use. **Paul Howell, 4033**

Response to Comment 8: Comment noted.

9. Threatened or endangered species didn't matter to TVA as it built Tellico Lake. Why should they now? **Richard Simms, 2233**

Response to Comment 9: Comment noted.

10. Project-specific recommendations to protect native aquatic species

While the Nature Conservancy appreciates the system-wide comprehensive nature of the ROS, in order to guard against further extinctions of native mollusk and fish species. TVA must focus financial resources and management efforts on specific free-flowing tailwaters downstream from several tributary and mainstem dams. We are pleased that TVA recognizes that "in some... tailwater reaches, the abundance and diversity of these aquatic communities could be improved through a combination of operational and physical modifications to the dam" (Section 34.1- Biodiversity Considerations). We also are very encouraged that TVA may consider "other project-specific actions to improve biodiversity...on a case-by-case basis as the opportunity for habitat improvement is identified" (Section 34.1- Biodiversity Considerations).

Based on TVA Heritage and other expert-derived data, The Nature Conservancy considers the following five tributary tailwaters to be of extreme significance for the protection of our remnant native fauna**:** the Duck River downstream from Normandy Dam, the Elk River downstream from Tims Ford Dam, the French Broad River downstream from Douglas Dam, the Holston River downstream from Cherokee Dam, and the Hiwassee River downstream from Apalachia Dam.

Surveys in 2001 and 2002 of the mollusk fauna in the Duck River funded by a grant from the Tennessee Environmental Endowment to The Nature Conservancy and conducted by U.S. Geological Survey and TN Aquarium Research Institute researchers indicate that the Duck River fauna is responding dramatically to improvements made in aeration and minimum flow releases from Normandy. We are pleased that TVA plans to continue these management strategies on the Duck in the future. The Elk River downstream of Tims Ford represents the second longest tailwater in the system and contains potential habitat for a wide range of native aquatic species. We encourage TV A to continue its investment in evaluating operational strategies at Tims Ford to improve native aquatic diversity downstream (Section 3.4.1- Biodiversity Consideration).

In addition to the Duck and Elk project improvements in the central Tennessee Valley, we support TV A's efforts to provide minimum flows on the Hiwassee downstream from Apalachia dam to enhance aquatic diversity (Section 3.4.1- Biodiversity Considerations). The Nature Conservancy requests that TV A consider evaluating management actions to improve water quality conditions for native species on the French Broad River downstream from Douglas Dam and the Holston River downstream from Cherokee.

Available data suggests that on the mainstem of the Tennessee River, the most significant reaches of habitat for native aquatic species are located downstream from Guntersville dam, including the tailwaters of Wheeler, Wilson, and Pickwick dams. TVA should explore potential management actions that would improve DO in releases from these four dams and create a more gradual drawdown from Pickwick. Managing these lower reaches of the Tennessee's mainstem for the enhancement native aquatic species, particularly mussels, is critical because of severe population declines in the upper 350 miles of the mainstem due to hydrologic alterations and sediment toxicity issues **Scott Davis, Executive Director, Tennessee Chapter of The Nature Conservancy, 3741**

Response to Comment 10: As indicated in Section 3.4.1, TVA is aware of the high diversity and the biological importance of several mainstem and tributary stream reaches within the Tennessee River basin. See Sections 4.13 and 5.13. Under TVA's Preferred Alternative, additional scheduled releases would be provided in several tailwaters. Apart from the ROS, as indicated by this comment, TVA has devoted substantial resources to addressing sensitive populations at a number of locations, including mussels in the Duck River. TVA decided to dismantle Columbia Dam and commit most of the property acquired for that project to natural resource management and recreation. This protected the diverse species that reside in the Duck River watershed, including a number of threatened and endangered mussel species. See Final Environmental Impact Statement, Use of Lands Acquired for the Columbia Dam Component of the Duck River Project (April 1999).

11. In addition to managing the Tennessee River system for navigation, flood control, power production and water supply, TVA must comply with the Clean Water Act and with the Endangered Species Act. In particular, Section 313 of the CWA, 33 U.S.C. 1323, requires TVA to operate its dams in compliance with Tennessee water quality standards, including the narrative standard for aquatic habitat which implicitly requires sufficient instream flow in the mainstem and tributaries to protect aquatic habitat for all native species of fish, mussels and other aquatic organisms. TENN. COMP. R. AND REGS. R. 1200-4-3-.03 (3) (j) (2003). The ESA, in turn, requires special attention be paid to the conservation and recovery of endangered and threatened species. 16 U.S.C. § 1546 (a); 50 C.F.R. § 402.02. The preservation and restoration of natural flow regimes can be important to meeting the requirements of both the CWA and ESA. **Southern Environmental Law Center, 4222**

Response to Comment 11: TVA has strategies in place for complying with all applicable environmental requirements, including those established under the Clean Water Act and the Endangered Species Act. Various sections address aquatic resources and habitats and threatened and endangered species. See Sections 4.7, 4.13, 5.7, and 5.13. As indicated in Section 5.13 and the USFWS Biological Opinion concerning this project (Appendix G), TVA has complied with Section 7 of the Endangered Species Act.

12. While both the World Wildlife Fund and The Nature Conservancy appreciate the system-wide comprehensive nature of the ROS, in order to guard against further extinctions of native mollusk and fish species, TVA must focus financial resources and management efforts on specific free-flowing tailwaters downstream from several tributary and mainstem dams. We are pleased that TVA recognizes that "in some...tailwater reaches, the abundance of diversity of these aquatic communities could be improved through a combination of operational and physical modifications to the dam" (Section 3.4.1-Biodiversity Considerations). We also are very encouraged that TVA may consider "other project-specific actions to improve biodiversity...on a case-by-case basis as the opportunity for habitat improvement is identified" (Section 3.4.1-Biodiversity Considerations).

Based on TVA Heritage, The Freshwater Initiative of TNC, WWF's assessments of priority watershed and other expert-derived data, the World Wildlife Fund considers the following tributary tailwaters to be of extreme significance for the protection of our remnant native fauna**:** the Duck River downstream from Normandy Dam, the Elk River downstream from Tims Ford Dam, the French Broad River downstream from Douglas Dam, the Holston River downstream from Cherokee Dam, and the Hiawassee River downstream from Apalachia Dam.

The same data suggests that on the mainstem of the Tennessee River, the most significant reaches of habitat for native aquatic species are located downstream from Guntersville dam, including the tailwaters of Wheeler, Wilson, and Pickwick dams. TVA should explore potential management actions that would improve DO in releases from these four dams and create a more gradual drawdown from Pickwick. **Wendy Smith, Executive Director, World Wildlife Fund, Southeast Rivers and Stream Project, 3548**

Response to Comment 12: See Response to Comment 10. As indicated in Section 3.4.1, TVA is aware of the high diversity and the biological importance of several mainstem and tributary stream reaches within the Tennessee River basin. TVA has evaluated, and will continue to evaluate, project-specific activities that could enhance or help recover endangered and other native aquatic species in these areas.

Managed Areas and Ecologically Significant Sites

1. The TVA managed areas are no longer managed or maintained well. Over the years, we have enjoyed these areas for picnics, camping, launching our boat, etc. There are no longer safe places to launch, mowed places to picnic or camp, trash barrels to deposit litter, or easy access to these areas because roads and drives are no longer maintained. It appears to us TVA is trying to restrict access to the waterways for recreational uses. **Jean Prater, 1379**

Response to Comment 1: The budgets for most of the governmental entities, including TVA, that have maintained managed areas have been strained. TVA continues to maintain its facilities within the constraints of its available resources.

Shoreline Erosion

1. We are aware that some of the small farmers had to place fences along the creeks and riverbeds to keep the cattle from eroding the edges of the streams and river. But at the same time some LARGE cattle farms are still using the shoreline for cattle watering holes, thereby eroding the edges of the natural river (lake) beds. **Anonymous, 611**

Response to Comment 1: Within the limitations of its resources, TVA tries to monitor such activities on its lands licensed for agricultural uses. Other entities, such as the USEPA and state environmental agencies, potentially have regulatory authority over the activities described in this comment.

2. Shoreline Erosion – Encourage USCOE [to provide] permission for riprap. **Anonymous, 3246**

Response to Comment 2: TVA recognizes that shoreline erosion can be a problem, and we work with the Corps and others to address the issue by providing technical help and information about preventing and repairing shoreline erosion.

3. I think that if TVA would help people with the erosion that live on the lake we could clean up the lake. **Anonymous, 141**

Response to Comment 3: See Response to Comment 1. TVA does provide technical help and information about preventing and repairing shoreline erosion. Contact the Watershed Team office for your reservoir.

4. Provide information and assistance to residents as to how to stop erosion. **Anonymous, 159**

Response to Comment 4: See Response to Comment 2.

5. I am concerned that areas of the lakes are filling with runoff soil and may cause increased chances of injury to users of the lakes and property values to fall over time as once used areas can not be accessed with water. **Beth Carey, 1714**

Response to Comment 5: Siltation of reservoirs is more likely caused by sediment from activities in the watershed rather than by shoreline erosion. Erosion issues are addressed in Sections 4.16 and 5.16.

6 Shoreline erosion needs to be addressed. Landowners should be allowed to protect their land from erosion. **Bill Dearing, 2189**

Response to Comment 6: Shoreline erosion was addressed as a major issue in this EIS. See Sections 4.16 and 5.16.

7. Shoreline erosion is ugly, pollutes the water. Trees, plants and others are also lost as the shoreline erodes back further and further. The only positive comment I can think of is that some aquatic species might find temporary shelter. But temporary shelter can be provided without the losses caused by shoreline erosion. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3092**

Response to Comment 7: TVA recognizes that shoreline erosion can be a problem, which is why it is addressed as a major issue in this EIS. See Sections 4.16 and 5.16.

8. I yield to your experts on this subject [of erosion]. However, 9 years on Watauga Lake (with its substantial Summer-Winter-Summer level changes) lead me to a somewhat different conclusion. The current system usually leads to a 10' water level drop (1959 to 1949) from June 1 to August 1. Thereafter, the level continues to fall, reaching 1940 or sometimes as low as 1935 during the winter. Then, the level rises in the Spring as the lake is refilled. The cycle repeats.

The issue is not the water level change. Rather, it is the level change during moderate to high boating seasons. What this does is subject almost the entire shoreline height to erosion. Specifically, as the level drops during the Summer/early Fall, you can see that boating waves cut a series of small "steps" in the shoreline. Then, when the level rises, these steps become focal points to undercut the shoreline.

In contrast, when levels are held at a high, constant point during the boating seasons, then erosion occurs mostly at that single high level. There is little if any of the "undercutting" which I have seen to cause large-scale erosion. Rather, over time the erosion pattern creates a stable, gentle slope. Please consider this. **Colman B. Woodhall, 392**

Response to Comment 8: Erosion of the reservoir bank below full pool is an unavoidable consequence of changing water elevations. Although there is a slight water quality impact from this erosion, it is small compared to the sediment contributions from the watershed. Most concern has been for erosion of the full-pool shoreline because usable land is lost when this area erodes. For erosion that occurs within the reservoir pool, no net storage is lost when the eroded material settles elsewhere in the pool. See Sections 4.16 and 5.16.

9. This comment applies specifically to Watauga Lake, and may just be a misunderstanding on my part. Currently Watauga is managed to Jan 1 = 1940', March 15 = 1952', June 1 = 1959', and August 1 = 1949'. Alternative A proposes (if I understand it correctly) to manage Watauga to Jan 1 = 1952', March 15 = ?', June 1 = 1959', and Labor Day no lower than 1949'. It seems then, that the lake level would actually rise from Labor Day (1949') to Jan 1 (1952'). Also, that implies that the majority of lake "pulldown" occurs in the Summer (1959' to 1949'). Somehow, these results do not appear logical. But, logical or not, the Summer pulldown does imply large-scale erosion during that period. Please consider leaving the lake somewhat higher (at least to the Mar 15 level) during the Summer, even if that means a more rapid pulldown after Labor Day.

PS – nowhere could I find specific lake levels corresponding to controlling the 7-day, 500-year flood. Based on the narrative, I presume these would be higher than the stated Alternative A levels. **Colman B. Woodhall, 394**

Response to Comment 9: Reservoir Recreation Alternative A would hold Watauga up to about 1,955 feet on Labor Day on average and not decline to 1,949 until mid-October.

All the action alternatives, except the Commercial Navigation Alternative, have higher average winter levels than the Base Case and, therefore, slower drawdown and higher water in late summer and fall. See the box plots in Appendix C.8 for median elevations.

10. In the past eight to ten years we have lost about six to eight feet of our shoreline to erosion. At the present time there's a real serious situation relating to watercraft safety in and out of our cove, located between lake markers 6 and 7. Both types of boats, especially jet skis, are creating a very serious problem relating to boat safety and shoreline erosion. Extreme watercraft speeds are wearing away the shoreline and may eventually cause a future serious accident. We are recommending that a No Wake safety buoy be located at the cove entrance to warn boaters about boat speed. Decreasing boat speed will hopefully decrease shoreline erosion. That's where we are with the situation. **D. C. Wenberg, 4411**

Response to Comment 10: Erosion is addressed in Sections 4.16 and 5.16. The state agencies are primarily responsible for regulating boating activity and setting no-wake zones.

11. In the DEIS it mentioned a negative shoreline erosion condition with Recreation "A" alternative. I can see that at full pool more erosion of shoreline would be possible, but I wondered if you took into account that under the Base Case we get tremendous shoreline erosion during the winter pool levels when we have erosion of the area from the full pool shoreline to the winter shoreline. In some areas this is 50 to 150 feet of bare ground and we get tremendous erosion during the low pool level. **Doug Triestram, 1752**

Response to Comment 11: TVA did take this into account when evaluating the potential effects on erosion from identified alternatives. Sections 4.16 and 5.16 summarize TVA's evaluations. Erosion of the reservoir bank below full-pool is an unavoidable consequence of changing water elevations. Although there is a slight water quality impact from this erosion, it is small compared to the sediment contributions from the watershed. Most concern has been for erosion of the full-pool shoreline because usable land is lost when this area erodes. For erosion that occurs within the reservoir pool, no net storage is lost when the eroded material settles elsewhere in the pool.

12. It might be cost effective along with the Water Study to initiate a 'soil erosion protection plan' for the Water Study area using air and satellite photos. This could be part of a water conservation plan for all states in Study area and inter-basin transfer states. **Frank DePinto, 3984**

Response to Comment 12: Relating to erosion, reservoir shorelines have all been assessed and catalogued, as have some of the tributary tailwater streambanks. TVA has ongoing programs to address erosion issues on TVA-owned land and to provide technical support on private land.

13. The lake [Kentucky] is so silted in that when you draw down to 354 the lake becomes very dangerous. Holding it to 356 during winter would make it much safer for winter activities. Since the 354 was established ,many years ago the lake has silted in many feet. The canal dredged behind my property in Jonathan creek, 7 years ago, has silted in over two feet. What considerations have been made on this problem in the last ten years? **Garland Wyatt, 2047**

Response to Comment 13: Erosion is addressed in Sections 4.16 and 5.16. Siltation of reservoirs is more likely caused by sediment from the watershed than shoreline erosion. TVA and other agencies have programs that work to reduce erosion and resulting sedimentation from upstream. TVA also provides advice and assistance to private landowners with erosion problems. Under the Preferred Alternative, the operating guide curves on Kentucky Reservoir would not change.

14. I have a home on Lake Chatuge. I'm also chairman of the Sediment and Erosion Overview Counsel for the state of Georgia. We are very concerned about the environmental impact of the erosion in the lakes. And this year, in particular, we have noticed or I have noticed since the lake has been as high as it is, the water quality has been substantially improved. And I believe the reason for that is that because the levels are more consistent instead of eroding the soil when the lake levels are lower than what they are now. And so by having the water level as high as it is, you don't have that constant up and down effect of the lake where it reaches not only the soil but it reaches the silt and allows the silt to come into the lake. **Jack Miller, 4304**

Response to Comment 14: If reservoirs were maintained at a constant level all year, it is likely that shorelines would continue eroding until they reached a stable angle. However, this process would be slower than under existing conditions because vegetation would become better established. Changes in water level contribute to erosion because the changes in the growing environment prevent establishment of stabilizing vegetation. Changes in elevation also make the erosion that occurs at high water visible. Sometimes banks that are undercut during high water collapse when the water goes down; however, these would collapse eventually anyway.

TVA formulated a preliminary alternative that held reservoir levels constant, but this was determined to result in unacceptable flood risk and was not included for further detailed study or as an element in the Preferred Alternative.

15. We suggest that the shorelines of all islands in Lake Chatuge be covered with broken rock to reduce shoreline erosion and improve beauty during periods of low level **James B. and Elizabeth F. Eppes, 4000**

Response to Comment 15: This EIS evaluates the potential effects of system-wide operational changes. Site-specific concerns, such as the one identified in this comment, are addressed in other forums. TVA has an ongoing program to assess and address shoreline conditions. This assessment information is used to prioritize the stabilization of TVA-owned areas. If the areas mentioned in this comment are owned by TVA, they are in this assessment. For areas not owned by TVA, we offer technical support. Also see Response to Comment 13.

16. In the winter the water goes down too much. It seems that we should be able to go through the winter so low. Especially on Lake Chatuge. There has also been so much erosion in front of my home …The Dock seems to be sitting in the mud sooner. Is there any way to slow that down or can the TVA correct this problem. **Jane Chinnici, 1421**

Response to Comment 16: Erosion is addressed in Sections 4.16 and 5.16. See Responses to Comments 13 and 15.

17. I think, there's been a lot of erosion of water going back and forth, and it seems to be worse now than it was ever before, and I don't know if they're going to have some kind of correction for the areas that are eroded so poorly. **Jane Chinnici, 4298**

Response to Comment 17: See Response to Comment 14.

18. Reaches downstream of the Bear Creek reservoirs have been sites of very bad stream bank erosion and stream bed instability since the dams were constructed. The regime for winter drawdown of those reservoirs appears to be the primary culprit, with water held well into the autumn, then released over a short period prior to the rainy season. **Jeff Garner, 2843**

Response to Comment 18: As indicated in Section 3.4.1, TVA is not proposing to change operation of the Bear Creek Projects as a part of the ROS. Erosion is addressed in Sections 4.16 and 5.16.

19. TVA needs to survey TVA controlled shorelines and develop a plan to minimize shoreline erosion. **Jerry Stephens, 253**

Response to Comment 19: TVA does have an active program that does this. See Section 4.16.2 and Responses to Comments 13 and 15.

20. It is a shame that each year we as landowners are losing our land to erosion, for the purpose of TVA profits, not flood control. **Jimmy and Amy Owens, 478**

Response to Comment 20: Erosion is addressed in Sections 4.16 and 5.16. Although the generation of electricity is one of the operating priorities of the TVA system and revenue is produced from the TVA power system, TVA does not operate the system to produce profit. TVA's operations are non-profit.

21. Jet skis are eroding the shore line on Lake Nottley. No one is monitoring the damage or concerned with doing anything about speeding jet skis and the destruction and safety hazards they cause **Joanne Wenberg, 2440**

Response to Comment 21: Erosion is addressed in Sections 4.16 and 5.16. This takes into account erosion caused by watercraft. State agencies, not TVA, are primarily responsible for the regulation of watercraft on the TVA reservoir system.

22. If the water level was maintained during the summer months it would eliminate some shoreline erosion. I believe more people who live on the lakes would build retaining walls which would further reduce shoreline erosion. **Joe Depew, 1286**

Response to Comment 22: See Response to Comment 14.

23. For 35 years I have watched the Decatur area shoreline of Wheeler Basin be destroyed by the action of high water on the bank structure. Over 150 feet on each side of the river in the Decatur area has been taken out through this action. Additionally, almost all islands with trees have been systematically destroyed along with all of their archaeological resources. Your proposal to increase the winter water levels by two feet will accelerate this process and may complicate immeasurably recreation navigation on the river all year long. Let me try to explain.

The erosion process attacks the root system and slow, but sure, exposes enough roots on the river side that the tree weight cannot be supported. The tree eventually falls into the river and is held in that location by the remaining root structure. The gradually drowns, dies, and begins the rotting process. At some point in time, sufficient erosion and rot occurs that the tree remains are freed to travel downriver for collection and removal at the dam.

The majority of large trees that have been downed at the shoreline are release during high water periods in the winter months after drying out somewhat during the earlier low water periods. The river at such times is dangerous to travel in recreational boats, but the event occurs over a relatively short time span and is then over.

Your proposal to increase the winter pool levels will accelerate shore bank erosion dropping even more trees into the river where they will hang on the bank until rotted to the point where currents and the actions of large boat waves will tear them loose. Without the opportunity to dry out somewhat, I predict that they will become periodic dead-heads or sink entirely to the bottom and tumble their way to the dam where they will be very difficult to recover. Since the higher water will continually do its job of erosion with no intermediate drying period, release of these dangerous masses will be highly unpredictable and most likely occur all year long. You are creating a very dangerous situation for recreational boaters all year long by raising water levels a couple of feet during the winter months. **John Gustafson, 2103**

Response to Comment 23: Analysis indicates that the amount of time that the reservoir surface is in the summer operating zone is the main factor in the rate of shoreline erosion on mainstem reservoirs.

The winter minimum pool level would be raised 6 inches in Wheeler Reservoir. On any reservoirs with substantial changes in winter pool levels, the difference in pool elevations should still allow drainage of shoreline soils. Shoreline erosion is addressed in Sections 4.16 and 5.16.

24. If the water were lowered and raised more quickly during a shorter period of time it would seem that less erosion would occur. As it is it is difficult to protect the lakeshore since the water moves so much so slowly. **Larry Mancini, 1605**

Response to Comment 24: The rate of drawdown is determined by the design of the reservoir and dam (see Section 4.20.5). The rate of filling is determined by the amount of water available, which can be changed little while maintaining operational commitments. Extremely rapid drawdown is likely to cause increased erosion from mass wasting.

25. Also, I am curious whether keeping the lake level higher would be more environmentally friendly, as silt and debris washing into the lake would be diminished. **Linda Wingo, 1677**

Response to Comment 25: It depends. Keeping the lake level higher would allow more residence time and, therefore, more opportunity for suspended material from upstream to settle out in the reservoir pool and for floating material to waterlog. However, high pool elevation also causes more shoreline erosion by delivering wave energy to steep banks for longer periods.

26. I live on the Douglas Lake system and during the recent flooding that took place in May 2003, lost 20+ feet of shore line because of a simple fact**:** that the level was raised too high too soon. When the Spring rains came as you are aware there was no place for the water to go but on to private property because the lake level was full. Debris and large logs where deposited on my shore and I even lost some trees as a result. If erosion continues because of flooding onto my land, my house will be in jeopardy in a few more floodings. **Mike Harris, 1014**

Response to Comment 26: As this comment recognizes, Douglas Reservoir was used to its full capacity in the May 2003 flood to minimize downstream flooding to the extent possible. This is a primary purpose of Douglas Reservoir. At no time during the May 2003 flood did the water level on Douglas Reservoir exceed TVA purchased flowage easements. TVA has an active program to address erosion on its lands as well as programs to assist private landowners with erosion problems. See Response to Comment 1.

27. Alternating freezing and rewetting of exposed shorelines in winter months generates heavy silt load into reservoirs. Eventually this will have an impact on flood control capability. Has this been considered in the study? **Norman Owen, 639**

Response to Comment 27: See Response to Comment 14. Erosion is addressed in Sections 4.16 and 5.16. Most sediment that is deposited in the reservoirs is at low levels and has little impact on the active storage zone. Buildup from siltation is not expected to be substantial in any of TVA's flood control reservoirs within the 30-year time frame of the ROS.

28. A certain level of shoreline erosion should be expected in any aquatic system. Oxbow lakes are great. Erosion control should be allowed where it is occurring at extraordinary levels. However, the cost of that control should be borne directly by those who benefit, not by ratepayers in general. And on that note, the excessive amount of rip rap that has been placed below Chickamauga Dam toward downtown Chattanooga is horrible! We've turned the Tennessee River into a glorified ditch. **Richard Simms, 2242**

Response to Comment 28: See Response to Comment 15.

29. The erosion on Douglas needs to be better controlled probably by maintaining higher water levels. At my Marina (Swann's) the bottom of the lake has risen 8 ft in 12 yrs. At this rate my children won't have to worry about water level but will worry about the Lily Pond **Stan Veltkamp, 926**

Response to Comment 29: See Response to Comment 13.

30. Shoreline erosion would increase dramatically if lake levels were left higher in late summer and drawdown was pushed back later, especially here on Kentucky reservoir. **Steve McCadams, 3172**

Response to Comment 30: If reservoirs were maintained at a constant level all year, it is likely that shorelines would continue eroding until they reach a stable angle. However, this process would be slower than under existing conditions because vegetation would become better established. Erosion is addressed in Sections 4.16 and 5.16. Under TVA's Preferred Alternative, operating guide curves for Kentucky Reservoir would not be changed.

31. Shoreline erosion, along with the loss of islands adjacent to the main river channel along Kentucky reservoir, would be worse under all the alternatives as keeping water levels up longer would further damage an already fragile area. **Steve McCadams, 2141**

Response to Comment 31: Erosion is addressed in Sections 4.16 and 5.16. Under TVA's Preferred Alternative, operating guide curves for Kentucky Reservoir would not be changed.

32. With rising and lowering the levels of the water it has caused enormous erosion on our lot and supposed TVA will not let you build retaining walls to keep that from happening. **Sue King, 1045**

Response to Comment 32: See Response to Comment 13.

33. Reservoirs like Nottely have areas where 90% of the lake bed is exposed during drawdown. The inflow of mud and debris each spring appears to be significantly reducing the available volume of lake after filling the reservoir each year. **Thomas Carey, 1708**

Response to Comment 33: See Responses to Comments 13 and 27.

34. You may not want to hear this, but the TVA is the largest source of shoreline erosion!!!! Every time you reduce or raise the lake levels, serious erosion occurs… We all know this, but it seems that the tva being the main source of erosion is not addressable!!!!!! **Thomas G. Sandvick, 2661**

Response to Comment 34: See Response to Comment 14.

35. The concerns listed in my March 4, 2003 letter to you noted the primary problems namely excessively high flood plain level and erosion or health hazard caused by the water released from the Nottely Dam into the Nottely River tailwater riverbank area. This water level backflows everyday into the creek that traverses our site. This backflow deposits debris, limbs, etc., or whatever flows downstream. The water level rises five to six feet and causes erosion along the creek and Nottely riverbanks at our site and also at the other sites along the river tailwater release area, especially sites #6, 7, and 8. Who can we contact at TVA to evaluate what can be done to hopefully resolve these health and erosion conditions? **Thomas L. Parker, 4057**

Response to Comment 35: See Response to Comment 15.

36. Over 10 feet of shoreline has been lost on our property, primarily due to wave motion. One potential solution might be for TVA to put a barge in Douglas lake for the purpose of installing riprap. We'd pay for the materials and labor if TVA would furnish this. This would stabilize soil, keep silt out of the lake, improve water quality and be an overall benefit to all parties concerned. **William and Velda Clayton, 782**

Response to Comment 36: See Response to Comment 15. TVA is also encouraging a contractor to begin serving tributary reservoirs, including Douglas, with a barge capable of installing riprap.

Prime Farmland

1. Yes, prime farmland must be protected. From topsoil runoff, from unnecessary flooding at inappropriate times of the year. We are losing topsoil and prime farmland. High priority. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3091**

Response to Comment 1: Although some of the alternatives could potentially increase flooding events and land development, with associated risks of soil erosion, TVA has determined that the impact on prime farmland is not likely to be materially different than under existing conditions. Prime farmland is addressed in Sections 4.17 and 5.17.

Cultural Resources (Archaeological & Historic Sites)

1. Cultural Resources will be significantly affected by increased water levels. The only way to reduce this impact is to reduce reservoir levels, even if it is only for a short time. **Anonymous, 2840**

Response to Comment 1: Although a number of alternative operations polices could adversely affect cultural resources, these impacts would be mitigated pursuant to agreements with the seven Valley State Historic Preservation Officers and other consulting parties prior to implementing any alternative. Under TVA's Preferred Alternative, potential impacts on cultural resources are expected to be only slightly adverse and only on some reservoirs.

2. While cultural resource may receive some protection due to less draw down, thus reducing the possibility for looting of archaeological sites, it is clear that it is not within TVA's authority to give additional protection to historic buildings and structure that are not on TVA lands. I would like to suggest that on lands adjacent to TVA holdings that contain cultural resource that TVA advise the local jurisdictions of the significance of these resources and ways they may be protected. **Barbara Garrow, 468**

Response to Comment 2: TVA does coordinate implementation of actions with local officials, as appropriate, as well as with State Historic Preservation Officers. Although cultural resources may not be located on TVA property specifically, TVA does consider impacts on these resources when it evaluates the impacts of its proposed actions. Cultural resources are addressed in Sections 4.18 and 5.18.

3 We also need to acknowledge the historical trauma associated with lake property, which once belonged to Native Americans, early settlers, and more recently (prior to the building of the dams) to farmers. The land was forcibly taken from the farmers to construct the reservoirs in the name of the most good for the most number of people

Now a class of wealthy lake property owners have the shoreline property. They seem oblivious to the history of the land they now own and the human suffering behind its current availability to them. **Guy Larry Osborne, 1265**

Response to Comment 3: The cultural history of the Tennessee River valley is addressed in Section 4.18.

4. For the sake of archeological sites that have been threatened and damaged for years by your current practices, please maintain your current plans. Raising the winter pool in Wheeler Basin will further erode and destroy what little archaeological treasures that currently exist. The Archaeological Resources Protection Act demands that you do your best to protect those sites from damage. Preservation could best be served by further lowering the basin water levels at all times during the year. The optimum preservation route would be to drain the basin completely back to it's original condition. Obviously, this is impossible and inappropriate to preserve and foster your other goals, but increasing pool levels in the winter will only damage those fragile archaeological sites that remain. **John Gustafson, 2093**

Response to Comment 4: See Response to Comment 1. As indicated in this comment, completely draining the TVA reservoir system—if it were possible—would conflict with uses of the reservoir system and would not increase overall public value of the system.

5. I am very concerned about the increased shoreline erosion associated with water levels kept high in Kentucky Lake for extended periods of time. What about the impacts on arch./historic sites? **John Taylor, 2751**

Response to Comment 5: Erosion and cultural resources are addressed in Sections 4.16, 4.18, 5.16, and 5.18. Under TVA's Preferred Alternative, the operating guide curve for Kentucky Reservoir would not be changed; therefore, risks of adverse affects on cultural resources would not change.

6. No problems on South Holston Lake. **Joseph A. Robinson, Jr., 2624**

Response to Comment 6: Comment noted.

7. As the water goes down in the winter, the fish go to the dam area. The lake near the hi-way turns to red mud and looks terrible. Property values go down and friend ask why you brought a home near just a big red mud-hole.

It is hard to visit historic sites due to the mud etc. **Marcia, 1652**

Response to Comment 7: Comment noted.

8. There are numerous archaeological sites that would be seriously affected or destroyed by the increase in year-round water levels. Some of them are among the most important in this nation. This is a MAJOR ISSUE.

Have the Indian tribes been contacted? Along with these sites, raising water levels will destroy a number of Native American burials in the Tennessee Valley, burials protected by federal law in the Native Americans Graves Protection and Repatriation Act.

Either these burials need to be moved to a safe place, via a complete and thorough archaeological investigation, or other actions need to take place. **Mark Cole, 2081**

Response to Comment 8: TVA has invited 17 federally recognized Indian tribes to be consulting parties in the process that addresses potential effects on historic properties, Section 106 of the National Historic Preservation Act. Cultural resource impacts are addressed in Sections 4.18 and 5.18.

Visual Resources (Scenic Beauty)

1. Visual beauty is always important and worth saving. Whenever possible avoid the drawdowns of many feet which expose rock and/or mud walls. Not attractive. Allow natural vegetation around the shorelines to become and remain mature. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3100**

Response to Comment 1: Many of the alternatives evaluated in the EIS would have beneficial effects on visual resources, including TVA's Preferred Alternative. Visual resources are addressed in Sections 4.19 and 5.19.

2. It is with great hope that TVA will make a change in their policy and give us lake owners, users, visitors and passer bys a much more beautiful site to see. With the mild temperatures we were swimming in October and the bad part was just walking out passed the mud. I appreciate the opportunity to voice my concerns and hope my choice of living on a TVA reservoir will continue to be a great investment with the beauty and recreation it offers. **Gordon, 1149**

Response to Comment 2: Comment noted.

3. It means a beautiful govt. provided lake adding more beauty in the winter instead of a wide ugly mud ring around it. **Harold Andrews, 2174**

Response to Comment 3: Comment noted.

4. The elimination of unsightly flats would have a favorable impact on our region. **Joe Brang, 881**

Response to Comment 4: See Response to Comment 1.

5. I love the beauty of the lake and being able to enjoy it as much possible. To me it is very important for TVA to keep up the good work so people like can continue to enjoy the beauty of our surroundings **Juanita Phillips, 2824**

Response to Comment 5: Comment noted.

6. Please take into consideration the families who plan to visit when you drop the water so tremendously, leaving an unsightly gap. **Mary Teaster, 422**

Response to Comment 6: See Response to Comment 1.

7. I do not like the lake to look like a mud hole in the winter. I think it hurts business and it is not necessary. **Penny Caudell, 1745**

Response to Comment 7: Comment noted.

8. Shoreline development should be discouraged in every way in every viewshed. Recreation is the Number Two priority (or should be) and the recreational experience is dramatically enhanced by scenic beauty. **Richard Simms, 2245**

Response to Comment 8: Visual resources are addressed in Sections 4.19 and 5.19. Shoreline development was comprehensively addressed by TVA in its SMI EIS process (November 1998). Section 4.15 discusses the SMI and its resulting policies.

9. The "viewshed"is an integral part of the recreational lake experience and it should be enhanced in every way possible. **Richard Simms, 2227**

Response to Comment 9: See Response to Comment 1.

10. One of the most beautiful times of the year in our area is the fall. Yet many of our reservoirs have levels that do not allow the enjoyment of our environment during that beautiful time. **Roger Williams, 2473**

Response to Comment 10: See Response to Comment 1.

11. The lake is an ugly sight and potentially dangerous when water levels are dropped low. Fences, pipes and junk are clearly visible. **Thomas Atkinson, 1411**

Response to Comment 11: See Response to Comment 1.

Dam Safety

1. Dam safety must always be a top priority. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3103**

Response to Comment 1: None of the alternatives identified in the EIS, including TVA's Preferred Alternative, would compromise dam safety. Dam safety is addressed in Sections 4.20 and 5.20.

2. The purpose of the dams in general is for the protection of the people and their livelihood down stream. Historically, the management of the twin lakes has been for flood control. I request that any management plan have this as its number one priority. Those of us who live in the valley are very fortunate to have TVA and its power-producing ability as an added convenience of the dams. We live with the comfort of knowing that operational procedures of the water management plan of the lakes have and need to continue with flood control as the priority for making water level decisions. **Doug Goodman, 3184**

Response to Comment 2: TVA developed its Preferred Alternative to reduce flood damages to acceptable levels while preserving increased opportunities for recreation and reducing impacts on other objectives.

3. I understood that there is a federal requirement for dams to be designed to handle the Probable Maximum Flood, at least for dams over a certain size, with potential loss of life downstream from dam failure. So I am curious as to why this option was even considered in the first place, because it raises the winter pool to a level that can only hold the 500-year inflow. But I don't know all the details on how such levels would affect flood control performance in the PMF, so maybe the reservoirs are still capable of passing the PMF. **Gary Hauser, 66**

Response to Comment 3: The alternative to which the commenter refers is based on the provision of flood storage sufficient to completely store the inflow volume expected in an event with a 500-year recurrence interval. In the event of inflow volumes larger than the 500-year level, flood control operations at a given project would still allow safe passage of these volumes. TVA would not adopt an alternative that compromises our ability to safely pass the design-basis flood for each project.

4. Dam safety is of high importance, particularly since the Tennessee Valley is in earthquake and tornado zones. **Larraine Nobes, 23**

Response to Comment 4: See Response to Comment 1.

Navigation (Commercial Barges)

1. In the discussion of navigation operations in Chapters 4.21 and 5.21, the current condition of navigation is not discussed. For instance, the EIS does not provide an indication of how many days the Tennessee River is not at least 11 feet deep. If there are only a small number of days per year when the river is not fully navigable, then a positive change in navigation operations may not be considered as important as a positive change in the other operational considerations. However, without the discussion of current conditions, it is difficult for an individual to ascertain the impacts of operation alternatives to navigation **Alabama Rivers Alliance, April Hall, Watershed Restoration Specialist, 3738**

Response to Comment 1: The Tennessee River navigation system was designed to provide 9-foot draft navigation 365 days per year as mandated by the TVA Act. An 11-foot channel is maintained to provide this 9-foot draft and a 2-foot margin of safety. The navigation industry is able to take advantage of summer conditions to ship at greater than 9-foot draft. The benefits or losses to navigation were computed for each alternative based on the number of months the alternative would change the existing navigation draft depth condition. TVA receives a number of complaints every year about insufficient depths for navigation at various locations on the waterway. The number of these complaints fluctuates annually. Partly in response to these complaints, the Preferred Alternative provides for a 1-foot increase in channel depth at Kentucky tailwater to elevation 301, by controlling releases at Kentucky Dam and raising the minimum winter pool depth at Wheeler Reservoir by 6 inches.

2. It is imperative that barge navigation receive serious consideration in this study. This one area has dramatic economic impact along the river. In Northeast Alabama, industries are closing their doors due to not being competitive. The industries on the river, especially the gypsum industry is growing, but if the river management increases the cost, this industry will be impaired. **Anonymous, 2198**

Response to Comment 2: Commercial navigation is important to the region's economy and is a primary objective for operating the reservoir system. Under the Preferred Alternative, the minimum winter elevation on Wheeler Reservoir would be raised 6 inches to address navigation problems on that reservoir. Also, TVA would commit to discharging a minimum instantaneous flow up to 25,000 cfs as necessary to maintain a tailwater elevation of 301 feet at Kentucky Dam, thereby aiding navigation on the reach downstream of Kentucky Dam. These changes would benefit the navigation industry.

3. We at Marine Terminals of Alabama would like to see the water level at the river to stay the same or raise. The impact of lowering the river would cause definite problems with barge traffic. We are already facing problems as is with the water levels with barge traffic. Please take that into consideration. Thanks **Anonymous, 2299**

Response to Comment 3: Under TVA's Preferred Alternative, minimum winter water level on Wheeler Reservoir would be raised by 6 inches in order to address navigation problems on that reservoir, and tailwater releases would be increased as necessary to allow deeper draft barges to move on the Tennessee River.

4. Inexpensive and environmentally-friendly means of transportation (barges) are also important to me. **Betty M. Fulwood, 2293**

Response to Comment 4: Water transportation is an important component of the nation's transportation infrastructure. This mode of transportation generates savings for industries that utilize it and it also produces a water-compelled rate effect in the region that benefits industries that use rail as a means of transportation. Transportation data indicate that, because water transportation is available in the region, rail rates are lower due to competitive factors and the need of railroads to maximize utility.

5. We have been penalized by limited draft on our barges for 40 years and it is time to raise minimum winter pools at least a foot and a half. It is foolish to limit the Tennessee River efficiency because of shallow drift in tow percent of the river. **Bill Dyer, 2770**

Response to Comment 5: Analysis of the alternatives evaluated in the DEIS indicated that raising winter flood guides 2 feet on the mainstem reservoirs would result in unacceptable increases in flood risk. Under the Preferred Alternative, the minimum winter elevation on Wheeler Reservoir would be raised 6 inches to address navigation problems on that reservoir. Also, TVA would commit to discharging a minimum instantaneous flow up to 25,000 cfs as necessary to maintain a tailwater elevation of 301 feet at Kentucky Dam, thereby aiding navigation on the reach downstream of Kentucky Dam. These changes would benefit the navigation industry.

6. All navigation channels need to be clearly marked. **David C. Johnigk, 4186**

Response to Comment 6: The U.S. Coast Guard marks the main channel of the Tennessee River; TVA maintains about 2,000 markers on the secondary channels and tributary reservoirs used primarily for recreation. Observed problems can be reported to TVA on its Info-line or at (865) 632 2906.

7. Navigation was a primary concern in bringing jobs into the Valley. **Dean and Mary Jane Heavener, 2214**

Response to Comment 7: Commercial navigation is important to the region's economy and is a primary objective for operating the reservoir system. Under the Preferred Alternative, the minimum winter elevation on Wheeler Reservoir would be raised 6 inches to address navigation problems on that reservoir. Also, TVA would discharge a minimum instantaneous flow up to 25,000 cfs as necessary to maintain a tailwater elevation of 301 feet at Kentucky Dam, thereby aiding navigation on the reach downstream of Kentucky Dam. These changes would improve navigation conditions.

8. In regard to the barge industry, your economic analysis there also rests on some unknown assumptions. If there is job loss due to increased shipper costs they too could pass on the costs. If the issue is shipping more tonnage by creating deeper channels that comes at the expense of the home owners and lake users of Douglas and other tributary lakes. I seriously doubt anyone other than the barge owners and their stockholders would benefit from the increased revenues generated by the increased tonnage shipped. At the same time, they would be creating more safety hazards and contributing to more pollution by continuing to support coaled fired power plants. Do we need more air pollution when the area already ranks nationally as one of the top five in poor air quality? **Drew Danko, 1023**

Response to Comment 8: Navigation on the Tennessee River supports industries in East Tennessee such as zinc mining, road paving, corn processing, aluminum production, agricultural inputs, and steel fabrication. It also produces a water-compelled rate effect in the region that benefits industries that use rail as a means of transportation. Transportation data indicate that, because water transportation is available in the region, rail rates are lower due to competitive factors and the need of railroads to maximize utility. Reducing the cost of transportation to these industries allows for more investment in jobs in the region. The ability to ship coal by barge helps TVA keep its power costs low, which is good for the entire region. As part of continuing efforts to address emissions at its coal plants, TVA has begun a major additional reduction program for air pollutants. The program focuses on reducing sulfur dioxide and nitrogen oxides emissions, which contribute to haze. TVA has spent almost $4 billion to reduce emissions from its coal-fired power plants, resulting in reductions to sulfur dioxide emissions of over 75 percent and reductions in nitrogen oxide emissions of over 60 percent. TVA is in the process of spending another $1.8 billion through the end of this decade on additional reductions. By the end of the decade, TVA will have reduced sulfur dioxide emissions by 85 percent

9. During high water conditions, some loading/unloading docks are unable to accept barges at their docks because they are unable to load/unload them with any degree of safety or the water is above their dock. That in turn creates an economic downturn in the local economy if the loading/unloading facilities are unable to load/unload barges. If that happens, freight owners will turn to the trucking and/or rail industry in order to move their product at drastically higher rate, which creates higher prices for raw materials and finished goods alike. **Eddie Adams, 3035**

Response to Comment 9: TVA operates the reservoir system to achieve multiple objectives, including navigation, flood control, and power supply. During periods of high flow, TVA stores water in the tributary reservoirs and controls releases at the dams, if possible, to reduce navigation disruptions.

10. I would like to encourage further exploration and support to the efforts concerning increased barge traffic. It continues to be the safest and most efficient means of transporting large amounts of goods. It is also a primary reason to eliminate the need of interstate truck traffic. **Harold DeHart, 2131**

Response to Comment 10: Navigation is an important element in the transportation of bulk commodities. Under the Preferred Alternative, the minimum winter elevation on Wheeler Reservoir would be raised 6 inches to address navigation problems on that reservoir. Also, TVA would discharge a minimum instantaneous flow up to 25,000 cfs as necessary to maintain a tailwater elevation of 301 feet at Kentucky Dam, thereby aiding navigation on the reach downstream of Kentucky Dam. These changes would improve navigation conditions and enhance the continued use of this safe and efficient mode of transportation.

11. Looks good, need to keep the navigation access available for economic development. The new automotive industry growth will need this. **Jeff Braun, 2335**

Response to Comment 11: See Response to Comment 7.

12. Understood from the video presentation that this alternative might decrease the depth of the channel for commercial navigation. I represent a large chemical plant in Decatur. We receive a billion lbs of chemicals at our site each year plus up to 1000 tons per day of coal shipments. We also ship some finished products out of the plant by barge. Barge draft is already a limiting factor on our shipments in the Base Case, and this case apparently might reduce that.

You can probably recite the plight of US chemical companies competing in a global marketplace - we cannot pass on these additional costs, and it is more and more difficult to absorb them ourselves. Commercial navigation is a responsibility that is somewhat subtle - I'm not sure the public appreciates the impact of barge transportation, or more importantly, the impact of losing some of that ability. We encourage you to retain at least the current commercial navigation capabilities of the river system. **Jim L. Collins, 2350**

Response to Comment 12: See Response to Comment 7.

13. On the decision of either lowering the river or raising the river please take into consideration the barge terminals on the river. We really could use the higher river waters for barge traffic for our terminal. We would really appreciate the consideration for this. Thanks! **Joe Huzar, 2342**

Response to Comment 13: See Response to Comment 7.

14. My comment commends TVA for recently installing blinking lights on the electric towers that cross the water ways, this has helped us greatly in navigating the river after dark. But now I am disappointed to find that the lights are no longer in use on the towers in the area where we live. Big Sandy arm and the Tennessee River toward Leatherwood. Please reconsider turning them back on. This was a great safety measure that you had put in place. **Kelly Brawner Chadwick, 2591**

Response to Comment 14: Recent tower construction required de-activation of the blinking lights. TVA staff has asked the construction superintendent to look at re-activating the lights on the tower.

15. I work for Marine Terminals & I would like to see the water table stay as it is. It is very important to me, my fellow co-workers, & several other people & industry in the area that rely on the river for their income. I also feel that if the water table was lowered it would present navigational problems for the boats & barges coming down river. **Kevin Sellars, 2336**

Response to Comment 15: See Response to Comment 7.

16. The nature of Chickamauga reservoir (including the Hiwassee branch) is that in most locations the primary deep water river channel is surrounded by large but very shallow flats. My experience is that with near full pool elevations (>682'), these areas can be navigated safely. However, when the elevation is decreased to the current August 1 guide (681' nominal), the shallow flats become hazardous. This tends to squeeze recreational boaters into the deeper main channel regions and, due to congestion in areas where the channel is narrow, increases the danger of accidents. Another negative aspect of the current operational guide for the late summer period is that access into and out of shallow bays and sloughs, where most private residences and docks are located, becomes difficult. In early August of 2002, my personal dock and boat lift become essentially unusable for the remainder of the season due the effects of silting and low water (nominally less than 681' during daylight hours). **Larry Rinaca, 1895**

Response to Comment 16: To achieve the multiple objectives for operating the system, reservoirs are drawn down to regain flood storage capacity, to generate hydropower to meet peak demands, and to meet downstream requirements such as providing cooling water for nuclear and coal plants. Under the Preferred Alternative, the summer operating zone on Chickamauga would be extended through Labor Day.

17. The Ohio and Mississippi Rivers have sufficient water levels to accommodate 10 and 11 foot draft barges. Most of the new barge construction today is 13 and 14 foot hull barges. These barges can be loaded to a draft of 10 to 12 feet. However the Tennessee River cannot currently these heavy draft barges. This results in additional cost to shippers in the Tennessee Valley and leaves our region at a competitive disadvantage as compared to other areas along the mainstream rivers. **Mark Hommrich, 2230**

Response to Comment 17: The Tennessee River is a multi-purpose system designed for a navigation draft of 9 feet, with a 2-foot under clearance for safety. Under the Preferred Alternative, the minimum winter elevation on Wheeler Reservoir would be raised 6 inches to address navigation problems on that reservoir. Also, TVA would discharge a minimum instantaneous flow up to 25,000 cfs as necessary to maintain a tailwater elevation of 301 feet at Kentucky Dam, thereby aiding navigation on the reach downstream of Kentucky Dam. These changes would improve navigation conditions.

18. We are concerned about water resources that supply the Tennessee Tombigbee Waterway and water supply for Tupelo and other communities. It is essential that water resources of the connected basins continue to be available for continuous transportation of barges and ports along the Tennessee Tombigbee Waterway. This vital link in Northeast Mississippi is critical in retention of jobs and creation of jobs in this needy area. The waterway is maturing at a measured rate as the economy firms up. The waterway also provides through passage of materials in the states of Kentucky, Tennessee, Missouri, Illinois and other northeastern states. Many natural products flow from this area in to coastal markets and global markets. **Mayor Larry Otis, 4347**

Response to Comment 18: All of the policy alternatives considered as part of this study included full design capacity use of the locks at Jamie Whitten Dam, offering maximum utilization of the Tennessee–Tombigbee Waterway and flows downstream of the project. See Appendix A, Table A-06 for additional water withdrawal assumptions for the Tennessee–Tombigbee Waterway.

19. My name is Mike McDonald. I am VP of Muscle Shoals Marine Service, Inc. in Florence, AL. We operate harbor and fleeting services at Florence mile 257 and Yellow Creek mile 215 (TTWW mile 448) on Pickwick Lake. Our primary concern of course is the safe and efficient operation of our vessels in accomplishing their work. To that end our specific concerns are pool and discharge levels on Pickwick Lake. Our major area of concern is low pool levels at Florence during winter pool and periods of low water. Pickwick levels below 410 at Florence cause unsafe conditions for our tugs and customer barges. Customer barges have been damaged on several occasions with lake levels below 410 costing the company thousands of dollars in insurance deductibles and contributing to increased insurance premiums. Low lake levels also cause problems with fleeted barges causing groundings which can potential damage barges and also inability to spot barges at docks. Also of great concern are dramatic fluctuations (we have witnessed 4 to 5 foot fluctuations overnight) in lake levels over a relatively short period of time. Fleeted barges in both fleets can suddenly be hard on ground after these rapid fluctuations and we must then "pull the barge off ground" to prevent sinking which can damage or hole the barge. This is of particular concern at Yellow Creek where our fleeting area is adjacent to limestone bluffs with many rock ledges the barges can "sit down on" when water levels are lowered rapidly. Also of concern are Lock discharge levels which can make it very difficult to shove barges upstream. **Mike McDonald, 2509**

Response to Comment 19: Under the Preferred Alternative, the minimum winter elevation on Wheeler Reservoir would be raised 6 inches to address navigation problems on that reservoir. Also, TVA would discharge a minimum instantaneous flow up to 25,000 cfs as necessary to maintain a tailwater elevation of 301 feet at Kentucky Dam, thereby aiding navigation on the reach downstream of Kentucky Dam. These changes would improve navigation conditions.

20. In conjunction with this I would hope that the lock can be replaced soon at Chickamauga in order to allow the transfer of such products as asphalt to Knoxville by barge rather than by highway or rail which increases costs, air pollution and accident risks on interstate highways and local roads. **Pete Barile, 1192**

Response to Comment 20: A 600- by 110-foot lock has been authorized at Chickamauga. Funding has been provided in Fiscal Year 2004 for pre-construction and design work.

21. As an employee with Marine Terminals of Alabama, I am very concerned that lower water levels will adversely affect our company. One of our main sources of income derives from unloading steel scrap from barges off the river. A lower water level will inhibit the ability for scrap to arrive at our port and therefore not provide the revenue to sustain our current job level and limit the potential for growth. Increased cost would also adversely affect the ability of NUCOR Steel to make a profit and again negatively impact the employment situation of our facility. **Ray Hancock, 2334**

Response to Comment 21: See Response to Comment 7.

22. We would like for you to take into consideration to keep the water levels at the same level or raise them. We are already facing problems with water levels as it is. With the barge traffic coming as it is we are going to have definite problems with lower river waters. Please take this into consideration. **Stanaley L. McClellan, 2341**

Response to Comment 22: See Response to Comment 19.

23. As an employee of marine terminals of Ala. I think this could cost jobs and a loss of profit to the company that I work for. We unload scrap steel from barges and load processed coils back onto barges for NUCOR Steel. If water tables are to low we can not get the product in to load or out with full loads. In turn this will cost more to ship causing a loss of productivity which will cause labor to go up and profit to go down this is where jobs will be lost. **Tim Bass, 2300**

Response to Comment 23: See Response to Comment 19.

24. I was here last time, I addressed about dredging the river from Guntersville to the dam. I would like to know where we're at and what has happened up until now. TVA has raised our power rates or are trying to. You cannot generate energy from silt or mud, so, you know, I would like to know why we're not doing any dredging to get more water flow, more capacity in the river. **Tim Stewart, 4344**

Response to Comment 24: The primary influences on improved hydropower generation are improving turbine efficiency or increasing the height of the water column that feeds the turbine. Dredging the main channel would have little influence on the production of hydropower. Subject to the availability of resources, the USACE performs dredging operations on the inland river system to support navigation and flood control objectives.

Flood Control

1. TVA raises lake levels too fast. Keep water 10ft. low till May 1st. Then finish filling lake so it is full on Memorial Day. This will help with flood control and fishing. Then everyone can enjoy a full lake until Labor Day or there abouts. Specifically South Holston and Boone and maybe others - everyone wins. You can't fish the banks of the reservoir when lake is full for limbs hanging over - especially true on South Holston and Boone Reservoirs.

TVA started as flood control and that should be the main concern. People who moved in and around lake should know this before they moved there. All I'm saying is why won't this work. Keep lakes 10ft from full till May 1st, then fill by Memorial Day. You would have your flood control, people could fish better along banks, and then you could have full pool for the rest of the summer. Why won't this work. **Alan Mitchell, 706**

Response to Comment 1: In general, the potential for increased flood risk is greater for any alternative operations policy that specifies higher pool levels for any reservoir during any time of the year. The reduction in flood storage associated with increases in pool levels necessarily implies a reduction in TVA's ability to regulate large floods. A goal of the ROS is to determine what kinds of operational changes could be made without resulting in an unacceptable increase in potential flood risk.

2. Flood control is not directly affected by TVA. Other impacts are causes of floods. We should, as a society, concentrate on correcting these imperfections, such as permeable surfaces in our parking lots. Creating greenroofs to help aid in the prevention of flooding. **Anonymous, 1809**

Response to Comment 2: Flood control is addressed in Sections 4.22 and 5.22.

3. Only one alternative was even slightly beneficial for flood control, Equalized Winter/Summer Flood Risk. **Anonymous, 2839**

Response to Comment 3: For the Equalized Winter/Summer Flood Risk Alternative, the increase in potential flood risk (relative to the Base Case) associated with the higher winter reservoir pool levels would be, at some locations, offset by the decrease in potential flood risk associated with the lower summer pool levels.

TVA developed its Preferred Alternative to maintain flood risk at acceptable levels while preserving increased opportunities for recreation and reducing impacts on other objectives.

4. Its seems that the tributary lakes carry an unfair share of the burden of providing flood control to some mystery person or city out on the Tennessee River. Surely a small increase in flood storage capacity on non-tributary lakes would allow us to have winter lake levels that would allow boat ramps to remain useable. **Bob Garrison, 1773**

Response to Comment 4: The TVA flood control system was designed and built to take maximum advantage of locations whose physiographic characteristics allowed the construction of dams and benefits justified the required costs. The tributary dams were located where they could provide the aggregated flood storage necessary for TVA's integrated reservoir system and flood control purpose. The flood risk analysis indicated that TVA could not replace flood storage lost on tributary reservoirs on the mainstem river without adversely affecting navigation.

5. Melton Hill Lake, downstream of Clinton, has had two serious floods in the last eight years, washing away boats and docks. About four years ago, the flood from local precipitation washed away several boats, and nearly lifted my floating dock off of its pilings. At that time, Norris dam appeared to be releasing water through the turbines at maximum flow. I extended my pilings about a foot after that. This year, the flood would have removed my dock if the pilings had not been extended. The dock and pilings are more than thirty years old, so this problem must be recent. With Norris and Melton Hill dams to control the water level, this situation should not occur. **Bob Olson, 3012**

Response to Comment 5: Flood control is addressed in Sections 4.22 and 5.22. A primary purpose of Norris Dam is flood control. However, some downstream flooding can, and does, occur. To prevent unacceptable increases in reservoir flood elevations during a flood control operation, TVA will release water through the turbines to generate electricity, instead of spilling water to lower the level upstream of Norris Dam.

6. Alternative A does not make sense to me by saying that flood control would be an adverse effect, when flood control is not even a subject here or a problem to begin with, in the Douglas area or any of the tributary lakes. But as Chattanooga is flooded every year, how can TVA blow their own whistle and say they've saved us millions of dollars in flood dams in Chattanooga, when we have plenty of water space in Douglas and other tributary lakes also. **Carroll and Gail Johnson, 4401**

Response to Comment 6: TVA's detailed flood risk assessment shows that the loss of available flood storage associated with Reservoir Recreation Alternative A would lead to an unacceptable increase in the flood risk at many damage centers, including Copperhill-McCaysville, Elizabethton, Knoxville, Lenoir City, Chattanooga, Decatur, Florence, and

Savannah. At several of these locations, increases in flood risk would be expected for all five of the seasons included in the assessment. Flood control is addressed in Sections 4.22 and 5.22. Chattanooga is not flooded every year. Douglas is one of many multi-purpose reservoirs that are used to reduce flood risk but have insufficient capacity to completely eliminate flood risk.

7. Being downstream of the dams of Kentucky Lake and Lake Barkley, flood control is critical and has an impact on navigation, economic development, agriculture and recreation. Many jobs, family farms and billions of dollars of economic activity depend on reliable flood control. In times of serious flooding, your alternatives would have an adverse effect on flood control and significantly increase the flood risk of people downstream. **Delila Sayre, Vice President, Caruthersville Marine Service, Inc, 3083**

Response to Comment 7: Flood control is addressed in Sections 4.22 and 5.22. Under TVA's Preferred Alternative, operating guide curves on Kentucky Reservoir would not be modified and it is expected that downstream flooding would not be noticeably affected.

8. Flood control was one of TVA's primary goals, and TVA has succeeded in meeting it. It should remain an important goal. As such, those alternates which have "substantially adverse" impacts upon flood control should be considered only with great reluctance. That said, it is very difficult to comprehend how the relatively small water level flood control changes (mainly shifting to the 7-day, 500-year flood) produce such large adverse impacts. **Colman B. Woodhall, 385**

Response to Comment 8: TVA remains committed to reducing the risk of flooding throughout the Tennessee River system. The adoption of the 7-day, 500-year inflow volume as a criterion for flood control storage would result in reservoir levels being substantially higher during the winter months at a large number of projects (relative to the existing operations policy). TVA's analysis demonstrates that such a reduction in total available flood storage would be accompanied by increased discharges at some points in the system during some times of the year. Flood control is addressed in Sections 4.22 and 5.22.

9. While I was unable to find the exact winter lake level (for Watauga) under the 7-day, 500-year storm criterion, the narrative leads me to believe it would be higher than the March 15 level. However, the March 15 level is such a substantial improvement over the Base Case Jan 1 level (1952 vs 1940 for Watauga) that any further increase would appear marginal -- particularly considering the stated increased flood risks. **Colman B. Woodhall, 332**

Response to Comment 9: The Watauaga winter lake level required to satisfy the 7-day, 500-year inflow volume criterion is about elevation 1,957 feet. The commenter is correct in the assumption that higher reservoir levels could lead to additional increases in flood risk.

10. Would be interested in separation of Kentucky and Barkley Lakes from other mainstream reservoirs regarding flood control as holding water from Base Case in July until Labor Day has minimal impact of flood in these lakes. This is by far our driest time. **Dave Baxter, 2803**

Response to Comment 10: Flood control is addressed in Sections 4.22 and 5.22. Under TVA's Preferred Alternative, the operating guide curve for Kentucky Reservoir would not be adjusted.

11. No alternative looked at the environmental impact of taking the reservoirs so low in the winter. In the case of Cherokee Lake, 15,000 acres are turned into a habitat that is similar to a strip mine. No amount of flood control can justify the damage to our environment the TVA is doing. **Dave Cooper, 1140**

Response to Comment 11: All the alternatives were evaluated in order to determine the potential environmental consequences of increasing or lowering water levels over different periods of time. The benefits of flood control are discussed in Sections 4.22 and 5.22.

12. Once again those of us living on the tributaries need real numbers to make a informed decision. We all know that the 500-yr. storm inflow is only a subjective number since there have only been lake level history since the 1940's and weather keeping records only for less than 100 years so there is no real data to base a 500 yr level on. So what level does Douglas Lake need to be to hold this 500 inflow? **David and Marylin Miles, 383**

Response to Comment 12: The estimated volumes are based on real data. However, uncertainty is associated with using the 99 years of available data to estimate an event with a recurrence interval substantially larger. This is a common situation in hydrologic design and analysis. TVA's estimates of the 500-year inflow volume were based on a rigorous statistical analysis of both estimated and observed inflows spanning the continuous 99-year period between 1903 and 2001. The analysis is based on techniques that were adopted by all federal agencies over 20 years ago.

The Douglas Reservoir level required to store the 500-year inflow depends on a number of factors**:** the duration of the storm event in question (for example, the 1-day, 500-year inflow volume is substantially smaller than the 3-day, 500-year inflow volume), the assumed operation of the project (which would dictate how much of the inflow volume could be discharged during the flood event), and the time or season of the year. The target winter flood guides for Reservoir Recreation Alternative B are based on the ability to store all of the volume from the 7-day, 500-year inflow.

13. Public comments were sought from within the Tennessee River watershed and the TVA service area but not from those outside this region. However, it is precisely those residents of communities downstream in the Ohio and Mississippi River basins whose lives, livings, and property are currently protected by the prudent and historically proven operation of the Tennessee River reservoirs.

In citing the benefits of reservoir operations, the documents on your website mention navigation, clean water supply, sustainable economic development, recreation, environmental enhancement, and flood control. For those of us downstream from the dams of Kentucky Lake and Lake Barkley, flood control is more than merely another benefit, more than an afterthought. Flood control has critical impacts on navigation, clean water supply, sustainable economic development, agriculture, and recreation. Indeed, flood control makes these benefits possible! Tens of thousands of jobs and billions of dollars of economic activity depend on reliable flood control.

All but one of your considered alternatives have an adverse effect on flood control, and that one, Equalized Summer/Winter Flood Risk, affords only a slight decrease in flood risk. Similarly, only two alternatives have a positive effect on commercial navigation, and those effects are negligible.

When TVA studies policy changes that have impacts which reach far beyond its service area, those who are affected by proposed changes should be equal participants in the decision process. **David P. Madison, Executive Director, Pemiscot County Port Authority, 3282**

Response to Comment 13: Notice of the availability of the ROS and EIS was widely provided, including in the Federal Register. Flood control, navigation, and power production are the three primary purposes for operating the TVA water control system. Under TVA's Preferred Alternative, operating guide curves on Kentucky Reservoir would not be modified; and analysis indicates that downstream flooding would not be noticeably affected.

14. We do have a couple suggestions for improving river management. When the threat of heavy rain in the eastern part of the state occurs, start lowering the reservoirs downstream to help control water levels. For our immediate area, the property on the west side of interstate 75 from the 24-75 split to exit 1 could be used as a catch basin for Chickamauga Creek back water. **Dean and Mary Jane Heavener, 2205**

Response to Comment 14: This comment describes typical flood control actions on the TVA system. Under any alternative, TVA would prepare for expected flood events by recovering flood storage capacity in appropriate reservoirs to assist in managing flood waters.

15 I also think the current flood control levels on tributary lake are excessive. Last year at Nottely we had higher than normal lake levels well into November because of work on the dam. Even with higher than normal rain fall level over the winter we were never in danger of flooding at our lake or downstream. **Doug Triestram, 1786**

Response to Comment 15: However, flood risk studies indicate that the risk of a major flood event during this time is high. The fact that no flood occurred in that particular year is not a valid indicator of the likelihood of future flood events.

16. Flood control with the Kentucky Lake and Barkley Lake dams greatly affects the Ohio and Lower Mississippi Rivers navigation, economic development, agriculture, and our clean water supply. Only one of your considered alternatives has an adverse effect on flood control, and that one only affords a slight decrease in flood risk. Similarly, only two of your alternatives provide a positive effect, but negligible, on commercial navigation. **Eddie Adams, 3036**

Response to Comment 16: TVA formulated its Preferred Alternative with the objective of trying to reduce the adverse effect on flood risk associated with the alternatives identified in the DEIS. Under TVA's Preferred Alternative, operating guide curves on Kentucky Reservoir would not be modified; and analysis indicates that downstream flooding would not be noticeably affected.

17. Why does TVA seem to be considering flooding some of our lands below Pickwick Dam and at the same time helping other people upstream with recreational activities, et cetera?

What effect will these have specifically with given elevation changes with the present 1991 operating system? By this, what would the alternatives that have been mentioned in the EIS do to storm events of the past and their relation to these easement levels?

With a given easement of elevation 372 and with a flooding of 385, what effect would each of these alternatives have -- back it up just a second. With a past rainfall event that crested at elevation 385, what would each of these alternatives do to this?

Also, what would be the duration of the flooding and the effect on this duration with these various alternatives? **Frank Mcginley, 4475**

Response to Comment 17: The downstream limit of TVA's detailed flood risk simulation model is Savannah. At that location, the model computes total discharges only. No data are available to demonstrate flood-crest elevations and durations for the various alternatives at Savannah. However, the analysis at Savannah is very comprehensive, and includes both period-of-record flow-frequency curves and analysis of a very large number of hypothetical design storms.

The intent of the flood risk study is to define the range of operations policy modifications that can be made without substantiallly increasing the potential for flood damage at any critical location, including Savannah. TVA developed its Preferred Alternative in order to maintain flood risk at acceptable levels, while preserving increased opportunities for recreation and reducing impacts on other objectives.

18. What economic effect on Agriculture below Pickwick Dam would each of these alternatives have had for each flood occurring from May through November from 1991-2002 which exceeded 372 feet in elevation? A comparison with the 1972-1990 period would also be helpful since, I've been told, different operating conditions were used in the earlier period. How much would each of these changes cost farmers in the flood plane below Pickwick Dam? Ag related records are available from Farm Service Agency, USDA and UT Extension Service Offices. Flood information should be readily available from the stream models developed as part of this EIS. Consideration of maximum elevation and duration should be made a part of this exercise. **Frank McGinley Jr., 3024**

Response to Comment 18: The hydrologic model used by TVA to assess potential changes in flood risk at critical locations across the Tennessee Valley region does not compute elevations at Savannah. Therefore, it was not possible to conduct the specific analysis requested in your comment. Assessment of potential change in flood risk at Savannah was based on computations of total discharge. TVA has computed annual and seasonal flow-frequency curves at Savannah for all the alternatives based on a simulation of 99 continuous years. In addition, TVA has analyzed the impact of 138 hypothetical design storms at Savannah.

TVA developed its Preferred Alternative in order to maintain flood risk at acceptable levels, while preserving increased opportunities for recreation and reducing impacts on other objectives.

19 I've lived on Douglas Lake for over 27 years and most of the 27 years the drawdown has started around the 1st of July. When I try to find out I'm told it's for flood control. If it's for flood control why so early, since the rainy season doesn't start till the end of the year and I know doesn't take that long to let the lake down. If you started to let it down after Labor Day you would still be ahead of the rainy season. **Fred Schaffer, 889**

Response to Comment 19: Since the implementation of the alternative operations policy recommended in the Lake Improvement Plan in 1991, TVA typically begins unrestricted drawdown on eastern tributary flood storage projects on August 1. In terms of monthly average rainfall, rainfall in the Tennessee Valley region is fairly uniform throughout the year. While the volume of runoff associated with that rainfall shows a strong seasonal variation—with maximum amounts in the winter seasons when most vegetation is dormant—the observed hydrologic history of the Tennessee Valley region clearly indicates that large floods can and do occur any time of the year. Restricted drawdowns during June and July, and unrestricted drawdowns afford other benefits to constituents in the region, including power consumers. Flood control issues are discussed in Sections 4.22 and 5.22.

20. We have not seen any potential flood hazard during the winter months more so than summer months since we have lived around the Douglas lake area. We do not understand the reason for lowering the lake levels so low that homeowners and boaters cannot enjoy the benefits of the lake year round. **Frederick L Steel, 404**

Response to Comment 20: TVA's system of integrated multi-purpose dams was designed and built primarily to provide a navigation benefit and to reduce the risk of flooding in communities that had been built in the floodplains of the Tennessee River and its tributaries. That flood risk varies seasonally. Because the probability of large inflow volumes is highest in winter months, the reservoi r pool levels are lowest then.

The inherent difficulty in demonstrating the value of flood control is the relative rarity of the flood events for which the system was designed. The TVA system was designed to provide protection for floods larger than those that can be expected every 500 years on the average. There is only about an 18-percent chance that one or more 500-year floods could occur within any given 100-year period. Therefore, the fact that large floods have not been observed within recent history does not necessarily mean that the potential for these large floods does not pose a significant risk. Flood control issues are discussed in Sections 4.22 and 5.22.

21. There seems to be concern about flooding downstream, Chattanooga. Chattanooga was supposed to build levees years ago. I don't see why our lake has to be drawn down because Chattanooga didn't build their levees. **Glen and Janice Boland, 4448**

Response to Comment 21: Flood control issues are discussed in Sections 4.22 and 5.22. Chattanooga's failure to construct levees, except on South Chickamauga Creek, was addressed in TVA's 1990 Lake Improvement Plan EIS, Tennessee River and Reservoir System Operation and Planning Review (December 1990). As discussed in the 1990 EIS, the likelihood that Chattanooga could now construct levees is remote. The consequence of this failure, however, is not increased lowering of tributary reservoir levels, but a higher risk of flooding in the Chattanooga area. The total Chattanooga flood protection plan included seasonal flood control afforded by the TVA system, as well as the planned levee system.

22. A better plan would start with deciding to keep flood risk equal and then set seasonal pool levels accordingly. This criticism seems to apply to other alternatives as well, such as Reservoir Recreation Alternatives A and B. That is, the increased flooding risk is an artifact of deciding to set winter pool levels such that there will be an increased risk of flooding.

A more honest alternative would be to start with a commitment to keep flood levels the same as the base alternative, then determine what winter pool levels should be and develop the rest of the alternative from there. **Guy Larry Osborne, 1206**

Response to Comment 22: TVA designed the alternatives to evaluate the broad set of issues and suggested operational changes identified during the scoping phase of the study. TVA performed the flood risk analysis to determine which of the changes evaluated could be made without unacceptably increasing flood risk at any critical location. TVA developed the Preferred Alternative in order to maintain flood risk at acceptable levels, while preserving desirable characteristics that were associated with the alternatives that were evaluated in detail.

23. The higher flood risk associated with Recreation Alternative B is an artifact of your decision to keep winter pool levels higher. This would be a stronger alternative if TVA committed to holding flood risk levels constant and then developed a plan for later draw down from that starting point. TVA has fudged in constructing alternatives from the Base Case by building in a higher flood risk. Who will vote for that? This is a rigged process to insure we stick with the Base Case which is what TVA wants to do anyway. **Guy Larry Osborne, 1271**

Response to Comment 23: Our analysis of Reservoir Recreation Alternative B has indicated an unacceptable increase in flood risk in all seasons of the year at critical locations in the Valley, including Knoxville. The increase in flood risk is not limited to the winter months. The alternatives analyzed as part of the ROS were based on extensive input received from the public, governmental agencies, and non-governmental organizations. TVA developed its Preferred Alternativein order to maintain flood risk at acceptable levels, while preserving increased opportunities for recreation and reducing impacts on other objectives.

24. We have weather systems today that tell us weeks in advance of major storms. Why do we have to pull the lakes down in preparation of a 100 year flood when we know it is not going to happen 99 of those years. As a worst case, we know well in advance of any rains that cause floods. **Harold Andrews, 2168**

Response to Comment 24: While the science of meteorological forecasting has improved over the years, there is still far too much uncertainty to allow effective operation of the reservoir system based on weather forecasts. In order to release water "as needed" to provide effective flood-risk reduction, reservoir pool levels would need to be drawn down days or weeks before the initiation of flood-producing rainfall (the rate at which pools can be lowered is constrained by downstream channel capacities and, in some cases, dam safety considerations).

A "release-as-needed" operation would frequently dictate the need to lower pool levels quickly based on rainfall forecasts. If the rainfall did not develop as predicted (or fell in an area outside the predicted area), the effective operation of the entire reservoir system would be compromised. Under this operating scenario, reservoir levels would likely fluctuate much more widely and often.

25. As you know the 99 year study excludes the three highest regulated floods of record at Chattanooga. This includes the 1867 flood (44.0 gauge) , which is above the 500 year regulated flood at Chattanooga (42.48), and the 1875 flood (40.6) and the 1886 flood (39.1), which are both above the 100 year regulated flood (35.88). The 1867 and the 1875 floods were both between the January 1 and March 15 period which Alternative A does not provide any extra flood storage. The scaling factors of 1.5 and 2.0 attempt to compensate for these larger floods outside of the 99 year study, and if storage is provided for these scaling factors, all floods of record would be accounted for in the study. **Jack C. Marcellis, 2862**

Response to Comment 25: The design of the flood risk study includes both a continuous simulation over the 99-year period between 1903 and 2001, driven by observed (historical inflows), and the discrete simulation of a large series of hypothetical floods, some of which are larger than the 1867 flood.

26. As for flood control. It is time Chattanooga built the dike. **Janice Boland, 1619**

Response to Comment 26: See Response to Comment 21.

27. The problem of flooding does concern me though in that less retention of water in the upper reservoirs does reduce the ability to hold back excessive runoff from rain.
An alternative to this may be the possibility of check dams along some of the larger inlet streams into the main channel rivers. An example of this was discussed about 12 years ago when TVA conducted a feasibility study in Claiborne County to see if damming the Big Sycamore Creek would benefit the economy of the region. At that time it was decided that it wouldn't. The dam would not be a hydroelectric but more to control the water flow of several large streams into the main channel. **Joe Payne, 2102**

Response to Comment 27: Flood control is discussed in Sections 4.22 and 5.22. In light of the environmental issues associated with constructing new dams and reservoirs, as a general matter it would be difficult to justify the construction of check dams at most locations in the Tennessee Valley region from a flood storage viewpoint alone. The objective of this EIS is to identify how TVA's existing reservoir system could be operated to improve overall public value of the system. TVA is not proposing to construct additional dams and reservoirs. If such a proposal was made, additional environmental review would be required.

28. Does this EIS consider the silt buildup that all dams have? How will this be addressed? From my readings, at some point in the life of a dam, it ought to have greatly reduced water holding capacity as the silt builds up. **John Hubbard, 2257**

Response to Comment 28: While the buildup of silt is problematic at some dams, this buildup and continued silt deposition in TVA reservoirs is generally below the range of elevations important for flood control pool operations. It is not expected to be substantial in any of TVA's flood control reservoirs within the 30-year time frame of the study. Erosion and its effects are addressed in Sections 4.16 and 5.16.

29. 500-year inflow?????? **Julia Householder, 3285**

Response to Comment 29: The 500-year inflow, for any given reservoir, is the volume of water flowing into the reservoir that, on average, would be expected to be equaled or exceeded every 500 years. This does not mean that the period between events of this magnitude is 500 years. It is more accurate to state that the probability of an event of this magnitude is about 1 in 500, or 0.2 percent, in any given year. Therefore, it is possible, although highly unlikely, that 500-year events could occur in successive years.

The 500-year inflow volume is usually understood to occur over a specified duration. The 7-day, 500-year inflow volume is the inflow volume over a 7-day period that is expected to be equaled or exceeded once every 500 years.

30. I'm from Savannah, Tennessee, and I'm a farmer. I farm approximately 1500 acres below Pickwick Dam, between Pickwick Dam and Savannah. I am concerned about the adverse effects on the flood control on the Tennessee River that were proposed in basically all the alternatives that are proposed except for the flood control or the flood risk alternative. I am very much opposed to any increase in flood control below Pickwick Dam especially.

I want to increase awareness that below Pickwick Dam TVA has several thousand acres that they use to flood or for flood control where there were no easements purchased back in the '40s. My concern is that if any of these alternatives are going to be selected and imposed on us, has TVA any kind of idea how to approach the easement issue below Pickwick Dam. I make my living 100 percent from farming and I am very much opposed, again, for increased floods that can be prevented with the system as it is now. **Karl Forsbach, 4438**

Response to Comment 30: TVA developed its Preferred Alternative in order to maintain flood risk at acceptable levels, while preserving increased opportunities for recreation and reducing impacts to other objectives. TVA is aware of the potential flooding impacts on farming in the Savannah area and will continue to operate the system to minimize these impacts on the extent possible.

31.
1. I would like to see data showing the duration and crest elevation of the flood at Mile Marker 190 (Savannah) for each alternative using the April/May 2003 storm pattern as an example.
2. I would like to see data showing the duration and crest elevation of the flood at Mile Marker 190 without any dams (flood control) using the April /May 2003 storm pattern as an example.

Let me point out at this time that every foot of additional flood water above 372' will dramatically increase the flooding of our farm land. In addition to that, the duration of a flood adds drastically to the damage of our crops and shorelines.

Furthermore, I would like to question why the analysis for flood risk did not consider areas downstream from Savannah? How can a study like the ROS be complete if it fails to neglect the lower part of the Tennessee River and Kentucky Dam?

It is my understanding that the Corps of Engineers only interfere with the discharge of Kentucky Dam when the Ohio River is at a certain flood stage, I believe measured at Cairo, Illinois. The result of that particular situation is well known here in Savannah. TVA blames the Corps of Engineers for holding water on our farmland, at our expense. Does your study suggest that the above described situations will get worse? **Karl Forsbach Farms, Inc., Karl Forsbach, Jr., 3731**

Response to Comment 31: The downstream limit of TVA's detailed flood risk simulation model is Savannah. At that location, the model computes total discharges only. No data are available to demonstrate flood crest elevations and durations for the various alternatives at Savannah. However, the analysis at Savannah is very comprehensive, and includes both period-of-record flow frequency curves and analysis of a very large number of hypothetical design storms. Separate from its modeling of flood risks, TVA did consider flooding effects downstream from Savannah.

For Kentucky Reservoir, TVA conducted a detailed investigation of the effect of different operations alternatives on the volume of water discharged from Pickwick Landing Dam. This investigation included the identification of the 10 largest annual and seasonal volumes discharged over 1-, 3-, 7-, 10-, 15-, and 30-day durations in the 99-year simulated period of record and, for each of these events, a comparison of the incremental volumes discharged into Kentucky Reservoir with respect to the No-Action Alternative or Base Case. This analysis shows that it is reasonable to expect that the differences in discharge at Pickwick in these large storms can be temporarily stored in the Kentucky pool.

TVA developed its Preferred Alternative in order to maintain flood risk at acceptable levels, while preserving increased opportunities for recreation and reducing impacts on other objectives.

32. Are you seriously looking at alternatives that would turn our privately owned land, free of easements, into a “holding pond” for the benefit of some developers on certain lakes, which were originally designed to ease the flooding of the Tennessee River and consequently the lower Mississippi River?

I would like to state adopting any one of your alternatives would be devastating to our farm operations in and around Savannah. Crop Insurance would become unaffordable for us, the Shoreline Erosion would drastically increase and our property values (farmland) would collapse. All these facts combined would be devastating to any family farm operation. **Karl Forsbach Farms, Inc., Karl Forsbach, Jr., 4172**

Response to Comment 32: TVA developed its Preferred Alternative in order to maintain flood risk at acceptable levels, while preserving increased opportunities for recreation and reducing impacts on other objectives. Flood control is addressed in Sections 4.22 and 5.22.

33. TVA owns flood easements along most of the Tennessee River and prohibits building permanent structures below the 500 year flood elevation to minimize high water damage.

They have no easements from Chickamauga Dam downstream thru Chattanooga because House Document 91, 76th Congress, 1st Session, 1939 planned the main Tennessee River reservoirs with limited flood storage, 4,000,000 acre-feet of tributary storage and a levee at Chattanooga to hold back water to Walnut Street gage height of 60 feet or thirty feet above flood stage. TVA constructed the Tennessee River dams and 9,000,000 acre-feet for flood control in the tributaries. Chattanooga refused to build the levee. After the March 1973 flood, TVA Chairman Aubrey Wagner made numerous proclamations making one think completing Tellico Dam wood solve Chattanooga's flood problems. But former TVA Chairman Herbert D. Vogel, who worked at the Corps of Engineers river hydraulic lab at Vicksburg before his TVA appointment, warned of continued extensive flood hazard because the levee was not in place in a March 25, 1973 letter to The Chattanooga Times.

The May 2003 flood shows General Vogel was right and extensive rains can fall any time of the year. Tributary communities are requesting TVA to hold reservoirs high into the fall for recreation. But TVA really needs to lower upland lake levels in warm weather so five inches of runoff can be stored like the Corps of Engineers does in their reservoir operation instead of the approximate one inch TVA keeps. Chattanooga also needs to help itself by limiting development below the 500 year flood plain. When an early season hurricane stalls over the eastern Tennessee Valley and the river washes out the foundations of the 21st Century Waterfront Development, FEMA and Chattanooga officials will wonder what happened. Anyone who has studied the situation will remember General Vogel's warning.
Minimum drawdown levels of navigable channel reservoirs should not be raised two feet during winter to accommodate heavier barges. These lakes have quite marginal flood storage under the current plan. **Kirk Johnson, 3794**

Response to Comment 33: Flood control is addressed in Sections 4.22 and 5.22. See Response to Comment 21.

34. All other options are either adversely or substantially adverse for the risk for flooding, with most other options being effected slightly plus or minus. It is great to look at alternatives for better recreation, power, or navigation and do what can be done to improve these by reservoir, tributary or by area, but do it scientifically and not err on the risk side of massive flooding, thereby defeating the purpose of TVA. **Lane Marte, 2395**

Response to Comment 34: See Response to Comment 32.

35. After reviewing the TVA document called "Weighing the Alternatives," I really don't understand why or how improving late summer recreational opportunities (particularly on mainstream reservoirs) has any significant adverse impact on flood control. Historically, it appears that the major flood risk is in the winter through spring time frame (i.e., the normal rainy season where the ground is usually saturated), particularly after the reservoir filling process has started or completed. Although it is obvious that raising winter reservoir levels would be adverse to flood control, it is not clear why increased mid-winter levels are necessarily tied to increased late summer levels. **Larry Rinaca, 1894**

Response to Comment 35: The flood risk analysis indicates that extending summer pool levels leads to an increase in flood risk in those months. The location and the extent of increased flood risk varies from alternative to alternative, but the notion that late summer is a period free from flood risk is not supported by the results of the analysis. See Sections 4.22 and 5.22.

36. In the video presentation, a somewhat negative impact on flood control . . . was indicated [for Alternative A], however this was based on computer modeling, which, while an approximation of reality, is subject to question. I am interested in how the data was gathered, and whether the current TVA baseline is really a true median for all the factors at stake. So many things are affected by any change in the system, but I have to assume the overall benefit to the public is the eventual goal.

A more balanced approach to raising and lowering the local lakes would be desirable. The tributary lakes should be dropped evenly, instead of drastic differences (for example, Lake Chatuge is only dropped 10 feet while Nottely is dropped 30. This is not fair to the homeowners and recreational industries on Lake Nottely.)

The tributary lakes seem to be a "red-headed -step child"of sorts. We are responsible for flood control and navigation, with resulting dramatic and detrimental changes in our lake levels. The main system realizes very few elevation changes, perhaps levees could be put in place to help regulate shipping needs. **Margaret H. Schramke, 1437**

Response to Comment 36: A computer model is only an approximation of reality and should not be interpreted as reality itself. However, a computer model that captures all of the important physical phenomena associated with the modeled process, and is driven by valid data, can be a very useful tool in predicting possible outcomes or in comparing the potential impacts of changes in the modeled system.

TVA's flood risk analysis was performed using a complex reservoir simulation model called RiverWare. The RiverWare model has been thoroughly tested and used routinely by TVA for several years. It accurately represents all of the physical characteristics of the TVA reservoir system that would affect the magnitude and the timing of floodflows.

The model was driven by an extensive database of both observed and estimated hydrologic inflows. The Tennessee Valley region was conceptually subdivided into 55 sub-basins, and a continuous record of flows in those subbasins over the 99-year period from 1903 through 2001 was developed. Observed inflow data included stream gage records maintained by the U.S. Geological Survey and TVA's reservoir operations data. Standard hydrologic techniques were used to fill in "gaps" in the available flow record where required.

The computer model makes decisions about how much water to release from each simulated project every 6 hours for the entire 99-year period. Those decisions are driven by rules incorporated into the RiverWare model that were developed and tested by TVA to represent the existing operations policy. Because TVA's operations policy has evolved since the inception of the agency in the 1930s, the model is not intended to "reproduce" historical flow and elevation data but rather to operate as if the 99-year historical pattern were to recur under the existing operations policy. Each time an alternative was analyzed, the RiverWare model operations policy rules were revised as required in order to reflect that new policy and the entire simulation repeated.

Based on extensive analysis, the computer model adequately represents both the Base Case and all of the simulated alternatives; therefore, any differences between the Base Case and a given alternative are meaningful. See Response to Comment 21.

37. I am surprised TVA would consider options that increase the risk of flooding. Unfathomable to me that TVA would manipulate the water levels in such manner to increase the risk of flood damage. Recreation for some is not worth the risk of flooding damage. Recreation for some is not worth the risk of flooding to the many of us downstream. Primarily TVA is to provide cheap electricity and control flooding. Providing water recreation should be of secondary importance. **Marianne T. Helton, 4058**

Response to Comment 37: Although navigation, flood control, and the generation of electricity are the primary objectives for operating the TVA reservoir system, TVA also operates the system to improve water qualityand water supply, and to provide recreation opportunities. TVA designed the alternatives that were evaluated in detail in the DEIS to reflect the broad range of issues and recommendations that were identified during scoping. This enabled a determination of the full range of associated potential impacts. Results of the analyses were then used to determine which elements of the alternatives would and would not meet evaluation criteria that were established for the primary system operating objectives, such as reducing the risk of floods. TVA developed its Preferred Alternative in order to maintain flood risk at acceptable levels, while preserving desirable characteristics that were associated with the other alternatives.

38. As a landowner in the upper bottom area in Fulton county on the Mississippi, (an area unprotected by levee) I am interested in seeing lake levels and flows managed to reduce flooding of our farmland at critical growing periods in our crop year. This may mean Alternative ES 7.5, or the Equalized Summer/Winter Flood Risk would be the best alternative for us but it is hard for me to understand how maintaining higher winter levels could reduce flood risk downstream. I can see how reducing pool levels in summer somewhat would give more storage to reduce downstream flooding in the event of growing season flooding conditions, however. I believe flood control continues to be a primary reason for flow management. This alternative seems to have few negative effects compared to some others. The overall change in area GDP is very slight and probably within the estimation margin of error. One thing is for sure, when the river takes your crop in June and July, it is gone, with no replanting recourse, and along with it comes the large negative economic impact in our farming economy counties. **Max Wilson, 2002**

Response to Comment 38: The Equalized Summer/Winter Flood Risk Alternative attempts to equalize flood risk for the two seasons of summer and winter, relative to each other. In fact, the higher winter pool levels specified in this alternative lead to an increase in winter flood risk over the Base Case condition. The lower summer pool levels specified in this alternative, conversely, lead to a decrease in summer flood risk over the Base Case condition. Flood control is addressed in Sections 4.22 and 5.22.

39. And the other comment would be the flexibility, flood control being probably the most important thing. And I find it's pretty hard to write a formula for flood control when there's too many variables that are uncontrolled and try to interject them the best you can. So, if probably a more flexible system were developed, that if flood is the problem, then do what you have to do to eliminate it, whether it's lowering the lake or letting it up here and lowering it someplace else. **Michael Kovich, 4469**

Response to Comment 39: See Response to Comment 32.

40. We've had very heavy rainfall in the watershed of the French Broad, Nolichucky, and Pigeon Rivers in August of 2001 and 2003. If drawdown had not commenced on August 1, there likely would have been flooding in the river system. I don't think a tradeoff of flood risk and recreational opportunities is fair. Even if the positive and negative economic impacts are balanced, recreation is fleeting and easily rearranged; flood damage is long-lasting and emotionally and financially burdensome. **Michael Sledjeski, 3221**

Response to Comment 40: Comment noted.

41. There was serious downriver flooding in 2003 despite the extensive system of TVA flood control dams. My impression is that the impoundments were allowed to build up too soon. In view of this failure, TVA should reconsider allowing summer pool levels to be reached too early. Likewise, TVA should make every effort to maintain early drawdown dates, i.e., August 1, for all lakes. Rainfall during August of this year, was quite heavy. There should be no margin of error when it comes to flood control. Failures by TVA in this area are inexcusable. **Michael Sledjeski, 2969**

Response to Comment 41: The Base Case, or No-Action Alternative, shows the flood consequences of an August 1 drawdown. The Summer Hydropower Alternative shows the flood consequences of a June 1 drawdown.

42. Flood control is the original reason for constructing the TVA dam system, but is being relegated to a secondary position by the demands of recreational users and tributary lakeshoreline property owners, TVA must not slack off on its responsibility to protect downstream communities from flooding. Lake levels were allowed to rise too high, too soon in Spring 2003, and considerable damage resulted from the inability to hold back floodwaters. Delaying drawdown will increase the likelihood of flood damage; in 2001, flooding was avoided in August because drawdown commenced an August 1. Comparing economic impact of recreational use and flood damage is unfair and egregious. Recreation advantages are trivial relative to the tragic effects of flooding. Property owners should have known about drawdown schedules before they bought; they should have to live with it, rather than ignore the risk to downriver property owners. **Michael Sylva, 2128**

Response to Comment 42: See Response to Comment 41. Table 3.5-02 shows changes in the percentage change (plus or minus) in annual flood damage and other economic effects, including recreation spending.

43. If the extra 2 months of full pool create a flood hazard due to excessive rain (which is very unusual for July and August), why can't the water be released as needed. **Mrs. Jean Roberts, 1913**

Response to Comment 43: See Response to Comment 24.

44. I do not know the number of rivers feeding into the 10 reservoirs addressed in Alternative A. Regarding Nottley, because it is only fed by one river, it has little impact on flood control to the overall TVA system. This spring exemplifies this. The highest level was 1777, 8 feet below the allowed level of 1785, as stated on the plats. How were the 10 reservoirs chosen for the study? Would the elimination of one or two reservoirs from having the levels maintained greatly impacting the "substantially adverse"flood control results?

I compliment the TVA system on its control when compared to the other reservoir systems in region, i.e., Lake Lanier. **Nanette M. McCarthy, 1494**

Response to Comment 44: The reservoir simulation model used to perform the flood risk analysis includes 36 dams. While several very small dams with little or no impact on flood control operations were not included in the study, all of TVA's major dams were included in an effort to conduct a comprehensive and physically realistic analysis. TVA's understanding is that the 10 reservoirs referred to are the eastern tributary projects with some flood control storage. These include Norris, South Holston, Watauga, Cherokee, Douglas, Fontana, Chatuge, Nottely, Hiwassee, and Blue Ridge.

The flood risk analysis of Reservoir Recreation Alternative A was based on the assumption that the operations policy of all of these reservoirs would be modified in a similar fashion. Separating operation of the system and operating reservoirs on an individual basis could be done, but this would be inconsistent with how the system was designed to be operated and would result in substantially adverse impacts on flood control and other important system operating objectives, such as navigation. TVA did consider excluding individual reservoirs from its system-wide operations policy, when it last comprehensively evaluated system operations for the 1990 Tennessee River and Reservoir System Operation and Planning Review (Lake Improvement Plan). TVA concluded that, while this may be feasible, it would raise serious equity issues because of the disparate treatment of reservoirs within the system. For example, if TVA substantially reduced levels on Nottely and other reservoirs in that basin, TVA might be able to maintain levels somewhat higher longer on Cherokee or Douglas Reservoirs (ignoring the increased risk of local flooding) without unacceptably affecting downstream locations. However, such preferential treatment would likely be objectionable to users of Nottely. For clarity, the Top-of-Gates at Nottely Dam is elevation 1,780. The 1,785 elevation referenced includes flowage easements.

45. [Recreation B] is a viable alternative; however once again those of us living on the tributaries need real numbers to make an informed decision. We all know that the 500-yr. storm inflow is only a subjective number since there have only been lake level history since the 1940's and weather keeping records only for less than 100 years so there is no real data to base a 500 yr level on. So what level does Douglas Lake need to be to hold this 500 inflow? **Anonymous, 4190**

Response to Comment 45: See Response to Comment 12.

46. Because of flood water in the last 3 years, I have lost about $20,000. They hold water in the lake to take care of these rich people. If you're going to flood us, then pay us for what we lose. There is no cause for this flooding. You could control the flooding if it is managed right. Instead of letting water raise in the lake, you could take care of the water without flooding. We are just as important as the lake side. I don't like to try to tell people how to do their job, but something got to be done. Our money running out. **Paul Howell, 4021**

Response to Comment 46: See Response to Comment 36.

47. I believe that the concern for flood control is overstated and is controlling the lake in an adverse manner not beneficial to all concerned, especially residents of the areas concerned. Anytime you raise water levels you will have an increase of flood concerns, however, look at recent flood situations, not 100 years, and you will find the concerns are not substantiated. Is a loss of power sales or a real concern of flood risks? Let the voice of the people be heard and respected as many who are involved have as much knowledge if not more than the elected officials involved. **Richard Rodriguez, 1338**

Response to Comment 47: It is correct that any time reservoir levels are raised, there is an increased risk of flooding. See Response to Comment 36.

TVA's flood risk analysis was based on extensive evaluation of the entire period for which good hydrologic data are available. Weather patterns are often cyclic, with both wet and dry conditions occurring in multiples of 2 or more consecutive years. Conditions over any period limited to several years are most likely representative of only a very small sample of the range of possibilities. If the last several years had been wetter than normal, the commenter's argument would suggest that pool levels should be reduced throughout the system. TVA's position is that the flood potential of any watershed is best understood by observation over a long period.

The flood risk analysis was conducted independently of the analysis of power costs. See Sections 4.22 and 5.22, where flood control and flood risks are addressed.

48. Flood control is critical; however the public in general places too much responsibility on government agencies, including TVA, for flood control. No matter what alternative is chosen, or what action's TVA takes, there will always be risk to those whose choose to live within the flood plain. There should be an education effort to help the public understand that. Mother Nature has the last word... NOT TVA! **Richard Simms, 2223**

Response to Comment 48: TVA and other agencies such as FEMA do try to educate the public about the risks of living in the floodplain. This EIS should contribute to that effort.

49. 7-Day 500-year inflow--what does that mean? Re**:** water levels? **Richard Smith, 4042**

Response to Comment 49: See Response to Comment 29.

50. Would like to see Kentucky and Barkley Lakes looked at separately concerning summer flooding impacts. **Roberta Baxter, 2046**

Response to Comment 50: Because Kentucky and Barkley Reservoirs are directly connected by a canal, any changes in pool level in one of the reservoirs necessarily causes an equal change in the pool level of the other. It is unrealistic to conceptually separate these two projects.

51. It seems that this spring and summer have been a prime example of how to deal with high water levels due to all of the rain that we have had. We keep a boat on South Holston and would like to see the water level stay higher until labor day. According to your study it seems that this would cause a lot of adversity, but like I said earlier, with all the rain that we have had, I believe TVA could handle it. **Sherri Hinkle, 189**

Response to Comment 51: Flood control and flood risks are addressed in Sections 4.22 and 5.22.

52. I don't think the risk of flooding is any higher up to this point than it is throughout the summer. The real risk of flooding is not until water- absorbing grass, crops, trees and shrubs have gone dormant for the winter, especially from November on. **Steven L. Cook, 327**

Response to Comment 52 : Comment noted.

53. The TVA ROS will have a widespread impact across the Tennessee River Valley. The critical balance between electricity production, flood control, economic development and recreational opportunities all contribute to our excellent quality of life in this region. TVA's initial mission to control flooding is critical and should remain an extremely high priority--the protection of human life is paramount. **The Honorable Zach Wamp, U.S. House of Representatives, 3896**

Response to Comment 53: See Response to Comment 36.

54. When TVA went to a 500 year flood level basis, it was done for one reason..... An additional excuse for justification of lower lake levels. This ploy is too similar to the insurance companies new revised hurricane forecast table for the gulf of Mexico, for the sole purpose of justification of insurance rate increases. **Thomas G. Sandvick, 2659**

Response to Comment 54: The TVA flood control system was designed to provide effective reduction in flood risk for events much larger than the 500-year flood. The primary flood risk evaluation criterion used in the ROS specifies that substantial increases in flood risk associated with events smaller than the 500-year level are not acceptable. Using the 500-year event as a primary criterion to judge flood risk acceptability could be viewed as being less conservative than the flood risk criteria originally used by TVA to design the system.

55. This is our primary concern since the floodplain level indicated by Cherokee County (NFI) flood damage prevention ordinance adopted 2/2/89 was based on TVA/ONRED/AWR 85/25 dated August 1985. We can find no basis for raising the flood plain level as shown on elevation certificate #6558 issued at 1/23/95 was to be raised from 1577.00 to 1585.00 at 7/2/95. TVA has no record of any changes in 1995 or after. **Thomas L. Parker, 3995**

Response to Comment 55: As discussed in the September 3, 2003 meeting where this comment was made, there has been no change in the 100-year flood elevation on the Nottely River since the publication of the 1985 flood study.

56. I am primarily interested only in the Nottely River area near bridge #74 at Cook Bridge Road (NCSR 1596) in particular our lot No. 1 and the seventeen (17) lots along the Nottely river in The Preserve subdivision. Our biggest problem is to confirm that the base flood elevation data is realistic and correct, since TVA closely monitors the release waters on a daily basis. Our observations at our site indicate that the daily flood level is maintained about 13' to 15' lower than the EIS info. **Thomas L. Parker, 4056**

Response to Comment 56: The pertinent TVA Watershed Team will be asked to contact the commenter about this.

57. I have never seen a rain in winter raise the level anywhere near full pool and am certain that the winter low draw-down could be raised about 25 feet with no adverse flooding. Most of the volume of the lake is in the top part of the lake any way. The lake would fill up sooner in the spring if the winter draw down was not so severe. **Tom Murphy, 1537**

Response to Comment 57: TVA has considered several alternative operating guidelines for Nottely Reservoir that specify higher winter flood guide levels than those for the Base Case. Under TVA's Preferred Alternative, higher winter flood guide levels would be established for 11 tributary reservoirs, including Nottely.

58. What I'm concerned about is a lot of times this lake as of right now is a foot higher than it should be. It's a foot higher than normal. This is our rainy season. Right now it's coming up on our rainy season. I just feel like that this could be controlled a lot better. They know this water is coming, so why not pull it down a foot? Why do they have to leave it up to as high as it is right now? Especially, what is the reason, do you know, that it's a foot higher?

…I just feel like that TVA handled their end of this last flood very poorly. I feel like that a lot of that could have been prevented to a certain extent by controlling the reservoir. The reservoir -- that's what a reservoir is for is to control the water. They didn't do it. They didn't control their end of it. **Tommy Epperson, 4529**

Response to Comment 58: Due to the multi-purpose nature of TVA's system of reservoirs and the unpredictability of weather, pool levels in TVA reservoirs can ordinarily be expected to fluctuate 1 or more feet over short periods. When reservoir levels increase above flood guides, TVA acts to lower them as expeditiously as practicable—consistent with the protection of downstream areas from increased flooding and using available water to generate electricity.

59. Another thing that concerns me is why the Tom Bigbee Waterway down here is running at a 35 percent capacity when they could route some of that water down the Tom Bigbee Waterway. I understand that the Corp of Engineers and the TVA is two different forms -- I understand that the Corp of Engineers is a form of the government, but TVA is a different form. I can't see why that two big organizations like that can't work together enough in an emergency situation to dump that other 65 percent of water down that Tom Bigbee Waterway. **Tommy Epperson, 4532**

Response to Comment 59: The amount of flow released on the Tennessee–Tombigbee Waterway is determined by the amount of traffic that moves through the locks at Jamie Whitten Dam. Current use is well below the maximum utilization level. Also, the waterway does not have sufficient flow capacity to be used effectively in a flood control operation. USACE and TVA closely coordinate operations during flood events.

60. The other thing that I see in water releasing is below Nottely Dam there are about 30 to 40 properties that it may be in the best interest of TVA to buy those so that they wouldn't have to worry about flooding in this particular area. **Vincent L. and June D. Greaves, 4295**

Response to Comment 60: Those properties are located in the floodplain and are subject to flooding. However, operation of the TVA system does not exacerbate this situation and, in fact, provides them substantial protection.

61. Many times we hear about the water reservoirs protecting Chattanooga from flooding. Approximately two months ago, Chattanooga flooded. Well, what happened? What happened was the entire area received so much rain that you couldn't stop it from flooding. If you'd had ten more lakes up here, it wouldn't have made any difference.

Putting that in context, there are many times when those lakes would prevent that, but there's also many times when Chattanooga is going to get flooded because they did not put in flood prevention walls down there in the city. When this act went into effect back in the '30s, I believe they were directed to do that. And they assumed that Douglas and Cherokee and Norris lakes would prevent them from getting flooded, but they have found out since that's not necessarily so. **W. G. Cahoon, 4383**

Response to Comment 61: See Response to Comment 21.

62. Douglas Reservoir - We need clarification on what depth change occurs to provide for a seven-day, 500 year storm inflow. Was the 8 inches of rain in 36 hours this spring a 500 year storm? If so, the level change of 10 feet or so in spring had little effect, and less effect than the quick drawdown following the next week. **Wayne Gallik, 2915**

Response to Comment 62: The depth change associated with the storage of a given inflow volume depends on the initial reservoir pool level. For Douglas Reservoir, our analysis shows that the annual 7-day, 500-year inflow volume is about 475,000 day-second-feet, or about 940,000 acre feet. This is a volume equivalent to 3.9 inches of runoff (not rainfall) distributed uniformly over the entire 4,541-square-mile drainage basin above Douglas.

Most of the watershed above Douglas received between 2 and 4 inches of rainfall (not runoff) in 72 hours on May 5–7, 2003. Based on a review of our rainfall data, this was the most intense rain over the watershed this spring (and was not particularly unusual). It is possible that the event you describe occurred over a small area, but we have no data that show rainfall of that amount.

Power

1. Reservoir operations policy should not be changed to increase power prices for Valley residents so that a few wealthy property owners around reservoirs can increase their property values and have better views of the lake. They bought their lake property knowing that reservoir levels would drop in August and the price they paid for that property reflected it. I should not have to pay any more for my power so they can get a windfall when they sell their property. **Anonymous, 2678**

Response to Comment 1: One of the objectives in the formulation of TVA's Preferred Alternative was to reduce the potential cost impact on the TVA power system that occurred under the recreation-based alternatives in the DEIS.

2. Power - Learn more nuclear! When coal is gone, nuclei will still be around. **Anonymous, 3248**

Response to Comment 2: Comment noted.

3. Keep power rates low **Ben Robinson, 3982**

Response to Comment 3: See Response to Comment 1.

4. Restrictions on when TVA can pass water through it's hydro-turbines would result in the use of fossil fired power for peak power demands instead of the hydro-turbines! This ultimately comes back to the consumer as higher utility bills. **Clifford J Rabalais, 2287**

Response to Comment 4: Potential effects on the TVA power system are addressed in Sections 4.23 and 5.23.

5. I am not in favor of any option that would increase my power costs. I am not in favor of increased recreation that would increase noise, increased pollution, increased boat traffic. **David R Cook, 1522**

Response to Comment 5: Potential effects on the TVA power system are addressed in Sections 4.23 and 5.23.

6. TVA was created to create affordable power for the Valley. **Dean and Mary Jane Heavener, 2213**

Response to Comment 6: Comment noted.

7. When the TVA originated low cost energy to stimulate growth in the Valley was very important. Today the energy out of tributary dams is but a small part of the power used by our area according to my contacts at Blue Ridge Mountain EMC. **Doug Triestram, 1787**

Response to Comment 7: Although hydropower generating plants provide less than 15 percent of TVA's annual power generation in the average year, the water released from the reservoirs is also necessary to assure adequate cooling water for the TVA coal and nuclear power plants that provide the majority of TVA's generation. Reservoir releases for cooling water and other purposes are dispatched through hydropower units when it is most valuable, reducing reliance on higher-cost fuels during high demand periods.

Also, the operational flexibility afforded by the hydropower units for adjusting the system generation to changes in demand is critical in order to maintain the stability of the power system at a low cost.

8. Do not hold it up past Sept 1. I do not want my power bill to go up. We like to go boat riding and my husband likes to fish when he gets the opportunity. **Glenda Wade, 234**

Response to Comment 8: Comment noted.

9. My suggestion to TVA is on Cherokee Lake that they build a coffer dam at the bottom of the big dam; and the water they're spilling to make electric power, that they catch it at the bottom and recycle it, pump it right back up into the lake and use it over again. That way they don't have to lower the level of the lake as much as they do. Now, they tell me that they're doing this at other dams currently. So, they do have the program working elsewhere. I guess that will do it. **Gordy and Helen Reed, 4369**

Response to Comment 9: The type of plant that you are describing is known as pumped storage. The concept of pumped storage is that two adjacent reservoirs are connected by piping and a combination pump-turbine. Electricity is used to pump water from the lower to the upper reservoir, and electricity is generated when the water in the upper reservoir is released to the lower reservoir.

Due to friction in the piping, mechanical equipment, etc, energy losses occur during both generation and pump-back; and the electricity required to pump exceeds the energy produced during the generation cycle, making the process a net energy user. Because pumped storage is a net energy user, it is not a viable stand-alone source of electricity and is only beneficial in limited applications. Pump storage applications can be beneficial if, for example, the difference between the value of peak- and off-peak electricity is greater than the cost of the energy lost during the generation/pump-back cycle. The plant operator would pump during off-peak periods and generate during peak periods.

TVA has one such facility, the Raccoon Mountain Pumped Storage project, and one pump unit located at Hiwassee Dam. Cherokee Dam is not being considered for modification for a pumped storage project.

10. The benefit of hydropower to maintaining low rates can not be under stated. **H. Ray Threlkeld, 2252**

Response to Comment 10: Comment noted.

11. Our utilities are government regulated, yet we have a government agency competing with them. TVA contracts and provides electricity when it wants to. The private companies do it because they have to by government regulations. GA Power has a power lake within 20 miles of TVA Power Lake Chatuge. It is never pulled down anywhere near the levels of the TVA lake while generating power.

If TVA elects to stay in the power generation business, competing with the private sector, then it should study that sector's method of returning the water from the generators back to the lake. This prevents all water used for generating power from being lost down stream. Rather, it is pumped back over the dam and used again and again without affecting the lake level. **Harold Andrews, 2176**

Response to Comment 11: Chatuge Reservoir is a multi-purpose project. As such, its uses include a critical flood risk reduction role. Annual drawdowns in Chatuge Reservoir are driven in part by the need to provide the seasonal allocation of flood storage necessary for this purpose. The Georgia Power lake near Chatuge Reservoir is not used for flood control purposes. In addition, as decribed in Response to Comment 9, pumped storage is not suitable for all locations. Chatuge Dam is not being considered for modification for a pumped storage project.

12. It seems strange to me that when fall comes and power demands drop because we are between cooling and heating seasons and our power consumption falls at the lowest is when the TVA drops the water levels with much pretty weather wasted for recreation use. Boat docks and other related businesses suffer. **Jay Wise, 224**

Response to Comment 12: Fall drawdown of the reservoir system is driven by many factors, including flood control. The water is used economically for power generation while evacuating water to regain flood storage space.

13. Power is a great resource from the TVA dams but I would like to know why we sell power to the north and if that is the reason TVA drains the lakes down so early in the fall is to supply the north with power, without regard to what is does to the recreation and beauty of the lakes, **Jay Wise, 239**

Response to Comment 13: See Response to Comment 12. Currently, TVA is a net importer of power. Interchange of power at favorable rates with neighboring utilities is performed to help maintain a reliable and affordable power supply for TVA consumers. TVA balances its reservoir system operating objectives to provide multiple benefits. These include year-round commercial navigation, reduced flood risk, reliable and low-cost power, improved water quality and water supply, and recreational opportunities.

14. Power generation should be a byproduct of flood control and recreation, not the driving force. I believe that a higher lake levels would have a much more beneficial impact on the region. **Joe Brang, 877**

Response to Comment 14: See Response to Comment 12.

15. But if it requires that we lose some the privileges of being in a low rate electric area as a tradeoff for a little bit more water in the lake, I don't mind paying the extra bill. **LARRY SAMPLE, 4414**

Response to Comment 15: Comment noted.

16. Cooling Brown's Ferry reactor is not an issue [for higher winter levels]. My father was an engineer there for many years and the cooling line draws from the channel, which makes raising water levels for Brown's Ferry a non-issue. **Mark Cole, 2080**

Response to Comment 16: The reason that this ROS has proposed alternative operations that include higher winter levels on the mainstem reservoirs is to increase the depth of the navigation channel. The increased depth influences the navigability, size of barges that can used, barge travel times, and a number of factors that could reduce the cost of shipping goods on the commercial waterway of the TVA system. Higher winter reservoir levels are neither a hindrance nor aid to withdrawal of water for cooling the Browns Ferry Nuclear Plant.

17. Raising rates without FIRST or, CONCOMITANTLY, creating new jobs to sustain the population's ability to afford it would be unconscionable. **Pr. John Freitag, 985**

Response to Comment 17: The potential socioeconomic consequences of alternative operations policy are addressed in Sections 4.25 and 5.25.

18. Please increase your use nuclear power. **Ronald Huffaker, 933**

Response to Comment 18: Comment noted.

19. As a ratepayer in the TN Valley, I am especially opposed to any alternative that might increase my cost of electricity. **Stephen L. Keever, 1967**

Response to Comment 19: See Response to Comment 1.

20. Relatively inexpensive power rates have been one of TVA's most important goals. Any reduction in the ability to generate inexpensive power penalizes all TVA customers. Cost of generation must still be tempered by water and air quality. **Terry C Smith, 2961**

Response to Comment 20: See Response to Comment 1.

21. Labor Day would be a good start for maintaining summer pool, but why just to labor day? Why not until November 30th or after Thanksgiving? The potential for floods in the fall is minimal. Once the water level goes below full pool by 14 feet, the efficiencies of generating power is significantly reduced. In other words, you have to use more water to generate power when the lake levels are down. Also, with current power outages in the northeast, shouldn't we consider higher lake levels as an alternative power source in the event of power outages in the south? **Thomas G. Sandvick, 2665**

Response to Comment 21: While hydropower generation is more efficient at higher levels, some of the water must be released to generate power, which lowers water levels. TVA evaluated a range of dates for unrestricted drawdown of reservoirs, including through November 1, as well as holding reservoir levels constant year-round. TVA conducted a comprehensive flood risk evaluation, based on hydrologic data for the 99-year continuous period between 1903 and 2001, and supplemented by consideration of a large number of hypothetical design floods. This evaluation is described in detail in Section 5.22. The evaluation allowed TVA to rigorously investigate the potential changes in seasonal and annual flood risk at a large number of critical locations in the Tennessee Valley that were associated with any given operations policy alternative. The Preferred Alternative satisfies the flood risk evaluation criteria established for this study. The results of the flood risk evaluation indicated that it is not possible to extend reservoir levels beyond Labor Day without increasing flood risk at some locations.

22. The delivery of low-cost reliable power to electric customers in the Tennessee Valley remains the primary interest of TVPPA and its members. Attainment of this critical priority requires using our region's natural resources, none of which are more important than the Tennessee River. Maximizing the value of Tennessee River system of reservoirs requires TVA policies that effectively integrate a robust, economical generation and transmission infrastructure with other beneficial river uses, including recreation. Considering TVA's critical role as the power supplier in the Tennessee Valley, TVPPA supports operating alternatives that maintain TVA's ability to provide low-cost, reliable power. **TVPPA, Richard C. "Dick" Crawford, President & CEO, 4233**

Response to Comment 22: TVA formulated a Preferred Alternative in an effort to achieve what this comment suggests.

23. I want Tennessee Valley Authority to meet the rates of Kentucky Utility. I think they should be able to compete. TVA has 6.40 cents per kilowatt hour. Kentucky Utility has 4.29 cents per kilowatt hour. And that's from the source Tennessee Valley Authority, out of the News Sentinel. **Winona and Hilton Tunnell, 4373**

Response to Comment 23: TVA has evaluated the potential effect of alternative operations policy on the TVA power system. See Sections 4.23 and 5.23. For a number of reasons, average rates on the Kentucky Utility system are lower than TVA's, including proximity to low-cost coal supplies and reduced transportation costs. Apart from the ROS, TVA is developing a strategic plan that will help maintain TVA's competitiveness in the electric utility industry.

Recreation

1. Lake Chatuge--Your recent allowing launching from Hwy.64 is Dangerous, unnecessary, and loads up heavy boat traffic which erodes private and TVA shoreline. Waters are flooded with loud jet ski boats racing back and forth in a small lake channel. BESIDES, there is an EXCELLENT dual concrete launching ramp about a mile away on Ledford Chapel Rd. where parking area, safe wide lake waters, etc. has been present for 30 years. On NC lakes, your present early drawdown reduces fishing & recreational use--mainly to help the barge navigation up to Knoxville--not fair! **Andrew J. Dickerson, 2394**

Response to Comment 1: TVA manages water to achieve a variety of purposes, including flood control, navigation, and power generation, as well as for recreation and water quality. The primary reason that TVA seasonally adjusts reservoir levels is for flood control, not navigation. See Sections 4.22 and 5.22, which address flood control issues. The commenter's concern about boat launching from Highway 64 has been referred to the pertinent TVA Watershed Team for an answer. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions—including Chatuge.

2. We are in favor of limited population growth on the shorelines of Hiawassee River/Lake, but USFS has a neglected campground on/near the lake that should be analyzed for possible contamination of the lake. Restrooms are simply port a pottys that overflow, smell bad, and are basically unkept. Private enterprise might be suggested to USFS on TVA Lake protection of the waterway. **Anonymous, 623**

Response to Comment 2: We will pass them on to our Murphy Watershed Team, which works with other agencies on this type of problem.

3. I realize there are a lot of issues to consider, however recreation is very important to a great many people and financial gains are not always the answer **Barbara Cavagnini, 542**

Response to Comment 3: One of the driving issues that prompted the ROS was stakeholder concerns about the decrease in reservoir levels between August 1 and Labor Day, and the effect this has on recreation use and property values. Recreation issues are addressed in Sections 4.24 and 5.24. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions.

4. Another thing I would like, I would like to see the recreation vehicles kept out of the closed-in coves because they are tearing up my land. I moved here 15 years ago and I have lost over two foot of land **Bart Dastolfo, 4488**

Response to Comment 4: The State of Tennessee's Wildlife Resources Agency (TWRA) is responsible for managing watercraft on Tennessee's water. TWRA has a regional office in Morristown (1-800-890-8366).

5. All other issues are "nice to have's" but incidental in my opinion. Recreation, especially is questionable to me. The emphasis on recreation may be affecting our environment negatively through large boats on our waterways, personal water craft and water pollution. **Betty M. Fulwood, 2294**

Response to Comment 5: Comment noted.

6. Congress has considered legislation to encourage TVA to consider recreation more prominently in it's operation, but I would hope that the Board would choose to move aggressively, rather than being forced by Congress.
As home owners on Blue Ridge, we have mixed feelings about more recreation as that means more pleasure boats on the lake. However the consideration to keep levels higher at least thru Labor Day would greatly benefit the economics of the Blue Ridge area. **Bob Harrell, 1687**

Response to Comment 6: See Response to Comment 3. Blue Ridge is one of the reservoirs that would benefit under the Preferred Alternative.

7. Lake level fluctuations make operating a marina way too difficult, unpredictable and unprofitable. **Carl Lakes, 965**

Response to Comment 7: TVA fluctuates reservoir levels seasonally and weekly for a number of reasons, including flood and mosquito control, as well as power generation. See Sections 4.24 and 5.24 for a discussion of recreation issues.

8. The recreation survey gives a biased view of reservoir-based recreation, as it fails to address wildlife-oriented recreation such as hunting and wildlife viewing. These recreation activities occur at public, commercial, and private sites, on reservoir waters and shoreline lands, and on mainstem reservoirs, tributary reservoirs, and on tailwaters. These activities have a growing economic impact, and both participation rates and expenditures likely exceed several of the recreation activities included in the survey. The recreation analysis fails to address the full spectrum of potentially affected recreation activities. **Charles P. Nicholson, 2889**

Response to Comment 8: The ROS was a system-wide analysis of 35 reservoirs. The recreation evaluation of that system was an effort to evaluate total water-based recreation use of 35 reservoirs. Over 4,500 interviews were conducted at pubic boat ramps and beaches, over 2,000 households on the shoreline were surveyed, and approximately 200 commercial recreation providers were surveyed to determine the most important recreation activity for any given trip to the reservoir. These interviews took place on reservoirs from Watauga, Tennessee; to Nottely, Georgia; to Guntersville Alabama; to Kentucky Reservoir. The results of those interviews, and the subsequent models developed from the interviews, were used to estimate recreation use and the potential effects of alternative operations policy on recreation use.

Because it was a system-wide evaluation, the models are not specific to specific reservoirs or recreation activities. It is possible that waterfowl hunting and late-fall bird watchers were underrepresented in the sample because interviewing and recreation counts were completed by mid-October. These data provide the most accurate water-based recreation picture of the TVA system. However, the potential for underestimating recreation use has been considered qualitatively.

9. Human paddle sport is becoming more and more common. Pay attention to this sector. Would like to see TVA cooperate in constructing portage routes around dams such as Fontana to enable multi-day trips by paddlers. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3098**

Response to Comment 9: Comment noted.

10. TVA and Tapoco lakes are being used by paddlers more. Constructed routes around the dams, making portage possible, and multi-day trips is highly desirable. APGI has consented to construct portage routes around Lakes Cheoah, Calderwood and Chilhowee. A portage route around Lake Fontana would make a wonderful multi-night trip available beginning somewhere around Bryson City on the Tuckaseegee River or even the Little TN River at its confluence with Lake Fontana. **Charlotte E. Lackey for WNC Group, NC Chapter, Sierra Club, 3106**

Response to Comment 10: The objective of this EIS is to determine whether changes could be made in TVA's system-wide operations policy in order to provide overall greater public value.

We are working with the Regional Resource Stewardship Council to examine TVA's recreation strategy. Because we have limited funds to invest in capital improvements, such as portage routes for paddlers, we currently give highest priority to investments with partners who have committed to fund part of the capital cost and assume responsibility for long-term maintenance. Groups interested in presenting partnership proposals to TVA should contact the local TVA Watershed Team. More information about these teams can be found on TVA's website at www.tva.gov/river/landandshore/index.htm.

11. There is also a safety concern. Many people who are weekend boaters do not see the change in the water level. They are not aware that last week there was 6' of water, and now there is less that 2'. The small inlets are fun places for people to play, but when the water goes down early, they become hazards. **Chip Miller, 1393**

Response to Comment 11: TVA recognizes that, on certain reservoirs and in areas of certain reservoirs, submerged hazards may become more problematic to boating safety when the reservoir is drawn down. Typically, this situation occurs at a time when the majority of the recreating public has reduced their use or stopped using the reservoir. No recreation activity is 100 percent safe. TVA makes an effort to mark particularly hazardous underwater obstructions; in the final analysis, however, it is the responsibility of individuals to be aware of the conditions under which they participate in recreation activities.

12. I believe that the stakeholders should embrace recreation as much higher valuable factor in future system management. **Chris Offen, 2328**

Response to Comment 12: Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions.

13. As a whitewater paddler, I request that reservoir releases be PLANNED in advance whenever possible and that current release data be available online or by telephone for as many navigable waterways as possible. I request that fall draw-down releases be conducted during daylight hours and with flows suitable for recreational uses. I appreciate the variation of these releases as this creates a more natural river environment than one sustained level at all times.

Please consider the importance of recreational information and releases on the Ocoee, Nantahala, Tallulah, Pigeon and Dries, Great Falls Hydrostation, and other popular whitewater streams that make the Southeast such a great place for paddlers to live, work, and play. **Clay Wright, 665**

Response to Comment 13: Under TVA's Preferred Alternative, TVA would schedule releases from a number of dams in order to enhance tailwater recreation. Call 1-800-238-2264 to obtain information about scheduled or planned releases.

14. The use of the lakes by fishermen and other persons who enjoy being on the water is a wonderful thing. In reality, the use by the majority of the users has nothing to do with the lake levels. I live in a Marina. The lakes are nearly empty after Labor Day every year and before Memorial day every May. There will be a big surge of folks coming to the lake when the weather first gets warm. Then immediately after school lets out, and the kids are free, between Memorial Day and the end of June there is a lot of recreational activity on the lake. By late June a lot of folks have gotten tired of "going to the lake"and the crowds diminish greatly. There will be a surge of folks for the week of July 4th, then the activity drops off again. August is generally considered "too hot"so there are not a lot of folks coming to the lake. The last week of August before school starts, a lot of people come to the lake for the ""last week of summer"". There will be a surge again for Labor Day, but by early September the lakes are nearly empty again.

This cycle has repeated itself every year. Rain and cold have a lot more to do with the number of folks who use the lakes for recreation than anything else. **Clifford J Rabalais, 2288**

Response to Comment 14: This pattern is generally close to many reservoir recreation use patterns. The ROS was an effort to quantify that pattern and the contributions that reservoir levels have in creating that pattern. When asked why people stopped coming to the reservoirs, the most common answer was the air temperature was either too hot or too cold.

15. At the present time there's a real serious situation relating to watercraft safety in and out of our cove, located between lake markers 6 and 7. Both types of boats, especially jet skis, are creating a very serious problem relating to boat safety and shoreline erosion. Extreme watercraft speeds are wearing away the shoreline and may eventually cause a future serious accident. We are recommending that a No Wake safety bouy be located at the cove entrance to warn boaters about boat speed. Decreasing boat speed will hopefully decrease shoreline erosion. That's where we are with the situation. **D. C. Wenberg, 4410**

Response to Comment 15: TVA employees from the Hiwassee Watershed Team in Murphy, NC, can help the commenter to assess the shoreline erosion problem. However, it is the Georgia Department of Natural Resources' responsibility to establish no-wake zones and regulate boating use.

16. Also during high water months, there is an increased risk for recreational boating along the Lower Mississippi River due to the fact that recreational boaters are unaware of the swift water conditions and are simply unable to or do not know how to react in certain situations. **Eddie Adams, 3034**

Response to Comment 16: Comment noted.

17. I live in view of South Holston Lake. I enjoy fishing all year long. During the winter months it is impossible for me to launch my boat from any boat ramp near by. Avons mill, Washington County, Observation Knob are boat ramps that are useless during the winter months on South Holston Lake. **Edward J. O'Neill, 683**

Response to Comment 17: If the commenter has similar problems in the future, it is recommended to use the TWRA ramps on Highway 421. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions—including South Holston.

18. However, many of the complaints from residents about water levels are actually about water access during recreational seasons (April 1 through October 31). Other than higher water levels increasing property values, most residents do not utilize the reservoir for recreation after the above mentioned date **Edwin D. Breland, Jr., 2451**

Response to Comment 18: Comment noted.

19. I am a whitewater enthusiast. and while I am not very versed on many of the particulars of land and river management, I do know that I love to paddle. It is my favorite thing in the world!! I first learned on the Ocoee river and I thought that was the only place people kayaked in the world, back in the '90's. Since then, my eyes have been opened, all from my experiences on the river! I have traveled the country, I follow politics so that I may not lose this privilege. I have become VERY aware of water quality and have interest in its improvement. I have made a decent living at recreation on TN rivers, and I have gotten to see some of the most remote and beautiful places in our state. Please take people like me into consideration when you make your decisions regarding recreation and water. recreating on water has changed my life for the better! I believe it improves the economies and lives of many others as well. **Amy Elizabeth Walters, Asheville, NC, 2095**

Response to Comment 19: TVA is concerned about both reservoir and tailwater quality. Eleven tailwaters were modeled to evaluate the Base Case and action alternatives. Tailwater quality was an important metric in the threatened and endangered species analysis. Temperature, DO, and water surface elevation were evaluated for the tailwaters.

Additionally, some of the reservoir metrics were chosen due to their potential impact on tailwater quality. For example, the Base Case and alternatives were compared for their potential to form anoxic (very low DO) conditions at the bottom of the reservoir. Under these conditions, manganese and iron in the bottom sediments may dissolve into the water. When this water is discharged into the tailwater, brown stains may appear on the rocks and shoreline downstream. Therefore, an alternative with better DO in the reservoir would result in better conditions in the tailwater.

Regardless of the alternative chosen, TVA is committed to maintaining the existing DO targets in the tailwaters. This may lead to adding aeration capacity at some sites. TVA's cost of additional aeration was included in the cost analysis. Under TVA's Preferred Alternative, it would schedule releases into a number of tailwaters to help enhance recreational use, including paddling.

20. In essence, the reason for increased duration of full pool is not valid! The recreational boaters and swimmers essentially start their season on Memorial Day weekend and vacate this reservoir after Labor Day. Fishermen make up the bulk of water recreationists at other times of the year, with several waterfowl hunters coming into the picture during September, November and December. The proposed alternatives that suggest full pool for a longer time frame have the potential to severely impact these users of the reservoir. **Gary D. Jenkins, Buchanan, TN, 2108**

Response to Comment 20: The reservoir system is used by people with different, and sometimes competing, objectives. The EIS presents a range of alternatives. TVA's challenge and goal is to select an alternative that improves overall public value of the reservoir system.

21. How is it not one alternative has a beneficial, yet a substantially beneficial advantage to recreation, according to your study? **Greg Batts, 2738**

Response to Comment 21: When evaluating the increase or decrease in recreation use associated with the various alternatives, TVA focused on the changes in recreation use that were estimated for August, September, and October. Reservoir Recreation Alternative B and the Tailwater Recreation Alternative showed an estimated increase in recreation use of over 23 percent for this period. When compared to recreation use for a 12-month period, however, the increase is only 7.4 percent.

22. There are lots or unmarked, very dangerous stakes and rebar that have been placed in the water. These objects could cause serious damage to water craft and injury to boaters and others using the water for recreation. What are the laws/policies about placing such dangerous objects in the water? Is anything being done to remove these objects? And if nothing is being done, why not? **H. Lee Fleshood, 2864**

Response to Comment 22: Under Section 26a of the TVA Act, TVA approval is required before obstructions can be placed in a reservoir. Our permits require that structures be kept in a safe condition. Unauthorized structures, such as fish attractors or duck blinds, that are built can pose a hazard. As resources are available, TVA does remove derelict facilities and mark hazards. Other federal and state agencies are also involved in boating safety.

23. We realize the need to continue the current cooperation between TVA and the rafting organizations in our area. Having appropriate water levels for the fishermen and rafters alike are an important aspect of the tourism and recreational opportunities that support our local economy.

The need for cooperation and support between Fannin County, State and Federal Governments are necessary for the quality of the growth in our area. We need to continue to build on the collaboration between TVA, US & GA Fish & Wildlife, USDA (Chattahoochee/Oconee) National Forests, GA Dept of Natural Resources and the GA Dept of Transportation. It is imperative that we continue and enhance the cooperative efforts on projects through the research, funding, design, and implementation stages. Working together with all of these organizations will insure the enhancement of the tourism and recreational opportunities around the Blue Ridge Reservoir and the entire Fannin County area.

We are respectfully asking for your consideration of all these alternatives. The additional revenues realized would provide an economic stimulus to our local municipalities, our county and the TVA region. We hope you will examine these options in the final adoption of policies for your Reservoir Operations as it pertains to Fannin County. **Jacquelyn O'Connell, 3802**

Response to Comment 23: TVA works closely with county and state governments, as well as federal agencies to promote recreation and economic development. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions—including Blue Ridge—in order to enhance recreational opportunities.

24. We need more parks bike paths, recreation areas and similar high touch areas to attract tourism. TVA also has property on these area lakes that will also be more useful. **Jerry Huskey, 2488**

Response to Comment 24: We addressed the impact of the various alternatives on water-based recreation on 35 projects (reservoirs).

TVA is working with the Regional Resource Stewardship Council to examine TVA's recreation strategy. As part of this effort, we are examining recreation trends. Our evaluation thus far shows that walking for pleasure is attracting a growing number of participants. The recreation strategic assessment will help us better determine the most beneficial role for TVA in meeting future recreation demands.

25. There seem to be two competing areas of recreation**:** Whitewater rafting, and lake boating. I feel the revenue benefit of increased rafting would only benefit the limited number of tour operators. Lake boating would benefit more of the general public. **Jim Mootrey, 1995**

Response to Comment 25: Recreation and recreation-based economic effects are addressed in Sections 4.24, 4.25, 5.24, and 5.25.

26. I also want to see the ramps improved so that they can be used when the lake is less than 5 ft. from full. **Jim Wood, 2317**

Response to Comment 26: The ramps at Clay County Park, Chatuge Woods, Towns County Park, and TVA's Dam Reservation should all be usable in the range of elevation the commenter mentioned. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions—including Chatuge.

27. There has been no analysis of the impacts on waterfowl hunters and birders associated with increased water levels adversely affecting flat habitat. There will also be adverse impacts on crappie fishermen due to a loss of button ball brush habitat used for spawning. **John Taylor, 2746**

Response to Comment 27: Additional information about potential impacts on these resources has been added to the FEIS. See Sections 4.10 and 5.10.

28. I live locally to South Holston and use the lake quite often. After the first of August we usually quiet using the lake due to so much mud around the shore line. This is very hard on a boat and has almost ruined mine. **Kevin Abel, 294**

Response to Comment 28: One of the driving issues that prompted the ROS study was stakeholder concerns about the decrease in reservoir levels between August 1 and Labor Day. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions, including on South Holston.

29. Whatever changes TVA considers, please realize the vital importance of BASS tournaments to the Columbus region. This year we've hosted 5 major tournaments this year. Each one brings over 250 boats, pumping $1.5 million PER Tournament. Tournament hosting is a growing area for B.A.S.S./ Bassmasters/ESPN. Others host smaller tournaments that also contribute. This is a significant shot in the arm to the local economy. At a 3x multiplier this represents a MAJOR contribution to our economy. 7% of this is sales tax. Next year in Columbus we will host 7 MAJOR fishing tournaments with additional sponsors looking. Recreation is a serious, significant component of the picture in the Columbus area. Please be certain that any considered changes recognize this. **Larry Turman, 3425**

Response to Comment 29: Comment noted.

30. Many fishermen think that they will be able to motor through the sloughs at will in the winter if this takes effect, but soon the number of just submerged boats hung on stumps will become an issue. Adding two feet of water will have serious consequences to boaters, as stumps that normally are out of the water in winter pool, or deeper in summer pool, become just out of site, but within the draft of a boat. It is an invitation for disaster. **Mark Cole, 2079**

Response to Comment 30: See Response to Comment 11.

31. This category is given too much significance in the evaluation. Recreational "needs" are frivolous and should be regarded as secondary to the primary functions of the TVA system. The greater community served by TVA shouldn't have to bear any extra cost or risk to satisfy the demands of recreational users of the system. Let them adapt to the schedule determined by the primary functions of TVA. **Michael Sledjeski, 2967**

Response to Comment 31: Comment noted.

32. Any increase in water level during Winter Pool would be very much appreciated for the LAUNCH areas of Ditto Landing and Whitesburg Boat and Yacht Club (WBYC) which is at mile marker 334. The rationale is that both harbors are in need (especially WBYC) of dredging. In fact WBYC cannot launch boats during the current winter pool. WBYC is teaming with DITTO for dredging needs; however, neither marina will have the proper funds to perform such a task this - year 2003. I will close for now with more to come and I appreciate your time and energy towards a worthy cause. **Mike Jankowski, Fleet Captain (WBYC), 2430**

Response to Comment 32: Thank you for the comments. Changes in winter elevations on mainstem reservoirs have been evaluated as a part of this study. Under TVA's Preferred Alternative, the minimum winter elevation on Wheeler Reservoir would be raised 6 inches. Unfortunately, unacceptable impacts on flood risk precluded raising winter levels on other mainstem reservoirs as part of TVA's Preferred Alternative.

33. At this time I am requesting an answer from you on one of your studies concerning recreation and the levels and drawdown of the lake. In particular from your study, Recreation 4.24.1, the last paragraph and the footnote**:** You state that you made your study on 19 recreation areas and usage out of a total of 70 properties, representing public, commercial, and private recreation areas. Using that small a number of areas is bad enough as a representation, but your footnote is even worse. You state that a user day is equivalent to a recreation day as a visit by one person for recreation purposes in a 24 hour period. That is a total of nineteen people, am I right? You refer to that as a study? How many people go swimming, boating, etc., alone? How about boating? Usually one person in a boat? Fishing? The fishing business certainly would not be able to stay in business if they rented only one boat, etc., a day. This is just a few questions on one category. **Mr. and Mrs. Schaffer, 4054**

Response to Comment 33: TVA organized the 35 projects (reservoirs) under review in ROS by type of reservoir, character of reservoir, and level of recreation use. TVA then conducted recreation surveys on 13 entire reservoirs and tailwater areas, and field interviews and recreation user counts at 121 recreation areas on the 13 reservoirs and 6 tailwater areas, for a total of 490 person days spent in the field collecting data.

TVA input the survey results from 4,587 different groups of people to generate results from the "trip response" model and the economic model. In addition, TVA sent questionnaires to approximately 200 commercial recreation operators on the reservoirs and tailwaters. Finally, TVA used the results of 2,200 questionnaires from private homeowners to estimate recreation use and behavior of private recreation users. TVA retained national recreation experts with experience in designing and carrying out recreation studies to lead this effort. The analysis of recreation issues done for this EIS was comprehensive and state-of-the-art.

34. I am surprised by the findings that Alternative A and Alternative B would only be "slightly beneficial to recreation. After seeing the growth along the TVA system over the last 16 years, I would think the benefits of recreation to the reservoirs would be greatly beneficial to the counties housing these reservoirs. **Nanette M. McCarthy, 2207**

Response to Comment 34: The growth you are describing is occurring without extending summer reservoir levels and is driven by population, increased incomes, and the desire to be on the reservoir—even one with fluctuating water levels. The majority of recreation use occurs during the May through July 4 period, and holding reservoir levels higher into Labor Day or longer would have a limited effect. From a regional economic standpoint, the more important recreational expenditures are those that come into the region from the outside and this is what TVA's economic analyses captured. The regional economy benefits regardless of whether a regional resident elects to spend money on recreation at a TVA reservoir or on shopping at the local mall. See Sections 4.25 and 5.25.

35. I'm a member of the lake watch at Pickwick and we've been working with TVA now to organize a lake watch on Pickwick and we're putting it together. We have about 100 signed up on it now. We plan to have one of the best lake watches on the entire system. I just wanted to make some comments about TVA, things they've done in the past and maybe about some changes that they may be going to make to it. **Roger Gant, 4533**

Response to Comment 35: Comment noted.

36. The other thing that I question is on your numbers. On your Recreation A, for improving recreation on reservoirs and tailwaters, you have a number here of 1.34 million user days. As I see it that's an increase of 20 percent. It would read better if it was added onto the base of 6.57, giving us a total of, a real number, of 7.9 million user days. And the same goes with reservoir or Recreation B. That 1.54 should really read 8.1 million user days. **Ted Bollman, 4378**

Response to Comment 36: Because there is no specific reference, it is unclear whether the commenter is referring to one of our visual presentations or the EIS document.

However, Table 5.24-01 lists the specific numbers the commenter identified and Section 5.24.4 includes a verbal description of the percent change of the various alternatives. In addition, Table D8-07 in Appendix D8 has the specific numbers and percents listed together.

37. We are also concerned and surprised that wildlife-dependent recreation activities including hunting and non-consumptive wildlife viewing are generally ignored in your recreation analyses, even though they are often directly dependent on reservoir waters. Based on results of the 2001 National Survey of Fishing, Hunting and Wildlife Associated Recreation, these activities are likely more popular than several activities your survey did address. Therefore, we question the results of your survey and the dependent recreation impact analyses. **Virginia B. Reynolds, President, Tennessee Ornithological Society, 3793**

Response to Comment 37: See Response to Comment 8.

Social and Economic Resources

1. The reasons being, Marshall County's #2 industry that contributes to our economy is "tourism". It would be of great economic impact to our community to have the water levels lowered at a later date at less drastic levels than it is currently operating under, which in turn would expand our tourism season thereby contributing more to our community and providing more dollars to our community. If used wisely these dollars will contribute to a better way of life for all citizens. **Anonymous, 2801**

Response to Comment 1: USACE expressed concerns about changing operations on Kentucky Reservoir because of the potential effect on the lower Ohio and Mississippi Rivers. Its position is that any proposed changes that would involve reduction in flood storage capacity would need to be evaluated within the context of the entire lower Ohio/Mississippi River system. In addition, USFWS, other agencies, and individuals voiced concerns about changing operations on Kentucky Reservoir. TVA did not include changes to the operating guide curve for Kentucky Reservoir as an element of its Preferred Alternative.

2. The need for revenue, which I believe is the reason you are using the water, can no longer be a rationalization for doing so. As more and more expensive homes are built on the Douglas reservoir there will most decidedly be a bigger tax base for the counties. Since the county affords little to these homes TVA should look into the trade off of less taxes to the counties and more water to the owners. Simplistic to be sure but a half century of doing things one way could certainly be modified if people got their heads together. **Anonymous, 554**

Response to Comment 2: This study analyzes whether it is possible to increase the overall public value of the TVA reservoir system by making changes in reservoir operations. TVA operates its reservoir system to achieve a number of goals including, primarily, navigation, flood control, and power generation. The first two priorities are not related to producing revenue. Socioeconomic issues are addressed in Sections 4.25 and 5.25.

Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Douglas.

3. TVA is a business, in your study you do not address the impact on TVA operating costs of any of the alternatives. My understanding is that you as an entity have been running at a substantial deficit for many years. Your baseline does not appear to address that problem and the new alternatives do not factor that in as beneficial or adverse. I think that if study participants knew what the cost advantages/disadvantages are they may have a different viewpoint on the best approach.

As a note; AMTRAK has been a federally funded operation for years that Congress is now seriously considering selling off because it has accumulated such huge cost overruns. I would think that prudence would dictate that a healthy operating business model should also be a operating goal for TVA and that it should be included in this EIS. **Anonymous, 2441**

Response to Comment 3: The economic analysis for each alternative is the net effect of economic drivers and includes an estimate of the gain or loss as a result of generating power. This is presented in Section 5.3. All these alternatives increase the cost of generating power—some more than others. TVA formulated its Preferred Alternative, in part to reduce the potential cost impact on TVA's power system compared to other alternatives that enhanced recreation opportunities.

4. I also believe that benefits assigned to recreation have been severely undervalued by the study team **Anonymous, 2013**

Response to Comment 4: TVA retained nationally recognized experts with experience in designing and carrying out recreation studies. Economic analysis regarding recreation was based on expenditure data provided by survey data of recreationists at various locations around the region participating in water-based recreational opportunities. A separate mailed survey to lakeshore property owners provided increased expenditures for those who would live in the area longer if the lake levels were held up longer. Surveys included restaurant, hotels, automobile rentals, and other related consumer spending. The analysis did not include expenditures from regional residents, only those coming from outside the region. Although local effects might be higher, TVA is looking at the regional economy for a determination of whether changes could benefit the overall public value of its regionwide reservoir system.

5. Most of the homes located on Douglas Lake only have lake access 3 months out of each year these homes are taxed as lakefront but 9 months of the year we don't even have lake view. **Bernard Johnson, 297**

Response to Comment 5: TVA does not set the rates at which property is taxed. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Douglas.

6. I attended your workshop at Gilbertsville recently. I understood that your economists came up with about 65 million dollars for the value of recreation on all TVA reservoirs. That strikes me as incredibly low. We discussed some of the things that were not deemed to be an economic impact and these economists surely don't think the way most of us do!! I would have expected the economic impact to be one or two orders of magnitude larger than the value given. Just an example, they didn't consider money spent playing golf or other recreation to be an impact even though the people were attracted to the area by the lake. And people who live here have no economic impact even though the lake may have attracted them and keeps them here? I could go on with other examples! **Bob Holdman, 2589**

Response to Comment 6: Recreational economic benefits were estimated based on survey data of customers at facilities located on reservoirs (recreationists at locations where water-based recreation is the primary activity), marina operator customers, and reservoir property owners. The survey provided the estimate of changes in water-based recreation spending but not what is spent in the Tennessee Valley region for all types of recreation.

The property owner survey sampled residents to determine whether they would spend additional time and funds in excess of what they do now (Base Case), if reservoir levels were maintained at summer pool longer. Their response provided information on expenditures for consumer goods, gasoline, groceries, and other items related to property owners. Therefore, property owners responses were included in the recreation spending gathered through the study.

Also, note that the estimate for recreation spending is the net increase, not the total spent on recreation. See Section 4.25

7. It seems like in the economic analysis that they didn't really address how lake levels on Kentucky Lake negatively impact the economy by people who live here or people who have bought a second home here deciding to leave because of their frustration with lake levels being lowered so quickly in the fall. And so the economic impact doesn't address the economic loss if I go elsewhere.

Also, when I participated in the survey. It addressed me and my family, but it didn't address that the last two weekends I've had 20 people each weekend down here with me, eating out at restaurants and spending money on the lake, and those people won't be coming down if I leave because I'm so frustrated with lake levels **Brian Keister, 4522**

Response to Comment 7: See Response to Comment 6.

8. I do not understand the "slightly adverse" label that has been placed on the job category. The video stated that jobs would be slightly effected but it failed to mention what types of jobs, how many jobs, and what exactly "slightly adverse" means. **Charles and Kristie Wallis, 1171**

Response to Comment 8: A "slightly adverse" effect on jobs means that the number of jobs in the region would be slightly less than under the Base Case in the year 2010. For a region with 6 million jobs in 2010, the loss for Reservoir Recreation Alternative A would be 43 jobs, a very slightly negative number. The impact of any alternative with a job loss of less than 1,000 was considered slightly adverse. The impact of any alternative with a job loss of more than 1,000 was considered adverse. Types of jobs vary across the economy and include industrial, business, retail, and agricultural.

9. Attended Blairsville meeting - interested in new paradigm for evaluation economic value. **Chris Offen, 3867**

Response to Comment 9: Comment noted.

10. As I understand the econometric model it seems to me that the economic benefit of higher lake levels and therefore better recreation has a negative bias from the beginning. The benefit coming from recreation is highly fragmented and impacts many sectors of the local economy which is hard to quantify. This challenges the TVA decision making in wondering whether the recreational value is underestimated. If this is so then alternatives may be favored where the driver is something other than recreation i.e. navigation and/or power. I would ask TVA decision makers to favor recreation more intensely than seen in recent years. **Chris Offen, 2326**

Response to Comment 10: The economic modeling for the ROS analysis was conducted with REMI, the regional economic impact analysis model most widely used in the United States and Canada. The economic relations designed in the model are well documented and the result of considerable research over many years. The REMI model was programmed for TVA by its creators, Regional Economic Modeling, Inc., using methodologies and assumptions consistent with existing economic thought and conditions. The economic outcomes of the various alternatives were derived by comparing the Base Case (existing conditions) with the changes to the economic drivers that result from changes in operations. The economic drivers were recreational spending, consumer spending resulting from changes in property values, shipper savings from commercial navigation, the cost of hydropower, and the cost of water supply. The model calculates the indirect, as well as direct, effects of the inputs; therefore, spin-off effects are captured in the analysis.

There is a description of the REMI model in Appendix C of the DEIS, and Section 4.25 contains descriptions of the economic drivers. Under TVA's Preferred Alternative, recreation opportunities would be enhanced by a longer duration of higher pool levels under median conditions on a number of reservoirs.

11. I have lived and worked along the lower Mississippi River, and in Houston, Texas along the ship channel. These areas are full of industrial facilities. While they may not be pretty, they provide the good paying jobs for a LOT of people. The Tennessee Valley area has some areas of economic growth, because of the access to water, and water borne commercial traffic. The ability to maintain commercial barge traffic is essential for the economic health of this area of the US. **Clifford J Rabalais, 2286**

Response to Comment 11: Comment noted.

12. Most of the people who come to the lakes, spend money on the recreational equipment, spend money on coming to the lake, and people who spend money to buy property on the lake all have jobs. Jobs that are supported in some form or fashion by the industrial base in the US, and particularly in this region.

Restrictions on TVA lake levels based on recreational activities is not only ludicrous, it is self defeating! **Clifford J Rabalais, 2289**

Response to Comment 12: Effects on jobs in the region is one of the key factors to be considered. The economic analysis showed that, under Reservoir Recreation Alternatives A and B, and the Tailwater Recreation Alternative, power costs and its effect on industrial, commercial, and residential customers—as well as shipping costs to businesses—would have more effect on the economy through loss of jobs than jobs created, due to increased recreational opportunities on a regionwide basis.

13. It is difficult to grasp that Summer Hydropower would actually increase the cost of electricity generation (albeit a tiny amount), while Commercial Navigation would actually decrease it. It is also difficult to grasp why Tailwater Habitat would cause such a large increase. **Colman B. Woodhall, 333**

Response to Comment 13: The Summer Hydropower Alternative would decrease navigation channel depth, which would increase the cost of shipping coal to TVA plants. System operations for the Navigation Alternative would be similar to the Base Case but would reduce TVA's shipping costs because of increased navigation channel depths. The Base Case already uses available water to achieve as much value as possible from hydropower generation, consistent with the constraints on the use of that water. Under the Summer Hydropower Alternative, TVA would change the start date for unrestricted drawdowns from August 1 to June 1, the date that existed before the changes made following TVA's 1990 Lake Improvement Plan study. This would make more water available for generation during summer months but would decrease hydropower generation in fall. Power costs would increase for this alternative due to additional coal derates, additional aeration costs, and higher coal shipping costs. Maintenance of tailwater habitat prohibits the use of the hydropower units for peak power production, thereby resulting in large power purchases.

14. Look to the western NC mountains or Lake Burton in NE Georgia as documentation of what happens. **Colman B. Woodhall, 349**

Response to Comment 14: The mountain areas in western North Carolina in the Tennessee River Watershed were considered in the economic analysis, including Watauga, Mitchell, Madison, Yancey, Buncombe, Haywood, Swain, Graham, Macon, Jackson, Transylvania, and Henderson Counties. In Georgia, Union, Towns, Fannin , and Gilmer Counties, and other counties in the watershed were included. The economic analysis used population, industry, and other economic data from those counties.

15. This comment combines Recreation, Social and Economic Resources, and Visual Resources. The comment is specific to Watauga Lake and its surrounding communities.

The DEIS states that the impact of any alternative is relatively minor upon the regional area. However, the combined impact of improved Visual Resources and Recreation would most likely have substantial positive impact upon the Johnson and Carter county communities surrounding Watauga Lake.

Johnson County (and to a lesser extent, Carter County) is poor. It in no way matches the Tri-Cities economic data the DEIS presents. In the past, Johnson County has tried to rely upon textile-oriented plants for non-agricultural employment. While these individually offer 100-300 jobs, unfortunately they quickly leave when wages become lower abroad.

In contrast, improved recreation, vacation, and retirement opportunities tend to build support businesses and jobs only a few at a time -- but, once created, these types of businesses and jobs almost never leave (see the area around Lake Burton in NE GA and the NC mountains in general as documentation).

This would be very important for Johnson County. Watauga Lake, with the surrounding mountains, could become a major resource to develop these jobs -- and several of the alternatives appear to greatly improve the Recreation and Visual Resources of the lake. As such, these alternatives should be strongly considered. **Colman B. Woodhall, 389**

Response to Comment 15: TVA used a regional economic analysis because it is considering changes to its regionwide reservoir system. This can mask benefits that specific locations might receive from changes. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Watauga.

TVA has programs such as its Special Opportunities Counties and Cities that specifically address the furthering of economic development and improving the standard of living in such areas.

16. Secondary comments on economic impact of delayed draw down. Based on three (3) years of financial data, please note following**:** Labor Day drawdown would extend our season by at least 30 days and possibly longer. Typical monthly income drops approximately $20,000.00 in August compared to July and another $20,000.00 in September compared to August. Fall in East Tennessee is some of the best weather to enjoy our lake, however, under current policy, levels are such that no one is interested utilizing our beautiful resources. **Dan Meek, 1313**

Response to Comment 16: See Response to Comment 2.

17. It appears that a very large economic impact has been overlooked, TVA should look at new commercial development that would come to our lake because the longer season now justifies the investment. It appears that TVA only considered the increase in recreation for the couple of months that the lake levels are extended. **Dave Cooper, 1138**

Response to Comment 17: See Response to Comment 10.

18. It appears that TVA only considered the increase in recreation for the couple of months that the lake levels are extended. The "quality of life" has not been taken into consideration. **Dave Cooper, 1139**

Response to Comment 18: Quality of life is a difficult concept to define and quantify. This EIS analyzes the impact of various alternative operations scenarios on visual resources (scenic beauty), cultural resources, property values, and recreation—in addition to environmental resources. The change in these resources should suggest whether "quality of life" would be improved or harmed.

19. First, the cranes might leave the area. The cranes are a significant source of revenue for the area. Hiwassee is the second largest concentration of cranes in the eastern United States. People have come from as far away as Indiana and New York to see them. The Sandhill Crane celebration that is held every year in Birchwood draws up to 10,000 people, spending $25,000 to $50,000 in Hamilton, Meigs, and Bradley counties JUST FOR THAT SINGLE WEEKEND! The loss of the cranes would mean a huge economic loss for the region. **David A. Aborn, Ph.D., 2088**

Response to Comment 19: Comment noted.

20. I am a resident of Fannin County. The county has traditionally lost jobs in the past due to plant closings. The region in general would benefit economically using Lake Blue Ridge as a recreation lake. More dollars would stream into the local economy thru increased spending. Property taxes, school taxes and sales tax would also increase not to mention the additional construction boom to the county. **Don Leonard, 2935**

Response to Comment 20: Comment noted.

21. This would also bring more birders to the area to see the birds, bringing in more revenue to Cocke Co. I personally have met birders at Rankin WMA who have come from Memphis, Chattanooga, Alabama, Kentucky, and North Carolina... all to see the birds. **Dr. K. Dean Edwards, 2728**

Response to Comment 21: TVA surveyed recreationists at reservoir access locations and property owners across the region. This effort should have captured comments from some birders.

22. I am concerned about the assumptions you made when building your models for the impact analysis. First, I wish you had made the assumptions more public. In fairness I can understand this may have been difficult, but to fully understand and TRUST your impact conclusions I would like to know what assumptions you made in order to do the analyses. For example, under Alt. A there is a slightly negative impact for employment. Further investigation revealed that this comes about because of the assumption made that Alt. A would increase power generating costs which could force certain employers to not hire or to lay off employees. But use of that assumption seems biased in favor of the base case. Why not assume some other equally or more plausible assumptions such as--1. the employer will pass on the increased costs to the consumer as has been done historically. 2. TVA could charge residential customers the small amount it would take to cover their losses. Would TVA not be able to further offset its increased costs by generating more power than it is doing now if the lake levels were up longer?

In regard to the barge industry your economic analysis there also rests on some unknown assumptions. If there is job loss due to increased shipper costs they too could pass on the costs. If the issue is shipping more tonnage by creating deeper channels that comes at the expense of the home owners and lake users of Douglas and other tributary lakes. I seriously doubt anyone other than the barge owners and their stockholders would benefit from the increased revenues generated by the increased tonnage shipped. At the same time, they would be creating more safety hazards and contributing to more pollution by continuing to support coaled fired power plants. Do we need more air pollution when the area already ranks nationally as one of the top five in poor air quality? **Drew Danko, 1025**

Response to Comment 22: See Response to Comment 10. There is no doubt that an extended recreation season on tributary reservoirs would result in job creation in the areas around those reservoirs, particularly in the recreation and tourism industry and in retail sales. However, the TVA region as a whole would be negatively affected by these alternatives because a loss of hydropower generation would increase power costs. These increased costs would drive up the cost of doing business in the region, the result of which would be the loss of jobs either through job reduction or plant relocation.

While coal and nuclear plants provide the base load of TVA's power production capabilities, hydropower is used to meet peak demands. The water that turns turbines at tributary dams continues to generate electricity at each location downstream. If that hydropower generation capability is reduced as a result of holding tributary pool levels up longer, TVA must replace that power by either generating it by other means (typically gas turbines) or buying it off the national grid at market rates. Either proposition is more expensive than hydropower generation, especially in July and August, when annual demand is at its greatest.

TVA costs are paid for by its power consumers. While the change in TVA costs may be relatively small, the change in the cost of doing business for industrial customers purchasing hundreds of thousands of dollars of electricity every day could be millions annually. These industries compete with others outside the region, and they can either reduce their workforce or relocate to remain competitive. Although extending summer pool levels would at least extend seasonal employment in areas around the tributary reservoirs, the resulting employment increases would be offset by decreases elsewhere in the TVA region, and would tend to outweigh those benefits from a regional perspective. The same may be said for increases in barge transportation costs.

23. What was the rationale for placing the three Georgia Counties in the Chattanooga Region as opposed to North Carolina? **Frank Maloney, 1760**

Response to Comment 23: The three Georgia counties**:** Fannin, Union, and Towns, are close to Chattanooga, as are two North Carolina counties, Cherokee and Clay, and are in the TVA Power Service Area. All these counties are in the Chattanooga region. The other counties in the North Carolina subregion are not in the TVA Power Service Area, but are in the watershed of the Tennessee River.

24. You will be guaranteed increased tourism dollars and weekend second home and rental dollars by allowing water to remain in Nottley lake throughout the year. Today everyone knows the lake goes dry in many areas, so they are buying homes at lake Chatuge and other lakes. Blairsville is not getting that added revenue. keep up the water and watch your revenue grow **Jeanne Sheahan, 2701**

Response to Comment 24: Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Nottely.

25. There is minimal information on the assumptions used for the economic analysis. It would be helpful to have some information on the inflation rate, interest rates assumed and other factors. Also there is no indication of the discount rate used, the assumed economic life of the projects, or any justification of any of the figures used. How were the values for fish, wildlife, value of lakefront land, etc established? All this seems very subjective. Changes in these numbers could have a significant impact on the answers. The final solution will likely have a mix of projects and which ones are viable and finally selected could be affected by all the assumptions above **Jim Mills, 3479**

Response to Comment 25: See Response to Comment 10. TVA did not try to monetize natural resources such as fish and wildlife. Rather, potential effects on these resources are reported in their natural metrics (e.g., changes in DO concentration for water quality).

26. Table ES-02 indicates that for all alternatives except for Commercial Navigation the impact on personal income and Gross regional product is slightly adverse. Is this correct?

Table ES-03 indicates that for all except the Commercial Navigation alternative the net effect of any changes is not beneficial (slightly). It seems that this would include several intangibles and other factors which would be very hard to evaluate and would be very subjective. How were these factors evaluated and included in the final result? It is true that the net loss is very small, but the region is so far behind that any loss at all may not be desirable. **Jim Mills, 3483**

Response to Comment 26: It is correct that all alternatives except the Commercial Navigation Alternative would negatively affect (however slightly) the region's economy because they would involve a loss of hydropower generation, which would increase power costs. These increased costs drive up the cost of doing business in the Tennessee Valley, the result of which would be jobs lost, either through plant relocation, job reduction, or slower job growth (as compared to the Base Case).

While coal-fired and nuclear plants provide the base load of TVA's power production capabilities, hydropower is used to meet peak demands. The water that turns turbines at tributary dams continues to generate electricity at each location downstream. If that hydropower capability is reduced as a result of holding tributary pool levels up longer, TVA must replace that power by either generating it using other means (typically gas turbines) or buying it off the national grid at market rates. Either proposition is more expensive than hydropower generation, especially in August when annual demand is at its greatest. TVA costs are paid for by its power consumers. Increased power costs are passed along to customers.

Although the percentage is small, the actual change in the cost of doing business for industrial customers purchasing hundreds of thousands of dollars of electricity every day could be millions annually. These industries compete with others outside the region, so they might, in turn reduce their workforce, add fewer jobs than would occur under the Base Case, or relocate in order to remain competitive.

27. Table ES-01—increasing revenue from recreation. Note 2 says this is the change in recreational expenditures from outside the TVA region. Please explain. **Jim Mills, 4168**

Response to Comment 27: See Response to Comment 10. For each alternative, we estimated the effects from five areas that affect the economy**:** power costs, navigation or shipping costs to industries and users of water-borne transportation, increased spending by consumers in categories related to recreation, increased spending in durable goods related to the wealth effect of increased property values, and water supply costs for municipalities or industries that rely on minimum elevations or flows. The economic analysis measures the net effect on the regional economy for each alternative. Because the analysis is for the entire region, shifting expenditures from one section of the Valley to another (i.e., recreationists choosing Chickamauga Reservoir rather than Kentucky Reservoir) are not counted, but transfers into the valley (recreationists choosing Chickamauga Reservoir rather than Lake Michigan) would constitute a net gain to the region.

28. There is minimal information on assumptions used for economic analysis. Some of the data is referenced to TVA revenue in 2010 but no indication of how this figure was arrived at. Some of economic data appears smoothed over a lengthy period. Has recent blackout of 2003 caused the evaluation of risks, etc., to be reevaluated? Questions on tables ES-02, ES-03. You are asking us to take nearly all your figures on faith. **Jim Mills, 3961**

Response to Comment 28: See Response to Comment 10.

29. There is a lot of revenue to be generated from use of TVA lakes for the economy of surrounding counties. **Jimmy and Amy Owens, 486**

Response to Comment 29: Sections 4.25 and 5.25 provide data on economic conditions and impacts.

30. Douglas Lake in 2003 has many more lakeshore land owners and users and is still growing by leaps and bounds and is an asset to the communities that surround it. **Jimmy and Amy Owens, 480**

Response to Comment 30: Comment noted.

31. The notion that increased power costs to the public would be detrimental is absurd when you're talking about 30 cents or so per hundred dollar electric bills. **John Honey, 2037**

Response to Comment 31: Applying the increased cost of power due to the loss of hydropower production across residential, commercial, and industrial customers is a method of showing the magnitude of the effects on customers. While the effect on an individual customer basis might be small, the effect when accumulated over the region might be in the $10s and $100s of millions annually, depending on the alternative. For some customers, any increase would be meaningful.

32. I feel income in the area is probably decreasing rather than increasing due to water control by TVA. **Karen Niehaus, 3856**

Response to Comment 32: On the contrary, U. S. Department of Commerce data indicate that personal income on the national average in per capita terms has been increasing. The Base Case economic forecast projects this trent to continue in the Tennessee Valley region, with personal income expected to increase yearly at a rate of 2–3 percent per year.

33. TVA concludes Alternative 2A would result in job loss. The explanation I read is based on a series of extrapolated assumptions. If that is accepted as valid, I offer this equally reasonable scenario with an opposite projection**:**

A lake season throughout summer would encourage commercial and retail development in our community. This growth would ADD jobs. It would also increase real estate value, both commercial and residential, adding to area financial health.

An additional comment about your job loss conclusion. If there were any increased downstream cost as the result of Alternative 2A, most businesses pass those costs along to consumers before resorting to job lay-off. You did not include that reality in your assumption base.

Honestly -- with the exponential increase in recreational use of TVA reservoirs since its charter in the 30's and accompanying commercial and residential growth, can trade-offs for allowing high pool to more fully mirror a full summer season really be that bad???

Thank you for all your hard work!! We await the December decision (with crossed fingers)! **Laurie Danko, 2732**

Response to Comment 33: See Responses to Comments 10 and 22.

34. I work at the public library here in Morristown, which is between Cherokee and Douglas Lake. We get a lot of people in who are looking for a place to move from out of state. In the summer they are real happy about the idea of living here on the lakes, but in the winter all they do is talk about mud holes and flats and they are not so encouraged to come and move into this area, which I think is detrimental to TVA's image and East Tennessee's image. **Marti Steffen, 4497**

Response to Comment 34: Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Cherokee and Douglas Reservoirs.

35. I believe TVA may be underestimating the scenic beauty and long run recreational values of some of our local feeder lakes. The natural beauty of S. Holston and Watauga rival some of the most beautiful water systems on our continent such as the inland passages from Vancouver to Alaska. I recently kayaked parts of this passage and when I returned I realized how similar those lakes with their adjacent mountains were to that inland passage. The August pull downs and resulting mud banks severely reduce that natural beauty.

I do not have enough information or expertise to know if those increased aesthetic and recreational benefits would outweigh the increased flood risks. However, I think, as a professional economist, TVA needs to weigh those benefits more heavily. **Mike Everett, 272**

Response to Comment 35: TVA did evaluate all of the issues identified in this comment. See Sections 4.19, 4.24, 5.19, and 5.24. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including South Holston and Watauga.

36. I think this section is just a guess. The best that can be done is to look at trends . A major event like 9/11 can have more impact than anything. I think it can not be a heavily weighted factor on the overall study. **Richard Wagner, 1635**

Response to Comment 36: TVA used the REMI model which was customized to industries, population data, and demographics, or the economic structure of the Valley. The model has been verified and results compared favorably to actual historical records. The forecasting model processes thousands of data points in order to formulate trends, and calculates variations from those trends related to changes in water management.

These variations are certainly smaller than the effect of 9/11 but are based on the same concept because an event like 9/11 was not predicted. The impact of that event over time is not only calculated in the Base Case forecast but also in all the action alternatives. As with all major events, it affects the Base Case and the action alternatives. What is being compared in this study is the net difference between the Base Case and each alternative. Comparing various river management effects against their economic impacts is a standard and reasonable way of evaluating change.

37. The economic study by the U of T seemed to consider the entire country rather than just the local TVA area in value of Higher lake levels for a longer time period. The presentor made a statement to the effect that if the recreation activity were to and the result was a wash. The reason for higher lake levels longer is to bring "recreationists" to this area. If recreationists that come here because the season is longer are new, great. If they come from other areas because the season is longer, that too is great. Bottom line is more will come here if the season is longer. That adds to the economy.

Another area that will be affected is dining on the lake. There is only one eating establishment left on the lake between mile marker 9 and 29. The other one closed because the season was too short and they could not make a go of it.

The economic study also indicated that the increase in value of the average home would be about $13,000. Ask a real estate agent about that erroneous information. **Robert J. Reynolds, 898**

Response to Comment 37: The comments seem to focus on the University of Tennessee report on recreation and tourism in 13 counties in East Tennessee. The report is available on the University of Tennessee Center for Business and Economic Research web site: http://cber.bus.utk.edu/lakeres.htm.

TVA's study is much broader in scope than that study—encompassing 201 counties in the Tennessee River watershed and TVA Power Service Area. The commenter is correct that an extended recreation season on tributary reservoirs would result in job creation in the areas around those reservoirs, particularly in the recreation and tourism industry and in retail sales. From a regional analysis perspective, however, those local gains would be offset by losses elsewhere in the region from increased costs in power production—due to the loss of the availability of hydropower to meet peak demands during the period of highest annual demand in August. Increased power costs would drive up the cost of doing business in the region, resulting in the loss of jobs through job reduction or relocation of production. The outcome of holding tributary reservoir levels up longer into fall is a net loss in jobs for the TVA region as a whole.

The reference to property value impacts seems to be specific to the University of Tennessee report. See Sections 4.25 and 5.25 for a discussion of how property value changes were evaluated for the ROS.

38. I am not sure what jobs are included or the economic impact on the communities surrounding the lake. I would assume that a more consistent lake level during the summer would make North Georgia a more attractive vacation area and stimulate the local economy creating more jobs. At this point, any jobs projection would be speculative at best. **Roger W. Hill, Jr., 2417**

Response to Comment 38: See Response to Comment 10. Recreation surveys around the reservoirs yielded increases in consumer spending, as a result of an extended recreation season. Additional jobs around the tributaries would be expected from the additional spending in the area (for example, at marinas and restaurants).

39. In your studies of economic impact do you look at retail sales, tax dollars, local jobs, hotel and cabin rentals and incomes, or any economic impact other than commercial navigation affects? The language does not indicate this. The only economic impact to the region TVA indicates in any of their studies is the impact on mass industry and shipping costs based on river navigation. Take Polk County for example. If you study the local economy of such counties that depend almost entirely on tailwater recreation for their economy, you will find that economic impacts are far more reaching than mass industry. **Stephen Smith, 48**

Response to Comment 39: See Response to Comment 10.

40. One item that I have not seen discussed is the benifit of increased tourism that the later summer pools and slower draw downs would encourage. **Teddy Murrell, 1248**

Response to Comment 40: The benefits of increased tourism were specifically addressed in the study as part of the recreation-related benefits. See Sections 4.25 and 5.25. There is no doubt that an extended recreation season on tributary reservoirs would result in job creation in the areas around those reservoirs, particularly in the recreation and tourism industry and in retail sales. The study looks at the economic impact of recreation, power costs, navigation and shipping costs, water supply, and property values simultaneously. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs, which would enhance recreation.

41. So what I would like to see is TVA to work with our local county executives, Johnson County, Carter County and the counties surrounding the Bristol area to help recruit industry as far as lakes are concerned. I know one industry in Mountain City, Tennessee, came here primarily because of Watauga Lake and they were trying to recruit some more people to come in that area because of the lake. **Terry Peters, 4359**

Response to Comment 41: TVA works cooperatively with the Northeast Tennessee Valley Regional Industrial Development Association and is represented on its board. More information about this organization, including contact information for representatives in your area, may be found on the internet at http://www.netvaly.org. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Watauga.

42. The growth in Fannin County over the past ten years is without doubt tied to the recreational and tourist opportunities provided by the region. Given recent industry shutdowns (Levi Strauss, etc.), recreation will be a key industry for the county into the future and Blue Ridge Lake is a critical component of this direction. **Thomas C. Roberts, 2908**

Response to Comment 42: Recreation and economic effects are addressed in Sections 4.24, 4.25, 5.24, and 5.25. The analysis did not look at economic impacts on specific counties but rather regionwide, where the economic outcomes of the various alternatives were derived by comparing the Base Case (existing conditions) with the alternatives.

Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Blue Ridge.

43. The initial purposes of the TVA projects of the 1930's were to control flooding, bring electricity to these underdeveloped areas and promote economic growth.....

Now, 73 years later, the fluctuating lake levels are restricting economic growth by forcing potential consumers to chose alternative locations for recreation, such as many of the lakes in Tennessee that do not fluctuate lake levels. **Thomas G. Sandvick, 2663**

Response to Comment 43: See Responses to Comments 10 and 17.

44. I challenge your economic assumptions regarding recreation revenue. While your figures may reflect the total universe of direct recreation revenue, I wonder if you have also fully captured the indirect effects of increased spending at local restaurants and businesses and the resultant multiplier effect on the regional economy. It hardly seems possible to me that the total economic benefit of 1.34 million user days of recreation would only generate an $11 million incremental contribution to local economies. While I'm sure you've captured direct revenue to TVA, I urge you to also consider the significant effect on the local economy as visitors spend in local shops and businesses, generating an economic engine in the region more than capable of offsetting the potential increase to electricity costs. **Thomas Still, 353**

Response to Comment 44: See Response to Comment 10.

45. Although the commercial navigation alternative seems to yield the greatest positive economic benefit, I urge the TVA and relevant parties to consider not only the impact on Gross Regional Product but also the potential impact on adjacent property owners of dramatic changes to reservoir levels in terms of adverse impact on property values. Literally thousands of property owners like myself have invested hundreds of millions of dollars in properties for purposes of enjoying the recreational opportunities and aesthetic beauty of TVA reservoirs. While this option may seem to have a positive impact on economic income, the potential impact on property values and the real estate market, especially surrounding tributary reservoirs, would likely be devastating. On the other hand, I believe that longer term positive benefits to the economy would result from the recreational opportunities, in terms of longer term attractiveness of the area to investors and retirees, ultimately providing a sustainable (versus cyclical) lift to the economy while preserving the aesthetic beauty of the Tennessee Valley watershed versus the Commercial Navigation alternative. **Thomas Still, 345**

Response to Comment 45: Changes in property values were included in the overall economic analysis; one measure of this is gross regional product. TVA has assessed the impact of changes in property value (a measure of wealth) on the regional economy in terms of consumer spending (a contribution to the economy) for each of the alternatives. This is discussed in Sections 4.25 and 5.25. Further information about property value modeling and the regional economic modeling process is available in Appendices C6 and C7.

Aesthetic impacts, while not quantified in the economic analysis, have also been considered for each alternative. More about aesthetics can be found in Sections 4.19 and 5.19. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs.

46. Recreational use of lake Nottely is vital to the economical and financial welfare of Union County. Presently, the amount of funds that the county and school system receives from TVA is not a fraction of the taxes that would be obtained if the property was private. Given this arrangement, TVA should allow the lake to be maintained at full pool at least until the tourist season has wained (late October). **Tommy Stephens, 1996**

Response to Comment 46: The 2002 in-lieu-of-tax payment to Union County was about $476,000, and payment to Blairsville was about $15,000. The existing value of the block group properties around Nottely was $237 million. Property taxes were considered in the Base Case. See Response to Comment 45.

47. I completely disagree with the information provided by TVA as to how jobs would be lost with Alternatives A and B. Jobs would have to develop around the tributary reservoirs due to increased usage of the lakes. There would be opportunities that would be attractive to land developers of many different types. I can only imagine how the housing would increase for not only vacation and second home purposes, but permanent residences, as well. Obviously, with more people in the area the potential for jobs would be much greater than currently exists. New businesses would start up immediately, with the greater number of users on and around the lakes. Please look at the tourist destination areas of Sevierville, Pigeon Forge and Gatlinburg and all of the jobs that have been created because of the millions of visitors in these areas, yearly! Surely, the real estate located on the banks of the Reservoir of Douglas Lake would see a significant increase in values, as well. Undoubtedly, the demand for these properties would significantly increase. With over 550 miles of shoreline, on Douglas Lake alone, the possibilities would continue past our lifetimes and into future generations. **Vicky Murrell, 1260**

Response to Comment 47: See Responses to Comments 10, 33, and 45.

48. At the review meeting in Bryson City it appeared as if the management is too committed to a computer model that is inflexible. Furthermore an economic projection that goes out 20 years is a joke. No economic model can work for anything but short term and as exhibited by today's economic conditions, models generally don't work well even in the short term. They are no substitute for common sense and good management practices! **William Gazda, 3193**

Response to Comment 48: See Responses to Comments 10 and 36.

F3.3 Other Areas

Water Levels

1. Why is it necessary to drawdown Douglas Lake before Labor Day of each year? This year with all the rain and bad weather proved that an early drawdown is not necessary. **Anonymous, 2407**

Response to Comment 1: The reasons why TVA reservoirs are drawn down each year are described in detail in Chapter 2 of the EIS. Reservoirs are drawn down to maintain flood storage availability in order to minimize flood risk, generate hydropower, and meet downstream water requirements (such as providing cooling water for nuclear and coal-fired power plants, processing water for industry, and flow for navigation). A single year, or small subset of years, does not provide an adequate basis for establishing or modifying reservoir management policy.

2. TVA officials have told us for years that tributary lakes must be started down by August 1 in order to get all the water through a single outlet downstream from Nottely. This really seems unjustified since we are drawn down way below any possible flood storage requirements that are ours. It seems our shores are exposed for months ahead of any real flood storage need. **Bob Garrison, 1799**

Response to Comment 2: See Response to Comment 1.

3. With the info from weather satellites, and accessibility to all types of weather patterns, are they being used to the fullest to perhaps move water in a more efficient way in the year 2003? **Carolyn R Clarkson, 1849**

Response to Comment 3: TVA uses a variety of weather information for guidance with our daily reservoir operations. However, as the commenter may know from following the local weather forecasters: weather forecasting, even in the short term, is not completely accurate.

4. I would like the water to be kept up until September. Every year half way into the summer season we lose use of our boat because the water level is so low. I think it would be nice to at least be able to go boating all summer. Instead all we are looking at is brown dirt , flats. At one time TVA said they would leave the lake up until August 1. THAT has never happened. TVA takes the lake down starting the middle of July. I don't think TVA is being fair. TVA has even lowered the full pool number. I would like to know why? **Catherine Kelly, 1500**

Response to Comment 4: The full summer pool of 1,777 feet on Nottely has been in effect since 1991. The existing operating plan restricts the drawdown to elevation 1,770 until August 1. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs.

5. I have never understood the need to start pulling the lake level down beginning in July which is still the middle of the summer. **Charles Butler, 1838**

Response to Comment 5: See Response to Comment 1. Under TVA's existing operations policy, unrestricted drawdown typically starts on August 1, not July 1, for most reservoirs.

6. When discussing summer pool as it relates to Cherokee Lake, a specific level should be clarified. 1060 or min. recreation level should not be used. 1073 is full pool and full pool is what level all other lakes are measured by. Please treat Cherokee as the other lakes are treated, so we don't see a 13 foot drawdown in July. **Dave Cooper, 1131**

Response to Comment 6: Full summer pool at Cherokee is 1,071 feet. Under TVA's Preferred Alternative, equitable treatment of the reservoirs that comprise the TVA system was a consideration. Under the Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Cherokee.

7. The only problem I have with your proposal is that those of us who live on the tributaries are use to dealing with specific lake level numbers while main reservoir users pay little attention to lake level numbers as the level fluctuates very little from summer to winter. I have lived on both for years and know this is true.

The reason I mention this is that it would be nice to know what the March 15 levels are in real numbers mentioned under the winter pool? We know full pool is 992-995. We know the winter pool level is usually pulled down to 940-942 level, but most of us are not sure what the level is supposed to be at March 15. Is it 965?

Also there is no mention of time schedule to raise tributary level from winter pool to summer pool. Would full pool levels be reached earlier since winter pool is kept higher or still be same as today? **David and Marylin Miles, 379**

Response to Comment 7: Full summer pool on Douglas is elevation 994. Flood guide elevation on March 15 is 958 feet. The fill schedule depends on which alternative is being discussed. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Douglas. In addition, winter flood guide levels would be raised. See Appendix C.8 for elevation probability plots and flood guides.

8. I question TVA as to their policy. This year for example the lake was within 1 foot of full pool. Then TVA "dumped"4 ft in the June/July period as contrary to the policy of not "dumping"water until August 1st. Will the acceptance of plan A change TVA from doing what they want at any time.

Another comment is that I have lived on the lake for 13 years. Up until last year "full pool"was 1779 ft. Last year TVA announced that "full pool"was now 1773 ft. **Debra Jensen, 1478**

Response to Comment 8: Full summer pool at Nottely, established by the Lake Improvement Plan in 1990, is elevation 1,777. The existing operations policy restricts the drawdown to elevation 1,770 through August 1, then allows unrestricted drawdown to winter elevations starting on August 1. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Nottely.

9. What is different about your management system that results in much lower water levels than what the Corps of Engineers is able to accomplish on other reservoirs? **Douglas Dean, 2903**

Response to Comment 9: Operation policies vary between organizations, but also depend on the objective of individual projects. It would be difficult to compare different reservoirs without knowing which specific reservoirs to compare. For example, some Corps projects in Tennessee operate with a larger fluctuation than similar TVA projects.

10. My first concern is that you may be taking too much water out of Nottely Reservoir compared to the other reservoirs. How can you justify the 30 foot drop in the winter water level? It makes no sense to comment on policy if Nottely is not treated fairly. **Gerald Langer, 3535**

Response to Comment 10: The drop in water elevation that occurs as water is withdrawn depends largely on the design of the reservoir. See Response to Comment 1.

11. Why not go ahead and lower the water levels to the 354 level on our lakes by Jan/Feb for Spring floods? Recreational needs would not be affected; flood control would then be positively affected. Power would still be available. Navigation would be affected over a drastically lower period than the base level.

Is it a fast rule that the drop must occur in a steady pattern? Why not stair-step it down? **Greg Batts, 2741**

Response to Comment 11: See Response to Comment 1. The stair-step pattern suggested was tested in the early to mid-1990s; however, the USACE and USFWS identified unacceptable flood risk and environmental consequences with this type of operation at Kentucky and Barkley Reservoirs.

12. Negotiated settlement of the Tapoco FERC relicensing is nearly complete. As proposed, the general relicensing changes to the Tapoco operations include**:** The Santeetlah reservoir will be operated at higher levels with an extended recreation season and significantly less drawdown **Greg Ott, Operations Manager, Alcoa Power Generating Inc. Tapoco Division, 3749**

Response to Comment 12: Comment noted.

13. The EIS does not contain sufficient detailed information to allow for an evaluation of the impact of the alternatives on the Tapoco facilities. To better understand the effect of alternative Fontana operations on the Tapoco facilities we need to have access to the model that was used to evaluate ... flood operations and the results from that model. In addition, the model should be modified to account for future changes in the operation of the

Tapoco facilities. **Greg Ott, Operations Manager, Alcoa Power Generating Inc. Tapoco Division, 3750**

Response to Comment 13: TVA continues to work with Tapoco to provide them with detailed data for their evaluations.

14. Why is it necessary to keep water levels so low in July, August, September and October? **H. Lee Fleshood, 3297**

Response to Comment 14: See Response to Comment 1.

15. Since we are virtually at the headwaters of Douglas Lake, we have absolutely no lake for 2/3 of the year. I believe a balance can be reached between the needs of TVA and the needs of those of us who use the system. Unfortunately, none of the alternatives will substantially increase the winter pool for our County. The lakebed will continue to be an unattractive, unusable mudbog for much of the year. **James Finchum, 1299**

Response to Comment 15: Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Douglas.

16. I guess I want the plan that is best all around. That's pretty much it. **Jane Chinnici, 4299**

Response to Comment 16: Comment noted.

17. Why is Lake Chatuge level still as high as it is when every other lake is not. **Joanne Wenberg, 2415**

Response to Comment 17: See Response to Comment 1. Chatuge has less planned annual fluctuation due to characteristics of the watershed and the reservoir shape.

18. Can you please tell me why TVA lets so much water down, in lake Chatuge, you are killing the fish, and causing more erosion, breaking up docks. i see no reason for such a let down, and yes i have heard all the stories, to which i find very hard to believe, can we find a happy middle point. **John S. Petraskiewchz, 2512**

Response to Comment 18: See Response to Comment 1. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Chatuge.

19. What factors dictate the dropping of water levels in August? Why must it be done before summer is over? **Judy Kirchner, 4558**

Response to Comment 19: See Response to Comment 1.

20. The lake has not been this high for 5 years and even with the high water this year the TVA has managed the water flow. Since we've had 5 lean years it appears it would in the best interest of TVA to maintain some water level in Lake Nottely so that there would be standardization. **June Hewett, 1830**

Response to Comment 20: Inflow fluctuates substantially on an annual basis and will result in varying water levels that TVA must manage, regardless of the policy alternative selected.

21. One of the biggest areas of concern over the past has been the varying degrees of draws between the surrounding tributaries. Nottely has had a lower level much earlier than Lake Chatuge and Lake Blue Ridge. A main concern is that all the surrounding lake levels be lowered consistently and that all are done on the same time frame. **Karen Adamson, 1666**

Response to Comment 21: Equitable treatment among the reservoirs that comprise TVA's reservoir system was a consideration in the formulation of TVA's Preferred Alternative. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Nottley.

22. "Why was not the month of October included in the study", since that is what anyone and everyone, plus Loud, was asking for; that the winter draw down would not take place until the 1st of October, which would be the time that the reservoir usage would start to really drop off and the summer usage would be coming to an end, so to speak?

WHY wouldn't it be feasible to OPTIMIZE each dam on its own, just like you have four tires on your automobile and two wheels are balanced and two are not. If that were the case, you would then balance one of the other wheels and then balance to last wheel and A MAXIMUM OPTIMIZATION would be the final result. **Malcolm P. Cotton, 441**

Response to Comment 22: October was included in some of the preliminary alternatives but not included for the detailed study in the EIS due to adverse impacts on many operating objectives.

TVA is responsible for managing the entire Tennessee River system watershed for the purposes of navigation, flood control, power generation, water quality, water supply, and recreation. The high and low dams were designed to work together as a system to reduce the impacts of damaging floods and to ensure that a navigable waterway could be maintained year-round. In order to achieve the greatest overall level of benefits for the region, TVA operates the reservoir system as an integrated unit rather than a set of individual projects. This approach allows each of the projects to contribute to the operating objectives for the system. Because the water that is released from each of the reservoirs is used repeatedly by projects downstream and because there are varying amounts of storage space available in each reservoir, a careful balancing and scheduling of reservoir releases is required each day to ensure that enough water is released to meet system needs while preventing a surplus of water that could result in flooding under high inflow conditions. If each reservoir were optimized independently, just for its own immediate region, system needs at downstream locations would be negatively affected and the overall level of benefits provided for the region would be diminished.

23. Minimizing fluctuations in water levels to provide a stable environment. **Mark Wiggins, 2278**

Response to Comment 23: TVA fluctuates water levels weekly and seasonally for a number of reasons including, but not limited, to flood and mosquito control and power generation.

24. As property owners at Lake Blue Ridge, (611 Magnolia Drive, Blue Ridge), my wife and I would like to ask a question ...Why is it not possible for the lake level to remain at or near full until much later in the year? Keeping it at a higher level until at least Labor Day would make a very great improvement in the quality of life at Lake Blue Ridge.
Mr. And Mrs. John R. Scott, 3718

Response to Comment 24: See Response to Comment 1. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Blue Ridge.

25. I confess to being uneducated with respect to broad requirements of coping with TVA's mission--flood control, navigation, water quality, power supply, recreation, etc. And I confess to having a personal interest in lake levels, I have problems understanding the rigid adherence to reducing lake levels as early as late July and not allowing those levels to return to recreational levels until late spring. Would it make a significant difference if three or four weeks were added at each end? There already is a sizeable population along the lakeshores--and even more who commute to take advantage of water sports. Several residential developments are in planning--and actual construction--stages.

Yours is a challenging task requiring the balancing of many conflicting interests. I hope there may be room for modifying the present scheduling of lake level adjustments--providing more "lake" and less "Gobi."! **Norman J. Knights, 810**

Response to Comment 25: See Response to Comment 1. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs.

26. I guess my specific comment is that I strongly recommend some combination of these alternatives, a blend, if you will, because as I see this, the benefits of Reservoir Recreation Alternative Aand/or Alternative B are not in mutual exclusive to an alternative such as commercial navigation, which was economically beneficial. So it seems that in the process of evaluating comments and then trying to assign value to those comments that it would be advantageous to look across some combination of alternatives, and I'm sure you're doing that.

The major impact on our property owners has to do with the extreme fluctuation of the water levels and the fact that the low water in midsummer seems to be unnecessary from our perspective even when you look at the study data, and that is -- Alternative B in our specific case would be the most advantageous, yet, I do not understand the specific impact on hydro production in that the same amount of water would eventually flow through the reservoir and the hydro plant under alternative Base Case.

It's a question of timing, and the timing issue is not clear to me other than the fact that summertime, August, is the prime peak season for power needs. However, I also know at that point in time that you are very unlikely to lower the gas- and coal-fired plant production because of the cost of the fluctuations of those plants as opposed to the ease of regulating a hydro plant off and on, if you will, in terms of generation.

So I'm here to speak in behalf of Alternative B and some combination of that alternative with any of the others, specifically, the commercial that seems to be the most economically advantageous. **Norman K. Owen, 4324**

Response to Comment 26: The commenter is correct that the adverse impact on power system costs is a question of timing. Generation from TVA's hydropower plants is used for and is most valuable during peak demands on the TVA system. Our coal-fired and nuclear plants are typically operated in a baseload manner (around the clock as necessary in order to meet demands). While the same amount of water may be available in most reservoirs to generate power at different times, that generation would likely be less economically valuable. The annual impact on the TVA power system from Reservoir Recreation Alternative B was estimated to be $67 million. In part to address these adverse cost impacts, TVA developed its Preferred Alternative. The Preferred Alternative has an estimated cost to the power system of approximately $14 million annually.

27. First let me identify my vested interest. I am a property owner on Boone Lake. As a result of this, TVA has a flowage easement for Boone Lake on my property and I interface with the lake every day. Therefore, I was most interested in the Reservoir Operations Study and attended the workshop you had in Blountville, TN in the spring of 2002 to collect input from concerned people about TVA operations and the impact on Boone Lake and others in the TVA System. I had great hopes for some improvement in the lake level that could be obtained by (1) raising the January 1 lake level target to reduce the unsightly nature of the uncovered lake bed in the winter and (2) extending the targeted summer level to obtain more use of the lake in the favorable months of September and October.

I obtained and read the DEIS and was extremely disappointed to see that after all the effort spent by a lot of people there was no change made to Boone Lake. This does not address my hopes or those of many others interested in this lake. I found it to be curious why this lake received no redress on these issues when clearly so many of the people who attended the input meeting in Blountville in the spring of 2002 were desiring an improvement. I spent some time researching the background of the changes that TVA has made on lake levels over the years and I have concluded that TVA has made no changes to Boone Lake in the last 35 + years in spite of at least three significant studies where numerous lakes have received improvements in TVA operations policy. I base that conclusion on the DEIS and GAO/RCED-99-154 GAO Report on Lake Levels to the Honorable Van Hilleary, House of Representatives dated May 1999.

It seems clear that Boone Lake is one of 14 TVA lakes that falls into a category of TVA lake called a multi-purpose tributary project (MPTP) and as such has much more significant changes in lake levels than main river lakes. I quote the GAO report:

Chapter 2, Page 25 and 26: "While all 54 projects were built or acquired as part of TV A's integrated system of projects and all of the projects contribute to maximize the value of the available water in the Tennessee River, the multi-purpose tributary projects generally have more significant changes in lake levels during the year. For example, the target lake level for Douglas - a multi-purpose tributary project - decreases 50 feet from 990 feet on August 1 to 940 feet above sea level on January 1. On the other hand, the target lake level for Fort

Loudoun - a multi-purpose main river project - only decreases 6 feet from 813 feet on August 1 to 807 feet above sea level on January 1. Table 2.1 shows the differences between the August 1 and January 1 target lake levels at the multi-purpose tributary projects.

Table 2.1: August 1 and January 1 Target Lake Levels for TVA's Multipurpose Tributary Projects. Of the 14 MPTP lakes, ten have a significant variation during the year in their lake level of greater than 10 feet. They are Blue Ridge, Boone, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Norris, Nottely and South Holston. Of these 10, all but Boone and Fontana received an apparent recommended increase in the January 1 target Level. I quote the DEIS: "Under Reservoir Recreation Alternative A, the winter flood guide levels would be increased on 10 tributary reservoirs (South Holston, Watauga, Cherokee, Douglas, Chatuge, Nottely Hiwassee, Blue Ridge, Norris, and Tims Ford) to the pool level targeted to be reached by March 15 under the Base Case."

Fontana has received increases before so that leaves Boone as the only Lake of these 10 with significant lake level variation to never receive an increase in the winter lake level in the last 35+years. I quote the GAO report: Chapter 3 page 39 "Over the past 3 decades, TVA has instituted two sets of significant changes in the way the multi-purpose tributary projects are operated. --- In 1971, TVA conducted a study to modify, if possible, some portions of its operations to improve recreational uses of TVA's multi-purpose tributary projects within the framework of the statutory requirements for flood control, navigation, and hydropower generation. As a result of this study, TVA concluded that raising the January 1 target levels and the normal minimum levels of nine of its multi-purpose tributary projects should provide higher lake levels during the winter in most years. -Table 3.1 highlights the changes TVA implemented in 1971. Table 3.1: Changes Made in 1971 to Multipurpose Tributary Lake Levels SEE ORINIGAL FOR TABLE.

Executive Summary Page 5 "According to TVA, while large storms can occur throughout the year, the major regional floods on the Tennessee River normally occur between December and April." -- "A key change resulting from its December 1990 review of project operations was TV A's delaying the annual lake drawdown at the multi-purpose tributary projects from Memorial Day to August 1. (The multi-purpose tributary projects were defined as Boone, Chatuge, Cherokee, Douglas, Fontana, Hiwasse, Melton Hill, Norris, Nottely, South Holston, Tellico, Tims Ford, and Watauga plus Blue Ridge)"

Executive Summary Page 6 "Since the 1990 review, little has changed in how TVA operates its multi-purpose tributary projects. Because it had been receiving an increasing number of requests to analyze changes in the lake levels for individual lakes, TVA determined that a piecemeal approach raised questions of fairness in how each lake would be treated within TVA's system. --- Therefore in March 1997, TVA established a 4-year moratorium on making any changes in lake levels."

Chapter 3 Page 41 & 42 "In December 1990, TVA released the results of its work examining lake management policies in a report entitled, "Tennessee River and Reservoir System Operation and Planning Review."-- Referred to by TVA as its "Lake Improvement Plan," this review evaluated (1) three alternatives to provide additional minimum flows from TVA dams to improve reservoir releases downstream and (2) seven alternatives to stabilize lake levels by delaying the drawdown of lake levels until August 1 or later. As a result of TVA's analyses, the 1990 review recommended that (1) TVA increase minimum flow requirements from mainstream and tributary projects and increase DO levels in the releases from 16 of its dams and (2) maintain summer target levels in 10 multi-purpose tributary projects until August 1st."

The 10 projects were**:** Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Norris, Nottely, South Holston, and Watauga. "The remaining four multi-purpose projects - Boone, Melton Hill, Tellico and Tims Ford - not included in the review were excluded for various reasons. Boone was excluded because its original design included its operation at prescribed seasonal elevations that result in a constant lake elevation from Memorial Day through Labor Day. Melton Hill does not have an annual drawdown; it is operated in a fixed range of about 793 to 795 feet. Tellico, which is connected by an ungated canal to Fort Loudon Lake, has a lake elevation essentially the same as Fort Loudon - a multi-purpose main river project. Because Fort Loudon is targeted to reach its summer lake level by April 15 and its drawdown does not begin until November 1, Tellico has a flat summer lake level until November 1. Tims Ford, by design and original project allocation, has always been operated with a minimum summer lake elevation of 883 feet, which extends until October 15."

Chapter 3 pace 44 and 45 "Table 3.3 shows the effects of the changes on the August 1 lake levels of the 10 multi-purpose tributary projects considered in the 1990 review. SEE ORIGINAL FOR TABLE

What makes this situation even stranger is the fact that TVA recognizes the fact that minimizing exposed reservoir bottoms, debris, trash and underwater structures and shoreline ring effects resulting from low winter pool levels is important and discusses it in Chapter 4 and 5 of the DEIS. Table 4.19-02 Existing Scenic Conditions for Representative Reservoirs specifically discusses Boone Lake and describes the negatives of the current situation under Landscape Visibility as**:** "High Concern Level," "High opportunity for viewing," "Recreational Use," "Substantial residential Development," and under the Existing Scenic Integrity as**:** "Low water levels create ring effect and expose flats." "High amount of shoreline residential development and related facilities are evident" The DEIS, Chapter 4.19.5 Exposure of Reservoir Bottoms and Flats goes even further and depicts the situation on Boone Lake in Figure 4.19-02 The Effects of Lower Pool Levels on Exposing Reservoir Bottom and Flats-Boone Reservoir Observed from a Rural Road Adjacent to a Residential Area, Figure 4.19-03 The Effects of Lower Pool Levels - Upper Boone Reservoir Observed from Highway IIE near Bluff City and Figure 4.19-04 Effects of Floating Structures Sitting on Exposed Reservoir Bottom and Other Exposed Structures Resulting in Lowered Scenic Integrity.

Yet the ROS did nothing to specifically address this problem on Boone Lake. Why? Why after all these years and studies has Boone Lake never received an adjustment in the winter pool level? The recommendations of this study would have been a great opportunity to address this problem on Boone Lake. I don't think this issue is going to go away.

On the second issue of extending the targeted summer level to obtain more use of the lake in the favorable months of September and October there was apparently no study done. The only two references to this I could find in the DEIS were in the Executive Summary ES.8 Other Actions Considered where the following was found**:**
"TVA considered but did not include a number of other actions. They included --- filling tributary reservoirs by March 1, and delaying drawdown until after October." and Chapter

3.4.2 Actions Not Included in Anv Policv Alternative where the following was found: "During the formulation of the initial 25 alternatives, the practice of raising tributary reservoirs to summer pool levels by March 1 and delaying drawdown until October 1 was evaluated but not carried forward. Because filing reservoirs before the end of the flood season would compromise TVA's ability to control runoff in spring, filling reservoirs to summer pool by March 1 was not considered for detailed analysis. Delaying drawdown until November 1 would reduce flows from the Tennessee and Cumberland Rivers during September and October when water levels on the lower Ohio and Mississippi Rivers already are likely to be low."

In my opinion, these statements seem like a broadbrush approach to basically staying with the status quo. The dates of March I and November I push the envelope and "likely" doesn't seem very definitive. There are 61 days between I March and I June and I don't understand why some interim points were not analyzed to consider bringing the summer levels earlier in the year by at least a few weeks. I do recognize that the spring months are flood sensitive. The same can't be said for the fall which is typically much drier than the spring and has excellent weather for recreational use of the lake. There are also 61 days between 1 September and 1 November and I don't understand why some interim points were not analyzed to consider keeping the summer pool levels into September or early October. I recognize that DEIS Reservoir Recreation Alternative A recommends extending the summer pool period until Labor Day on 10 of the 14 MPTP's (South Holston, Watauga, Cherokee, Douglas, Fontana, Chatuge, Nottely, Hiwassee, Blue Ridge, and Norris) but since Boone Lake already had the summer pool extended until that date, this lake got no improvement. Why? It's difficult to believe that holding Boone Lake at summer level for another month would have much impact on the Ohio and Mississippi River water levels. Earlier studies had shown that the impact was apparently not significant. I quote the GAO report: Chapter 4 Page 52 and 53, "Despite the changes made to its policies impacting lake levels earlier this decade, TVA has continued to receive a number of requests to make further changes. TVA ultimately decided in March 1997 to implement a 4-year moratorium on making further changes to these policies." -- "After the 1991 Lake Improvement Plan was implemented, requests for changes to TVA's lake-level policies slowed for a year or two but began again in 1993. According to TVA, constituents were no longer satisfied with the changes made in 1991, or new constituents were not aware of the changes that had been made." By March of 1997, several requests for changes to policies impacting lake levels had been submitted to TVA. For example, (1) TVA had completed a preliminary study that examined the power and flood control aspects of extending Boone Lake's level later into the fall:"-- .(In addition, TVA has commented on two studies discussing the potential economic benefits resulting from higher lake levels later in the year (Oct 1) at Cherokee and Douglas Lakes in Tennessee and Blue Ridge, Chatuge, and Nottely Lakes located in northern Georgia and users at South Holston and Watauga Lakes requested changes in policies at those lakes)

"TVA staff had performed analyses for Boone Lake, which indicated that the impacts on TVA's system-wide cost of supplying electric power associated with the requested changes were relatively small, with a net present value of less than $1 million. TVA estimated that increased cost of supplying electric power associated with the requested changes at Boone Lake was much less than for other TVA lakes analyzed in the past, primarily because the changes in lake levels during the year at Boone were smaller in comparison to other lakes, and TVA had already extended the summer target lake level at Boone Lake until Labor Day. As a result, TVA would not need to shift power production at Boone Lake from the peak summer months to the fall. In addition, the flood impact analyses indicated that based on historic data, flood control at Boone Lake would not be affected. However, TVA indicated that potential storms would have an impact on the frequency of floods downstream from Boone Lake. TVA became concerned that more and more users were requesting studies for the lakes they used, resulting in an analysis of the system on a piecemeal basis. To TVA, this raised a "fairness" issue of treating these lakes differently in the TVA system. OF particular concern to TVA was the relatively low impact that the requested changes at Boone Lake would have on TVA's system-wide cost of supplying electric power. TVA believed that the implementation of these changes would give even more favoritism to a lake that already had high lake levels envied by users at other tributary lakes, while also promoting a "first come/first served" attitude to the lake users."

Why was the earlier study that had shown the feasibility of extending the summer pool level on Boone Lake later into the fall and had been placed on hold because of the moratorium on changes to lake levels, not now implemented in the ROS? Of the 14 MPTP Lakes, 4 received no benefit from the DEIS recommendation to extend the summer pool period. They are Boone, Melton Hill, Tellico and Tims Ford. Of these only Boone would receive some benefit from a summer pool extension into September or early October. Melton Hill has an operating range of 793 to 795 feet year-round so this is a non issue there. Tellico's level is determined by Ft. Loudoun's level which does not start drawdown until 1 November. Tims Ford already has the summer pool level extended until 15 October. So why not give Boone some benefit by extending the summer pool level-into the fall for some amount? Is it TVA's view about Boone Lake, as I found in Table 4.19- 02 of the DEIS, that "compared to other reservoirs, high water level is held longer (Mid-May to early September)" and therefore they don't need a benefit from this Reservoir Operations Study? I would point out that both the "run of the river" projects such as Ft. Patrick Henry and "mainstream" projects such as Guntersville all have high water levels longer as well as Melton Hill, and Tellico of the "tributary projects."

I hope you and your team have an opportunity to reflect on my comments and make some favorable adjustment in your recommendations concerning Boone Lake and the issues I have discussed in this letter. There are many other constituents in East Tennessee that are affected by TV A's operations policy on Boone Lake and they may be happy with continuing to get the status quo, but I doubt that the majority is. I write this letter hoping to achieve a positive benefit for both you and I. **Richard F. Odum**

Response to Comment 27 As stated in your comments, Boone Reservoir typically has high, stable reservoir levels through Labor Day. For several reasons, this duration of summer levels would not be extended under TVA's Preferred Alternative. Providing a longer duration of higher pool levels at Boone would negatively affect reservoir levels upstream, including Watauga and South Holston; increase residence time of water in the reservoir, which would likely lead to decreased water quality in the reservoir; and raise questions of equitable treatment among TVA reservoirs. Regarding your desire for higher winter levels on Boone, the winter flood guide level would be raised under the Preferred Alternative, which would likely result in higher winter water levels.

28. We can't see any valid reason to drop them [lake levels] before October. **Pete and Diane Heinen, 981**

Response to Comment 28: See Response to Comment 1. TVA considered extending reservoir levels to October but determined that this would result in unacceptable impacts on flood risk, as well as adverse impacts on many other operating objectives.

29. Would like Watts Bar held at normal pool from April to November for maximum power generation. Gradually lower by 6 ft before 1/1 for max power generation and held there during January for pier maintenance, filled 2 ft. in Feb. to increase turbine pressure and decrease ice formation by flow rate, then filled normal pool in April. All lakes lowered up to 2.5 ft. below normal pool to prevent flooding. Initiate lowering prior to rain. This year even piers installed by USACE destroyed. **Peter Low, 3956**

Response to Comment 29: Changing the operating guidelines for Tennessee River mainstem projects was included in all action alternatives. However, results of the flood risk analysis indicated that raising the winter operating guide levels would result in unacceptable increases in the potential for flood damage. These analyses led TVA to propose under the Preferred Alternative to delay the complete filling of upper mainstem river projects—including Watts Bar—until May 15, in order to reduce potential flood damage. Existing meteorological tools do not allow TVA to adjust reservoir levels quickly enough to respond to all possible flood events. Also see response to Comment 3.

30. If the water is drawn down after Labor Day rather than August 1, I fail to understand why the winter level has to be maintained at a higher level. Why can't the water be brought back down to the same level in September that it is in August, effectively leaving the winter level the same and avoiding the potential flood control danger? **Phyllis Miller, 287**

Response to Comment 30: This would eliminate some of the flood control concerns, and TVA considered this in the formulation of its Preferred Alternative. The analysis of flood risk impacts was conducted on a seasonal basis; therefore, data for each location and season were analyzed. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs.

31. No one cares so much in the winter so draw it down more then if needed. Power can still be created and everyone will be a lot more happy. **Regina Frisbey, 1453**

Response to Comment 31: TVA has also received a number of comments from people who care very strongly about reservoir levels in winter. While electricity can be and is generated during the winter months from TVA's hydroelectric units, natural inflow usually provides adequate water to maintain high use of the units.

32. The March 15 elevation on Nottely (1755' base line) was found to be 5+ feet lower than necessary by the TVA's 3R group in 1989. The increase to 1762 should solve your perpetual problem of not being able to fill Nottely. I guess 15 years later isn't very bad, assuming something is actually going to happen. **Richard Bell, 2025**

Response to Comment 32: TVA's Preferred Alternative would raise the winter flood guide levels at Nottely, as shown in elevation probability plots in Appendix C.8.

33. I have found no reasonable reason for the extreme drawdowns. **Stan Veltkamp, 930**

Response to Comment 33: See Response to Comment 1.

34. I am disappointed that the most important water level issue that is of significant concern to the users of Melton Hill is the pool level that is being maintained, mostly in the summer and more importantly, on weekends. Since Melton Hill is a pass thru only with a minimum capacity for storage, we have asked that levels be maintained at higher levels. As an example, we have requested that the day start off (AM) at 794 or higher so as you generate thru out the day, you have more flexibility without leaving many recreational boaters stranded at the end of the day. Many of the lake users have come down to their docks on a Saturday or Sunday, only to find that they cannot take their boat out due to the low lake level. Many complaints also are that they do go out in the morning, only to find out that the water level has dropped so much that they cannot get all the way home. We respectfully request that TVA consider working with higher levels on weekends during the summer so the users of Melton Hill Lake who live on some of the more shallow areas can have access to their docks. **Steve Lewis, 3281**

Response to Comment 34: As noted, Melton Hill has very little usable storage between the normal operating range of 792 to 795 feet. Therefore, it has no planned seasonal fluctuation: this is an advantage for year-round reservoir users, when compared to many other tributary reservoirs that seasonally fluctuate an average of 30 to 35 feet and, in some cases, more. Operations at Norris Dam and Melton Hill Dam support hydroelectric production and provide adequate water supply for the efficient and reliable operation of TVA Bull Run Steam Plant. The available usable storage space in Melton Hill is used on a daily basis to allow the hydroelectric units at Melton Hill and Norris Reservoir to generate during high-demand peak power hours in summer—typically from mid-day through early evening. Because the units at Norris generate at a flow rate of about 9,000 cfs, the units at Melton Hill generate at a flow rate of about 21,000 cfs, and travel time is required for the water released from Norris to arrive at Melton Hill; the stored water in Melton Hill Reservoir is used to supply water to the units at Melton Hill during the peak hours. Reducing the pool level fluctuation at Melton Hill would severely diminish TVA's ability to shape hydropower generation to cover the highest-cost peak hours.

35. I'd like to preface my comments with a disclaimer saying that, of course, I only have knowledge of what the TVA does with the lake levels from a purely personal point of view(and probably a selfish one too.) BUT, I would like to understand the timetable you folks work on a little better. thus enabling me to justify why a recreational lake, that provides much economic growth to this area i.e. BLUE RIDGE, cannot be used for recreation and the enjoyment in the splendid months of September, October, and in some instances, even as early as August. I understand you must maintain flood control, provide water for upstream usage, generate power elsewhere,, and maintain the dam...and probably many other projects that I have no clue about...., but why do we have such a full pool in March and no water in September? I'm sure I am being rather simplistic in my views, and I apologize for that, but I know that I am not alone in wishing with all of my heart, that we could change the timetable of events to rotate the drawing of the water level , delaying it for one month. I feel sure that the trade off for less water in March, would be met with great happiness from many of us who love our lake. Thank you for having this forum for our communication with you, who make such important decisions in our lives. **Susan Carruth, 3197**

Response to Comment 35: See Response to Comment 1. Blue Ridge Reservoir is actually a single-purpose power storage reservoir, not a recreation reservoir. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Blue Ridge.

36. So, what I want to find out is why they say the base is supposed to be August 1st, when we know they were drawing down early in July. That's really my only complaint. **Sydney Y. Cole, 4412**

Response to Comment 36: The existing operations policy (Base Case) allows for a restricted drawdown on the tributary storage reservoirs from June 1 to August 1. This means that TVA can draw down reservoirs a certain amount, while remaining above the minimum summer pool levels that were established in the 1990 Lake Improvement Plan. Unrestricted drawdown to winter elevations begins on August 1.

37. The late drawdown of the upper reservoirs during the month of August reduces the amount of water available for power generation during the peak months of TVA's generating scheme. The extended recreational requests of the small number of property owners in the upper reservoirs should not be able to cause increasing power production costs due to less available water flow when it is most needed. Additional coal must be purchased and burned to generate power. Landowners in the upper reservoirs (with few exceptions) knew the drawdown schedules when their property was purchased and the entire TVA customer base should not be penalized by higher generating costs and additional pollution created by lack of water flow. **Terry C Smith, 2965**

Response to Comment 37: Comment noted.

38. Am I correct in assuming that the total volume of water in Lake Nottely is decreasing over time? If yes, then increasing winter pool levels would help reduce the rate of change occurring. **Thomas Carey, 1707**

Response to Comment 38: There is no indication that the total volume of water is substantially decreasing over time.

39. When water levels are reduced below the maximum efficiency levels for the production of electricity, what is the justification????

It is not flood control on Blue Ridge Lake except during certain months. Who and why does TVA pick August 1 as the date to start reduction of water levels??

I believe that the TVA does not want to change or change as little as possible its water level policies, because once the people who use the lakes see how great it is to have a higher water level in months other than May, June, and July, they will protest future water level reductions vehemently. **Thomas G. Sandvick, 2664**

Response to Comment 39: See Response to Comment 1. Unrestricted drawdown begins on August 1 as a result of the 1990 Lake Improvement Plan that was adopted by TVA in 1991.

40. As far as I know TVA has never given any logical or believable reason for the low lake levels. Lake levels need to be higher in the winter. I do not believe a need has been shown for lowering the levels to the point at which they are now lowered. Also, levels should be reduced later. There is no documentation proving that the lake levels must be reduced as much as they are now reduced. Cherokee is dropped much more than appears necessary in the winter. For some reason TVA has not been open to this. **Vonda M. Laughlin, 2406**

Response to Comment 40: See Response to Comment 1.

41. I think things are operated reasonably well. I'm a little surprised this summer that Blue Ridge and Nottely are not full with all the rain we've had. **W. H. Cross, 4362**

Response to Comment 41: Comment noted.

42. I am voting to express my concern for the varying lake levels seen throughout the year for Lake Blue Ridge in Blue Ridge, GA. Aside from depriving lakefront property owners with year-around recreational opportunities, lowering the lake level too far below full pool, negatively affects property values and depresses economic development efforts of the surrounding municipalities. By depressing assessed property values, you are in fact robbing the City of Blue Ridge of additional tax dollars that are imminently important to improve and construct new economic and physical infrastructure necessary to support the growing popularity of North Georgia cities. I do not profess to be a hydrologist, water scientist or civil engineer, however, I can deduce that there are other ways to satisfy all necessary water and power obligations throughout the Toccoa/Ocoee River Basin without draining Lake Blue Ridge to such low levels. There are lake models, which serve as precedent outside of the TVA system. Lake Keowee in South Carolina, which is controlled by Duke Power, is able to maintain high lake levels, while still meeting necessary water and power obligations. As a result, housing developers and residents of the lake are very cognizant of their part in maintaining the natural characteristics of the shoreline to promote real estate value and tax dollars for the community. I hope that I have made a somewhat compelling argument for consistently high lake levels for Lake Blue Ridge, as I feel that this is the correct action to take. Everyone will have a role in this effort to promote economic development, and the TVA has the privilege of starting the process. **Wes Hardy, 3031**

Response to Comment 42: See Response to Comment 1. Under TVA's Preferred Alternative, flows would be adjusted from June 1 through Labor Day, resulting in a longer duration of higher pool levels under median conditions on a number of reservoirs—including Blue Ridge.

43. I just can't understand why the water level [on Kentucky]can't be up to at least 357 all winter. That's about it. **Wilbur Neil, 4367**

Response to Comment 43: USACE expressed concerns about changing operations on Kentucky Reservoir because of the potential effect on the lower Ohio and Mississippi Rivers. Its position is that any proposed changes that would involve reduction in flood storage capacity would need to be evaluated within the context of the entire lower Ohio/Mississippi River system. In addition, USFWS, other agencies, and some individuals voiced concerns about changing operations on Kentucky Reservoir. TVA did not include changes to the operating guide curve for Kentucky Reservoir as an element of its Preferred Alternative.

44. I manage Cancun on Boone. My concern is -- I asked a TVA representative here about 20 minutes ago, about the lake levels and why can't they leave the lake summer level until the end of October, and his comment was they didn't make that study on Boone Lake.

And October and November, to me, is a really dry month, and for us and economics of Boone Lake, it would be advantageous for TVA to maintain the lake level, at least to October. Then they could begin to drop. If a storm surge comes in, like a tornado, sure they could drop it, but, you know, we would take that chance. **Wynn Beidleman, 4310**

Response to Comment 44: See Response to Comment 27.

45. I am disappointed that the most important water level issue that is of significant concern to the users of Melton Hill is the pool level that is being maintained, mostly in the summer and more importantly, on weekends. Since Melton Hill is a pass thru only with a minimum capacity for storage, we have asked that levels be maintained at higher levels. As an example, we have requested that the day start off (AM) at 794 or higher so as you generate thru out the day, you have more flexability without leaving many recreational boaters stranded at the end of the day. Many of the lake users have come down to their docks on a Saturday or Sunday, only to find that they cannot take their boat out due to the low lake level. Many complaints also are that they do go out in the morning, only to find out that the water level has dropped so much that they cannot get all the way home. We respectfully request that TVA consider working with higher levels on weekends during the summer so the users of Melton Hill Lake who live on some of the more shallow areas can have access to their docks. We do not think that this will have any impact on TVA other than how they schedule power generation at Norris and Melton Hill. By running Norris Dam power generation for a set period longer than Melton Hill, and starting it sooner than Melton Hill, you should be able to accomidate these people. Melton Hill power generation usually draws the lake down much faster than Norris Dam power generation can replenish it. Our request is simple-Can TVA balance the power production at these two dams to maintain higher lake levels with special consideration to the weekend operations. With a little creativity in the scheduling of power production, you can produce the same power, provide the Melton Hill Lake user more ability to use the lake due to higher levels, and have no negative impacts on Norris, Melton Hill or Watts Bar Lakes. **John Croes, President, Milton Hill Lake Users Associations, 1374**

Response to Comment 45: See Response to Comment 34.

Minimum Flow

1. Why was 25K [at Chickamauga] chosen for August for this alternative? Average since LIP is 31K for August. The change only results in an increase of about 3 feet in tribs on Labor Day. 20K would have added about 6. What were the impacts for 20 that excluded it's consideration. **Arland Whitlock, 2171**

Response to Comment 1: A range of flows was considered for the August minimum flow requirement. Higher flow rates would have provided little increase in reservoir recreation levels compared to the Base Case; lower flow rates would result in greater negative impacts on water quality and power costs.

2. Release only minimum flows between June 1 and Labor Day. Douglas is my main concern. **Louise Murray, 688**

Response to Comment 2: Under TVA's Preferred Alternative, only minimum flows would be released from a number of tributary reservoirs, including Douglas, from June 1 through Labor Day. See Appendix B for details about summer minimum flow releases under the Preferred Alternative.

NEPA Process

1. I have reviewed the June 2003 Draft Environmental Impact Statement (EIS) prepared by TVA for the operation of 35 reservoirs in the Tennessee River Basin and am pleased to submit the following comments on behalf of the Alabama Rivers Alliance (the Alliance). The Alliance is a nonprofit conservation organization committed to the conservation, restoration, and preservation of waters in the state of Alabama. We would like to thank TVA for inviting the Alliance to participate as a member of the Public Review Group during the development of the EIS. We hope that these comments will be helpful in the development of the final operations policy. **Alabama Rivers Alliance, April Hall, Watershed Restoration Specialist, 3733**

Response to Comment 1: We are very grateful for all the time contributed by the participants of the Public Review Group established for the ROS.

2. Although we understand that several factors including recreation, environment, navigation, and power generation were considered in the development of operations alternatives, we consider the protection and enhancement of the natural aquatic environment to be the most important priority in the management of a natural resource such as the Tennessee River. The environmental impacts of TVA's reservoir system were not fully considered. When the first dams were constructed in the early 1900's because the system was constructed solely for navigation and power production and the many environmental protection laws that exist today were not in effect at the time of dam construction; Therefore, steps should be taken by TVA to protect the existing native habitat and to operate the system in a manner that will halt or reverse —the adverse impacts on the environment already created by the dams.

The results of the public scoping process indicate that 20 to 30 percent of individuals polled feel that protection of the environmental should be the top priority of TV A's operation. However, the proposed operations alternatives do not provide a "balance" to many TVA objectives. It is obvious that improved environmental quality and recreation may likely come at the expense of other objectives such as power generation. We suggest that the information gathered during this lengthy and complicated EIS process be used to develop additional operations alternatives that actually reflect the opinions of the public. As presented in the draft EIS, alternatives were developed based on public input, but the results of the alternatives do not actually achieve an acceptable balance. Therefore, some of the proposed alternatives should be revised to achieve the results desired by the public. **Alabama Rivers Alliance, April Hall, Watershed Restoration Specialist, 3734**

Response to Comment 2: TVA was aware of the wide support for environmental protections when it formulated the identified alternatives. As recognized in this comment, the public identified a range of values and objectives for operation of the reservoir system and many of those are in tension with one another. Except for the alternatives that were formulated to be primarily single purpose (e.g., the Summer Hydropower or Tailwater Habitat Alternative), the identified alternatives were designed to achieve or enhance a number of different values. We are not surprised that the “balances” struck by these alternatives fail to satisfy all of those commenting on the EIS. As suggested, TVA did use this and other comments to help fashion the Preferred Alternative that is identified in the FEIS. TVA hopes that this alternative, and the balance it strikes, will be more acceptable to those who opposed earlier alternatives.

3. We acknowledge the Complexity of the ROS process conducted by TVA and appreciate the efforts put forth to compile and model the available data for the betterment of the TVA system. We urge TVA to consider the alternative best suited to provide improvements to the natural environment and prevent further damage. Since the alternatives discussed in the draft EIS do not provide a great deal of environmental quality improvements, modified alternatives should be developed and studied to optimize environmental improvements through TVA operations **Alabama Rivers Alliance, April Hall, Watershed Restoration Specialist, 3739**

Response to Comment 3: From scoping through the FEIS, TVA considered a large number of alternatives. Sections 1.6 and 3.2 discuss how TVA developed the range of alternatives that were evaluated in detail in the EIS. All of these alternatives would produce varying effects on the environment. Many of the alternatives would result in substantially adverse impacts on one or more environmental resources. Some alternatives would enhance a number of environmental resources but with substantial impacts on other objectives that are valued highly by the public. These results provide both TVA decision makers and the public a solid basis for judging the consequences of increasing or decreasing environmental protection.

4. For the people in communication that monitor the emails — I have asked for info twice, no reply

Have followed the study closely and know staff and consultants have done a tremendous amount of work. There must be a lot of technical data somewhere. Is it available to an old retiree like me? **Arland Whitlock, 1927**

Response to Comment 4: Technical data are in TVA’s administrative files, which are available on request.

5. Another issue is that it seems like it's a system-wide analysis, but it doesn't seem to address just Kentucky's needs; that if Kentucky Lake was held at winter pool currently the way it is but held at a foot higher until October and then drawn down more quickly, the flood control problems with that are probably less severe, just when you look at Kentucky, than if you look at that on a system-wide basis.

And so I think that there's not enough information that looks at what happens to recreation on Kentucky and what impact does it have if all we do is hold the summer pool at where it's at for two more months. I think you'll find substantial recreational benefits, rather than tying it all to all the other systems. That's what I wanted to say. **Brian Keister, 4523**

Response to Comment 5: USACE expressed concerns about changing operations on Kentucky Reservoir because of the potential effect on the lower Ohio and Mississippi Rivers. Its position is that any proposed changes that would involve reduction in flood storage capacity would need to be evaluated within the context of the entire lower Ohio/Mississippi River system. In addition, USFWS, other agencies, and individuals voiced concerns about changing operations on Kentucky Reservoir. TVA did not include changes to the operating guide curve for Kentucky Reservoir as an element of its Preferred Alternative.

6. How many people attended Blairsville workshop? **C.G. Boland, 3958**

Response to Comment 6: Table F1-01 identifies the number of attendees at the TVA workshops. The attendance for the Blairsville workshop was 407 people.

7. I have been to these meetings at least two or three times. You waste your money by asking people what they want, because you do not listen. **Carolyn Lakes, 4388**

Response to Comment 7: TVA's Preferred Alternative was formulated largely in response to public comments.

8. I have a number of questions about this telephone survey:

Question # 1 is why wasn't the telephone survey made known up front when the information about the ROS was published?

Question # 2 is what questions were asked of those people surveyed?

Question #3 is what area codes and telephone exchanges were called in the survey? **Cecil G. Boland, President Lake Nottely Improvement Association, Inc., 4163**

Response to Comment 8: One of the first ROS documents released, TVA's Scoping Document, did provide information about the referenced telephone survey. This was a random survey and included telephone exchanges (and locations) throughout TVA's 201-county Power Service Area. Approximately 3,600 registered voters were contacted. An independent opinion research firm developed the questions that were asked. Both the EIS and the Scoping Document refer to the results of this survey.

9 First, determine which alternatives have large numbers of "substantially adverse" or "substantially beneficial" impacts. If so, these alternatives should be either strongly considered for elimination or for acceptance.

Summer Hydropower = 6 substantially adverse (SA), 1 substantially beneficial (SB)
Resevoir Rec B and Tailwater Rec each = 4 SA, 1 SB
Tailwater Hab = 3 SA, 1 SB
Equal Summer/Winter = 3 SA, 0 SB
Res Rec A and Comm Nav each = 0 SA, 0 SB

On that basis (and also noting the specific SA's), I would consider eliminating Summer Hydropower, Res Rec B, and Tailwater Rec. Equal Summer/Winter and Tailwater Hab would be considered poorly. Res Rec A and Comm Nav, although neither has strong benefits or negatives, should be considered as the best candidates. Of these, I would recommend Res Rec A as the preferred alternative. The basic reason is that it would provide benefits to a wider range or region residents than Comm Nav.

Finally, congratulations on an excellent, detailed DEIS. As a resident, thank you! **Colman B. Woodhall, 399**

Response to Comment 9: The general approach described in this comment is the one TVA used to produce a set of alternatives that covered a reasonable range of possible operations policy changes. As described in Chapter 3, TVA began by eliminating alternatives that clearly produced unacceptable results that did not achieve TVA's objective of greater public value. This task was conducted in an iterative fashion to reformulate and reduce the number of possible alternatives. The eight alternatives identified and discussed in detail in the DEIS (including the Base Case) were the result of this process. Finally, after considering the environmental and economic analyses conducted for the ROS and the comments from the public and interested federal and state agencies, TVA formulated its Preferred Alternative, which appears in the FEIS.

10. I favor the use of scientific data in the determination of which alternative to use to better make use of the water resources of the Tennessee River and the many tributaries to the River. The proper decision needs to be made with the entire system in mind. I would favor the decision that maintains a "high" summer pool level in as many lakes as possible; but, keep "flood control" in mind. **David Slagle, 490**

Response to Comment 10: Comment noted.

11. It is my sincere hope that you will take the time to just use some of your God given common sense and not let someone inundate you with so many "facts" that you can't see the forest for the trees.

This is not meant in any way as an antagonistic approach and I hope that you will give this and the many other comments I am sure you have received serious consideration. **David Trotter D.D.S., 541**

Response to Comment 11: TVA has reviewed and considered each comment received.

12. I thank you so much for considering changing policy to better serve our lake region as it has changed over the years, requiring a different approach to water management, realizing the huge importance recreation and property values have become to our region. **Diane Layton, 2490**

Response to Comment 12: Comment noted.

13. During the course of TVA's study, they should have broadened their scope to include a larger population, not just their service area, that would be affected by the proposed changes and involved them in the decision making process. **Eddie Adams, 3037**

Response to Comment 13: Notice of the availability of the DEIS was published in the Federal Register, a publication that is distributed nationally. TVA received a number of comments from persons outside the TVA region. TVA also coordinated preparation of the EIS and ROS analyses with other agencies that have responsibilities beyond the TVA region, such as USACE.

14. I would also like to say that so far this year TVA has done a good job with lake levels. That is as of July 24th. Thank you for hearing my opinion. **Franklin D Brown, 117**

Response to Comment 14: Comment noted.

15. I am using this area to enter a general comment. Obviously an enormous amount of good work went into these evaluations, and TVA is to be commended on this study. I certainly admire the tenacity and skill of the technical folks who took on this enormous task. I hope the results will carry the day against political pressure that I know TVA faces day in and out which can work against a balanced operations policy. **Gary Hauser, 1899**

Response to Comment 15: Comment noted.

16. Based on the Executive Summary tables, I am struck by the fact that Res Rec A and B appear to focus on extending summer pool levels, which according the the tables have negative impacts pretty much across the range of reservoir objectives. So why do we continue to look so hard at extended summer lake levels when only benefits seem to accrue to a few? **Gary Hauser, 65**

Response to Comment 16: Comment noted.

17. And I hope, after $12 million, that TVA comes up with something more than "This is the way we've always done it and so we're going to continue to do it this way." **Glen And Janice Boland, 4449**

Response to Comment 17: Comment noted.

18. I am a little disappointed with the alternative options. I feel that they were somewhat limited in scope and did not include enough options in the area of winter pool draw down levels. **Gloria Dahlberg, 2040**

Response to Comment 18: TVA considered a wide range of alternatives, as described in Section 3.2.

19. TVA has fudged in constructing alternatives from the Base Case by building in a higher flood risk. Who will vote for that? This is a rigged process to insure we stick with the Base Case which is what TVA wants to do anyway. **Guy Larry Osborne, 1273**

Response to Comment 19: Chapter 3 describes the process TVA used to formulate alternatives. A substantial number of those commenting during the EIS scoping process asked TVA to change its operations policy in ways that would maintain reservoir levels higher for longer periods or that would fill reservoirs sooner after fall drawdowns. Most of the resulting alternatives were formulated in response to these commenters. In almost all instances, however, holding reservoirs higher for longer periods or filling them sooner would negatively affect flood management control. More water in reservoirs translates to higher flood risks because it corresponds to decreased flood storage capacity. Eliminating unacceptable effects on flood risk was one of the primary drivers in TVA's effort to formulate its Preferred Alternative.

20. I do not think TVA has adequately communicated to the non-lake user the potential impact of this study on them. The potential for higher electric rates due to efforts to maintain higher reservoir levels and increased water quality problems have not been communicated to the public. I agree the cost is not significant on the valley economy, but I don't think the non-lake user is really aware of the potential for a rate increase. **H. Ray Threlkeld, 2254**

Response to Comment 20: The DEIS; materials available at the 12 workshops that TVA held throughout the TVA region, including a short video that summarized results; and the Executive Summary of the DEIS that was widely circulated all presented information about potential impacts on power costs and water quality. TVA did receive a relatively large number of comments for an EIS process; however, relative to the more than 8.3 million people in the region that TVA serves, only a very small percentage chose to participate in the EIS process.

21. It was also noted that the material, entitled "Weighing the Alternatives" containing charts listing Base Case and seven policy alternatives, as distributed as color handouts and as part of the video, is different from the same document presented on the TVA website info. It is most confusing to prepare a response when the information presented is so completely different concerning the same specific alternative. Before any determinations are made, it would appear that clarification of this difference should be made known to the public so that accurate and consistent response could be made. Also, with conflicting information presented on the charts, it is unclear bow this information was obtained. **Janice L. Jones, Executive Director, Tennessee River Valley Association, 4176**

Response to Comment 21: Comment noted.

22. TVA is doing their best to get public input on all aspects of their operations which is the proper and responsible thing to do. From looking at information in the report it appears that the public input has been minimal despite TVA's best efforts. From the Executive Summary the total of public responses appears to be about 19,200, counting form letters and petition signatures, which amounts to about a 0.24 % sample of the public opinion. With this small an input, it seems that staff opinions will have a very great (overwhelming) impact on the final course of action. If the public does not speak up, then they have no right to complain if the final results don't suit them.

You are asking us to take nearly all of your figures on faith. The computer programs and models used are from reputable sources and are widely accepted in the industry, but there appears to be no way the results could be independently verified without repeating the ROS by another entity. After the recent debacles with some companies that had their financial reports (supposedly) verified by independent auditors and the results of that, you can understand why "trust me, I know what I am doing " is no longer acceptable. **Jim Mills, 4165**

Response to Comment 22: See Response to Comment 20. We appreciate the recognition that TVA has made a concerted effort to obtain public input. Staff analyses, as opposed to staff opinions, have traditionally had a strong influence on preferred actions identified in TVA EISs. The ROS EIS process was not an exception. TVA attempted to conduct as open and transparent a process as possible in producing the ROS EIS and its associated analyses. This included employing nationally recognized experts from outside TVA to assist in analyses; using widely accepted models and computer programs; and coordinating analyses with a group of interested federal and state agencies, as well as public stakeholders with diverse interests.

23. Many of the public utilities are having difficulty raising capital for improvements. How does this affect TVA, especially if TVA is required to pay down its debt more rapidly than now? The scarcity of capital may also affect which course of action and improvements are finally selected. **Jim Mills, 4167**

Response to Comment 23: TVA has not experienced problems in raising capital, but because one of its goals is to reduce its debt, capital expenditures are held to a minimum. None of the ROS alternatives, including TVA's Preferred Alternative would involve large capital expenditures. Under the preferred alternative, about $20 million in capital costs are expected to be incurred over a 3-year period.

24. I hope TVA is listening to the public this time around. Thank you for your consideration. **John Honey, President, Dandridge Yacht Club, 1070**

Response to Comment 24: Comment noted.

25. Much appreciation to all the TVA employees who created the many and somewhat varied alternatives. Once again though you have created an octopus of alternatives when those who desire a somewhat simplistic scenario get covered up in verbage. **John S. McClellan, 2032**

Response to Comment 25: Comment noted.

26. I don't even feel a social aspect of this is of much importance. I think the environmental effects are major concerns. **Linda Coons, 2308**

Response to Comment 26: Comment noted.

27. The (Road Show) presentation by TVA deserved an A+ for SPIN. I have never seen such bias mumbo jumbo misinformation on anything in my life. **Lloyd V. Bible, 2010**

Response to Comment 27: Comment noted.

28. We had hoped this would change in our lifetime, but there are so many people here that won't even come to these things because they say, and I quote, it's TVA, it's the way it will always be, it will never change. **Marilyn Allbritten, 4545**

Response to Comment 28: Comment noted.

29. TVA's responsibility is to consider all the alternative and come up with a compromise that will satisfy the needs of most users. **Michael A. O'Brien, 2482**

Response to Comment 29: TVA's Preferred Alternative was purposefully formulated with the intent of accommodating as many of the public's stated values and objectives as possible.

30. Public comments are a misleading indicator in support of this alternative. The few who stand to gain a lot are more likely to submit comments than the many who would have to share the load of adverse impacts. Increasing recreational opportunities and 'scenic integrity' for a few people, for one month, shoulcd only be given minor consideration in planning river operations. **Michael Sledjeski, 3215**

Response to Comment 30: See Appendix F1. TVA is aware that those commenting during EIS processes are self-selected and may not represent the opinions or preferences of the public at large. TVA uses a qualitative approach that is guided more by the merits of the comments made, than the numbers of the comments.

31. Thank you for the workshop and opportunity to comment on issues. Thanks for all the work you do and benefits TVA supplies not only to the seven states it encompasses, but the rest of the nation as well...Again thanks for the TVA system!! It's a great organization and makes many benefits to millions of people and has for many years. We love being a part of it, but feel that some policy changes are necessary now. **Mike Harris, 4555**

Response to Comment 31: Comment noted.

32. Based on all the data presented, including impact statements, a lot of work went into this study. I must say, however, that the average person will be overwhelmed by its volume and sometimes complexity. **Robert MacDonald, 1912**

Response to Comment 32: Comment noted.

33. At this time, The Nature Conservancy does not endorse any specific ROS alternative outlined in the draft PeIS. Rather, we encourage TVA to consider the outcomes of any decision on management alternatives in the context of TVA's responsibility for protecting the natural heritage of the Tennessee Valley. While other federal agencies such as the USFWS and state wildlife resource agencies hold responsibilities for managing and recovering native species, TVA remains the caretaker of the Tennessee Valley in many ways due to the extensive nature of its reservoir system.

In the coming years, TVA no doubt will be challenged to adapt to changes in regional and national power production and transmission markets. Despite the uncertainty of these future challenges, The Nature Conservancy strongly encourages TV A to remain committed to its environmental stewardship responsibilities and to explore opportunities for expanding its financial investment in protecting and restoring the Tennessee Valley's natural heritage. **Scott Davis, Executive Director, Tennessee Chapter of The Nature Conservancy, 3744**

Response to Comment 33: Comment noted.

34. I Just Hope And Pray That You Do Not Take A Split Vote Among The Other Plans That Keep The Water Level Higher And Allow A Hydro Electric Only Plan To Sneak In With A Lower Percentage **Scott Pisciotta, 1864**

Response to Comment 34: Comment noted.

35. These comments are submitted on behalf of the Tennessee River Gorge Trust, a nonprofit organization committed to the protection of land, water and wildlife resources of the Tennessee River Gorge. We commend the Tennessee Valley Authority for undertaking this Reservoir Operations Study, and we appreciate the thought that has gone into outlining various operations alternatives and the effort to include the public in the development of this study. However, this study fails to fully consider several key impacts on aquatic resources. Moreover, the study fails to offer an alternative which significantly improves water quality and benefits aquatic species. We hope you will expand upon your analysis of potential impacts on water quality and aquatic habitat in the final EIS. **Southern Environmental Law Center, 3612**

Response to Comment 35: The system operating parameter that appears to have the most direct effect on water quality is reservoir water retention time. TVA's 1990 EIS on its proposed Lake Improvement Plan addressed this issue. TVA changed the date for unrestricted water releases on most tributary reservoirs from June 1 to August 1 and mitigated potential water quality impacts at select locations by installing equipment to increase DO concentrations. Reversing that decision—changing back to the June 1 release date—was an element of the Summer Hydropower Alternative. Our analyses indicate that some, but not all, water quality parameters would be beneficially affected. The effect on other parameters would be variable or adverse.

It may be possible to combine operating elements in additional ways in order to achieve more consistent beneficial effects on water quality, but this would likely require more frequent and aggressive water releases. Such an alternative would be strongly opposed by a large segment of TVA reservoir users. A substantial majority of those commenting on ROS alternatives prefer a completely opposite operational change; that is, retaining water longer in order to maintain reservoir levels longer. Because of the concerns about water quality effects expressed here and by others, TVA has formulated its Preferred Alternative to lessen potential water quality impacts, as compared to other alternatives that would enhance recreation.

36. The DEIS Should Be Supplemented With an Alternative Designed to Protect Aquatic Habitat and Species. The DEIS admits that "no policy alternative represents a clear benefit to aquatic resources." DEIS at 5.7-31. Actually, most alternatives will decrease instream flow, lower DO and adversely affect biodiversity. DEIS Table 5.7-02, Table 5.7-04, Table 5.7-05; DEIS at 5.7-29. This is contrary to the stated intent of the ROS, which is to determine whether changes in operations policy would increase public benefits. DEIS at 1-4. **Southern Environmental Law Center, 4225**

Response to Comment 36: The intent of the Tailwater Habitat Alternative was to improve biodiversity and aquatic habitat by more closely approximating natural flow conditions. This was accomplished by reducing hydropower peaking and releasing a portion of the natural inflow on a continuous basis. However, this alternative would result in unacceptable adverse impacts on other operating objectives. To further address this, TVA formulated its Preferred Alternative that responds to the public's desire for increased recreational opportunities, while reducing adverse impacts associated with the action alternatives identified in the DEIS that would enhance recreation.

37. During the scoping process, the public expressed a strong desire for TVA to protect aquatic biodiversity and threatened and endangered species and to improve water quality and aquatic habitat. DEIS at 1-12. The DEIS characterizes these issues as "objectives , " yet no alternative meets these objectives .An alternative which meets these objectives and provides appreciable benefits to aquatic habitat and species throughout the Tennessee River system must be evaluated as one reasonable alternative. Under NEPA, this alternative cannot be ignored. Dubois v. USDA, 102 F.3d 1273, 1289 (lst Cir. 1996), cert. denied 521 U.S. 1119 (1997). **Southern Environmental Law Center, 4227**

Response to Comment 37: See Response to Comment 36. The Tailwater Habitat Alternative was formulated specifically to enhance aquatic habitats and promote biodiversity. Unfortunately, the subsequent analyses of this alternative suggest that it largely failed to improve aquatic habitats and minimize variable effects on aquatic resources overall. TVA has now formulated its Preferred Alternative to offset some of the projected adverse effects on aquatic resources and water quality. TVA consulted with the USFWS about the potential impacts of this alternative on threatened and endangered species. TVA's analyses and USFWS' Biological Opinion are included in the EIS. TVA believes the range of alternatives analyzed during this EIS process was adequate, and that the alternative formulation process used by TVA has been well explained in the EIS. Unlike a proposal to expand a ski area and increase snow-making capacities for skiing, there are countless possible alternative policies for operating the TVA reservoir system. The objectives of the alternative suggested here were made part of the alternatives examined in this EIS.

38. While we understand that attaining the appropriate balance for all the purposes and uses of the Tennessee River System will be a difficult job, we urge that the effects of the final River System will be a difficult job, we urge that the effects of the Final River System operating policies on all of the Valley's residents be taken into consideration, especially those who are not in regions of the Valley that can take advantage of all the uses of the Tennessee River. **TVPPA, Richard C. "Dick" Crawford, President & CEO, 4239**

Response to Comment 38: TVA was aware that the varying segments of the public served by TVA would be benefited and affected differently by any changes it may make to its existing operations policy.

39. It would be very helpful if the impact of each alternative on lake levels could be graphically depicted in the handouts and supporting materials. It can be challenging to determine what the impact of each alternative is predicted to be on lake levels. This is the primary concern of most attendees tonight. **Valerie Smith, 2424**

Response to Comment 39: Based on workshop attendee responses, reservoir operating guide curves appear to be readily understandable and may provide the graphical depiction sought by this commenter. For the workshops that TVA held throughout the TVA region on the DEIS, staff set up computers and large projection screens to show how changes in operating guidelines would affect the levels of reservoirs of interest to attendees. Elevation probability plots along with flood guides for tributary reservoirs and operating guide curves for mainstem reservoirs under the Preferred Alternative are in Appendix C.8.

40. This is a comment on the entire revised survey form. The original was more informative and easy to read but the shoreline draft which was done a few years ago was a much better way to present the information so that a person could make an informed comment. In other words, you have made a simple presentation very complicated and should just refer back to the shoreline study and redesign the format to show all the information in a chart form. Please respond **W.L. Panter, 2436**

Response to Comment 40: Comment noted.

Authority

1. What I don't understand about TVA is why every time we have a meeting with them, with LOUD, they send a representative, they never answer questions. It's always asked who is TVA responsible to. The people or the congress? They're supposed to be -- I understand they're supposed to be responsible directly to congress. I'd like to find that out. I'd them to respond to that some way. **G. L. and Billie Bowman, 4423**

Response to Comment 1: TVA is a federal agency. A three-member board governs TVA operations, and Congress provides oversight of TVA activities.

2. TVA is funded by the federal government and it is the government that will be receiving benefits of a lifetime by having productive citizens earning good wages and paying taxes instead of the government having to spend on them for lack of opportunity for a better education. **George Gantte, 4547**

Response to Comment 2: TVA is not funded by the federal government and receives no federal appropriations to fund its activities.

3. One thing, the water originates here in Georgia, and we seem to have the least use of it of any of the people downstream. They draw it right out and send it down to do whatever they want to do with it downstream and leave our lakes practically dry most of the year. We feel that like we should have first choice on this water and that we should have a fuller lake for a much longer period of time. **Glen and Janice Boland, 4450**

Response to Comment 3: Comment noted.

4. Past experience has shown, on South Holston Reservoir, that retaining greater quantities of water to extend the boating season has had the effect of reducing the ability to control flooding below the dam. There was an experiment run since 1990, and it had the effect of raisng the lake level almost to its overflow level. As a result of having held back a greater quantity of water, the influx of water from the streams feeding the lake due to storms is what caused the lake level to rise to dangerous levels.

I live below the dam. Outside of the above example, TVA's management of its properties has been excellent. I have been a user of the lake, with two separate boats, I use the park facility below the dam, I occassionally fish in the river, and I live on its banks.

TVA's enabling legislation, 16 USC, Sect 381, mandates navigation below Knoxville and flood control elsewhere as the purpose for creation and continuation of the Authority. Sub-section 381h-1 states that the operation of the dams is primarily for the purpose of navigation and flood control.

If TVA, for purposes of meeting the needs of a few boaters, and dock owners, increases the amount of water behind South Holston Reservoir so as to increase the need from time to time to release greater than normal quantities of water downstream, it will have violated its purpose and will be acting outside of its legal authority. Resulting damage to me and my neighbors will be considered actionable. **James Elliott, 172**

Response to Comment 4: Section 9a of the TVA Act (16 U.S.C. sec. 831h-1) directs the TVA Board to operate the TVA reservoir system primarily for the purposes of promoting navigation and controlling floods and, to the extent consistent with such purposes, for the generation of electricity. Consistent with these priorities, the TVA Board has discretion to adjust operations, including achieving collateral benefits, such as recreation. Under the Preferred Alternative, potential damages from flood events with less than a 500-year frequency would be lower than under the other action alternatives and essentially the same as under the Base Case.

5. I hope that TVA will not in attempting to meet the recreational needs of boaters forget that they will be creating dangerous situations for flood control, and I would remind the Authority that it was created and that creation or that enabling Act that created TVA still states that it's created for the control of destructive flood waters in the Tennessee Water basin and Mississippi River basin in section 831 of the U. S. Code. And 831-H-1 requires that the Board regulate stream flow primarily for the purposes of promoting navigation and controlling floods, and you're authorized to provide and operate the facilities for electric energy whenever the opportunity is afforded. Recreation is really not mentioned in the Act.

So your primary object is navigation on the streams from Knoxville Dam; flood control on all the streams, particularly in the areas above Knoxville; electric energy generation when that can be accommodated without jeopardizing your flood control purpose and activity.

So what we're asking is, and I say this for all my neighbors, we're very concerned about flood control south of the dam or below the dam, South Holston Dam, and bring to your attention the fact that your governmental purpose, the reason for TVA's existence, is primarily for the control of destructive flood waters in the Tennessee River basin. **James W. Elliott, Jr., 4357**

Response to Comment 5: See Response to Comment 4.

6. The comments one most often hears concerning TVA are as follows**:**
TVA is arrogant. TVA never changes. TVA only cares about electric production. You are wasting your time trying to get them to change drawdown dates. For too long the tributary lakes have been the neglected stepchildren of the TVA system. The tributary lakes are TVA's electrical cash cow yet the benefits accrue downstream. **John Parker, 871**

Response to Comment 6: Comment noted.

7. We bought property up here three years ago. We had a lake when we bought it. After September, the lake went down, turned into a big red mud hole; it wasn't a lake anymore. Whose water is it anyway? I mean, if it rains up here, it seems like it ought to be our water, even though TVA did build the dam. **Marcia Papatyi, 4363**

Response to Comment 7: Comment noted.

8. Constraints Introduced Outside Mississippi**:** The introduction of legislation by the State of Tennessee on inter basin transfers of waters on or through Tennessee stands to restrict both transportation and water resources for human use. We request that TVA use its collective influence to assure that the needs downstream are considered through this process. We also have concern that if the Great State of Tennessee claims the water from Tennessee sources that they also assume the responsibility for flooding that occurs when those waters leave that state and impact Mississippi and other states.

Conclusion**:** Our main concern is fairness and availability that will enable our communities to continue to receive water resources from the TVA reservoir system. **Mayor Larry Otis, 4349**

Response to Comment 8: Sections 4.5 and 5.5 address water supply issues. Appendix D9 presents an analysis of potential effects from inter-basin transfers including operation of the Tennessee–Tombigbee Waterway.

9. There is a major snag to this or any other alternative which changes the water level on Kentucky Lake and therefore Lake Barkley. Since the USACE controls Lake Barkley and per your report, they would need to do studies for which they have no money or authority, nothing can be done on either lake for some time. I believe the solution is to turn over the day to day operation of Lake Barkley to TVA, let them extend their study to the lower Ohio and Mississippi and then let them implement their findings. This will be substantially less expensive then having the USACE do a separate study by starting over with new contractors and a new approach and then trying to beat the two together for some compromise. Let the USACE continue to have over-riding authority in cases of National Emergency or Homeland Security and allow them to use their already scarce resources toward this end. **Stephen D. Hiland, 2827**

Response to Comment 9: TVA agrees that applying possible changes to its operating guidelines at Kentucky Reservoir is complicated. USACE expressed concerns about changing operations on Kentucky Reservoir because of the potential effect on the lower Ohio and Mississippi Rivers. Its position is that any proposed changes that would involve reduction in flood storage capacity would need to be evaluated within the context of the entire lower Ohio/Mississippi River system. In addition, USFWS, other agencies, and some individuals voiced concerns about changing operations on Kentucky Reservoir. The Preferred Alternative identified in the FEIS would not change the operating guide curves for Kentucky Reservoir.

F3.4 Cumulative Effects

1. The water quality modeling that was done to evaluate the water quality effects of the various alternatives is impressive. I have a concern about cumulative water quality impacts of incrementally extending summer pool levels in each reservoir operations review (TVA seems to be doing them every 10 yrs or so now). While it is good to review the operations policy, using the current policy as Base Case each time results only considers the incremental changes, which might seem acceptable, and not the cumulative changes, which might not be acceptable.

I believe this is particularly true for reservoir water quality. During the previous operation review (1987-1991), summer drawdown was delayed from about June 15 to Aug 1 in many reservoirs. This had a modest water quality impact, and now 10 years hence we are talking about further delays in summer drawdown timing, which will further impact water quality in the reservoirs. So in a short period of 10-15 years, significant impacts are likely relative to pre-1991, yet using "current" conditions as Base Case, ignoring the changes already made, is masking the true cumulative impacts.

I think this should be addressed, at least on a small scale for a few reservoirs (e.g., Douglas, Cherokee), to show how important cumulative impacts might be. And certainly if TVA repeats these lake level policy reviews every 10 years, succumbing to pressures to hold summer pools longer each time, the cumulative impacts will dwarf the incremental impacts, so cumulative impacts should be given more consideration. **Gary Hauser, 49**

Response to Comment 1: The analysis of the Base Case (the No-Action Alternative for purposes of this EIS) and the description of existing resource conditions in Chapter 4 capture the effects of previous operations policy changes, including the effect of extending unrestricted drawdowns from June 1 to August 1. A comparison of the water quality effects under the Base Case and the Summer Hydropower Alternative, which moves the date for unrestricted drawdowns back to June 1, suggests how water quality was affected by the changes made as a result of TVA's 1990 Lake Improvement Plan. The action alternatives that would extend the date for unrestricted drawdown would increase water retention time in reservoirs and result in adverse impacts on water quality. In the formulation of its Preferred Alternative, TVA substantially reduced the adverse effects associated with other alternatives that would enhance recreational opportunities by extending summer pool levels on a number of reservoirs. However, anoxic conditions potentially increase in a number of reservoirs in dry years for a limited period in late summer, even under the Preferred Alternative. While TVA has reconsidered its reservoir system operations policy in the past and is doing so again here, TVA is not committed to doing this periodically. Future events will dictate when and if TVA conducts another analysis of this nature. The water quality analyses conducted for the ROS suggest that it would be very difficult to further extend summer pool levels (even with mitigation) without causing, or contributing to, unacceptable water quality impacts.

2. The Cumulative Impacts Analysis Needs to be Strengthened

First, the DEIS portrays the effects of the reservoir operations alternatives as minor and, therefore, without significant cumulative impacts on the environment. DEIS at 6-3- 4. The DEIS ignores the reality that TVA's management of the Tennessee River has already wrought extremely significant impacts, transforming a free-flowing river to a series of reservoirs with limited stretches of river in between some of them. In addition, small impacts multiplied many times over throughout the entire Tennessee River system could, in the aggregate, significantly affect water quality and aquatic species. ~ 40 C.F.R. § 1508.7; Natural Resources Defense Council v. Hodel, 865 F.2d 288, 297-300 (D.C. Cir. 1988) ; Neighbors of Cuddy Mountain v. USFS, 137 F.3d 1372, 1378-80 (9th Cir. 1998) ; Pacific Coast Fed'n of Fishermen's Ass'ns v. Nat'l Marine Fisheries Serv., 265 F.3d 1028 (9th Cir. 2001) .

Second, the DEIS fails to consider the cumulative impact of the effects of reservoir operations combined with the effect of other activities in the Tennessee River watershed. In particular, the DEIS does not provide meaningful information about the cumulative impact of inter-basin transfers and related water withdrawals from the river. Early in 2002, the Tennessee Department of Environment and Conservation (TDEC) placed a moratorium on permits for inter-basin transfers pending the completion of this ROS. TDEC and the public expected the ROS to provide necessary information about the cumulative impacts of anticipated and potential inter-basin transfers on aquatic resources. The ROS, planned as a comprehensive study of the entire Tennessee River system, appeared well-placed to provide this long-overdue information. Not only does the DEIS fail to meet expectations, but this information is a crucial component of NEPA cumulative effects analysis.

The DEIS predicts inter-basin transfers will increase by 488 mgd by 2030, in addition to potential flows of up to 600 mgd through the Tennessee-Tombigbee Waterway. DEIS at 4.5-6; DEIS Appendix D9-2. The DEIS does not clearly state whether these transfers are in addition to existing inter-basin transfers or whether these are the total estimated transfers by 2030.

We understand the speculative nature of some of the long-term withdrawals, including potential inter-basin transfers to serve Atlanta and Birmingham, but TVA should at least outline the factors used in estimating inter-basin transfers for the 2030 time frame and identify the assumptions made and the degree of uncertainty for that estimate.

The DEIS purports to analyze the "sensitivity" of the Tennessee River to inter-basin transfers, yet the DEIS considers only the effect of water withdrawals on median reservoir elevation. Given the pressure from some members of the public to maintain reservoir levels, we are concerned that water releases from dams will be reduced if reservoir levels begin to drop as a result of large withdrawals. The DEIS ignores the effect of predicted inter-basin transfers on water quality and quantity, in particular instream flow levels necessary to protect aquatic habitat. The DEIS should evaluate the flow levels and trends necessary to support aquatic life in the Tennessee River and its tributaries. Based on this information, the DEIS should determine the Tennessee River's ability to accommodate water withdrawals.

Although the DEIS is vague about the source of future requests for other withdrawals from the Tennessee River system, the DEIS predicts future consumptive water needs will more than double. DEIS at 4.5-5-6. Again, we would appreciate it if you provided further detail about the uses expected to increase and the factors and assumptions involved in the estimates. Moreover, development in the Tennessee River watershed is expected to increase, bringing other pressures to bear on the watershed. Development in the region "may result in regional impacts, such as reduction in habitat, changes in surface water runoff, increased water use, and increased wastewater for disposal." DEIS at 6-15. The DEIS predicts these significant effects will occur but then breaks off the analysis.

NEPA requires TVA to consider the cumulative impact of its reservoir operations when added to the effects of other activities in the Tennessee River watershed. See 40 C.F.R. § 1508.7. Through this analysis, TVA. should predict the future pressures on aquatic resources and determine how its reservoir operations will affect those resources. TVA cannot avoid this analysis by concluding that future demands on water resources "may or may not lead to cumulative impacts on the quality of water resources." DEIS at 6-3. Likewise, the DEIS cannot evade thorough analysis by concluding, without evidence, that cumulative impacts are unlikely because the effects of the alternatives and existing management plans would be within the "range of natural variability". DEIS at 6-15. What does that mean?

Further, TVA cannot defer cumulative impacts analysis until future project-level analysis. Thomas v. Peterson, 753 F.2d 754 (9th Cir. 1985); Neighbors of Cuddy Mountain v. U.S.F.S., 137 F.3d 1372 (9th Cir. 1998). Future project-level analyses cannot conserve water resources and protect species throughout the region and is no substitute for comprehensive cumulative impacts analysis in this DEIS. Nor can the DEIS rely on other federal and state regulatory programs, "such as establishment of TMDLs" to "maintain certain levels of water quality and minimize cumulative effects," DEIS at 6-3, at least not without some evaluation of the effectiveness of those other programs. There is no support for the conclusion that these programs, standing alone, can protect aquatic resources and avoid cumulative effects. The TMDL program, in particular, has never been implemented adequately and thus far has failed to measurably improve water quality. Now, with the recent rescission of USEPA's July 2000 TMDL rules, the program appears less likely than ever to result in meaningful improvements……

We urge you to revise this draft EIS to fully analyze the cumulative impacts of reservoir operations and other activities in the region on aquatic resources. In particular, the public and Tennessee state agencies expect the final EIS to include comprehensive, meaningful information about the cumulative effect of inter-basin transfers and other water withdrawals on aquatic species and habitat. We also urge you to develop an alternative which substantially improves water quality and benefits aquatic species. A supplemental draft EIS should then be released for public comment before a final decision is made. **Southern Environmental Law Center, 2283**

Response to Comment 2: Chapter 6 has been substantially modified, in part to respond to some of the concerns expressed here and clarify the information. Both Chapter 6 and specific resource sections in Chapters 4 and 5 discuss existing resource conditions and their trends over the next 30 years. Environmental analyses are unavoidably and inherently uncertain, especially those involving long periods and large regions. Because cumulative impact analyses require predictions about what others may do in the future that could affect resources potentially affected by a proposed action, this uncertainty can quickly become speculation when potential cumulative impacts are discussed. TVA's analysis of cumulative impacts appropriately recognizes this uncertainty and its speculative nature. In recognizing this, TVA is not seeking to avoid conducting cumulative impact analyses until more site-specific actions may be proposed and may be less speculative. Rather, failing to recognize the uncertainty and speculation involved in these analyses here could mislead others into believing that TVA's ability to predict the future is more certain than it is or can possibly be.

As suggested by a number of commenters, including the Department of the Interior, an appropriate way of addressing the uncertainty of future predictions, including cumulative impact predictions, is to monitor and measure changes to potentially affected resources and be prepared to flexibly adjust operations policy in response. This is called adaptive management. As Section 3.4.1 discusses, TVA has long used an informal adaptive management approach to management of its reservoir system and is committed to doing so in the implementation of any changes that result from the ROS. See Chapter 7 for the monitoring programs that TVA expects to conduct in order to implement this approach.

The possible consequences of inter-basin transfers are a good example of an uncertainty for which TVA accounted in its analyses. Sections 4.5 and 5.5 provide specific information and analyses about water supply and the inter-basin transfers. In the Base Case, TVA assumed that flows from the Tennessee River system down the Tennessee–Tombigbee Waterway (an inter-basin transfer) would increase up to 600 million gallons per day, albeit this amount is uncertain and involves some degree of speculation. The waterway is designed for this flow, however, and we think it is prudent to assume that it will be reached eventually. As a Base Case assumption, this is part of all of the resource analyses in the EIS.

Other inter-basin transfers are more uncertain and speculative. Not only do we not know what amounts could be involved in future inter-basin transfers, but we also do not know the location on the TVA reservoir system from which they might be withdrawn. Both of these facts are important in reasonably determining potential impacts on water quantity and other resource conditions. To get a sense of how important large inter-basin transfers could be, TVA prepared a sensitivity analysis and provided the results of this analysis in Appendix D9. TVA concluded that subject to the withdrawal location, the TVA system could handle several additional transfers from the standpoint of the quantity of water in our system. Because TVA should be able to control future inter-basin transfer proposals through its

Section 26a permitting authority over water withdrawal structures on the Tennessee River system, TVA will be able to better account for the effects of such proposals when the specifics of any such proposals become known.

Sections 4.5 and 5.5 and Appendix D9 provide substantial details about our inter-basin transfer analyses and estimates of future demands on the TVA reservoir system. Two important technical reports provide much of the foundation for our analyses. These are referenced in Chapter 10, Literature Cited**:** Bohac, C. E. 2003 (Water Supply Inventory and Needs Analysis) and Hutson et al. 2003 (Estimated Use of Water in the Tennessee River Watershed in 2000 and Projections of Water Use to 2030). Both reports are in TVA's administrative file for this action. The latter report is a U.S. Geological Survey report.

3. The DEIS fails to address whether the adverse effects of these [policy] alternatives, especially cumulative effects, jeopardize the continued existence of threatened and endangered species, in violation of the Endangered Species Act. 16 U.S.C. § 1536(a) (2); 50 C.F.R. § 402.02. The survival of endangered species is already at risk. It seems likely that the adverse effects of these alternatives could reduce the numbers and distribution of species and impair reproduction, thus further reducing the likelihood that these species will recover. 50 C.F.R. § 402.02. **Southern Environmental Law Center, 2285**

Response to Comment 3: TVA's analysis of potential impacts on protected species in Section 5.13 considers direct and indirect effects. All cumulative effects are addressed in Chapter 6. TVA consulted with USFWS about the potential impacts of the Preferred Alternative on protected species. USFWS' Biological Opinion is included in the EIS (see Appendix G). TVA concluded that its Preferred Alternative would not adversely affect most of the protected species in the region and would not affect any species sufficiently to jeopardize their continued existence.

F3.5 Mitigation

1. Maybe a plan to try for a trial period for the most popular alternative would be feasible. **Barry Hinkle, 1933**

   Response to Comment 1: This suggestion is a form of adaptive management. TVA has long used an adaptive management approach to operation of its reservoir system and intends to continue to do this, regardless of which alternative is selected. This involves extensive monitoring of a number of different reservoir and ecological parameters, and flexible application of reservoir operating guidelines that consider the monitoring results. See Section 3.4 and Chapter 7.

2. I suggest that if lake levels are changed to provide for higher lake levels in late summer, fall and winter, that mitigation areas be established to replace important habitats for shorebirds and waterfowl that are reduced by such actions. **David Vogt, 3420**

   Response to Comment 2: The FEIS more closely examines the potential impacts on migrating birds. Our analyses show that habitat changes—both increases and losses—would vary across the alternatives and across reservoirs within alternatives. Discussion of possible mitigation measures in Chapter 7 has been expanded in light of the identification of TVA's Preferred Alternative. TVA's Record of Decision will identify those mitigation measures to which TVA commits.

3. [If you choose to deviate from the Base Case] I urge TVA in the strongest terms to (1) mitigate the loss [of critical habitat for migrating shorebird, herons and egrets] by providing a comparable or greater amount of habitat distributed across the reservoir system, and (2) commit to properly manage this replacement habitat in perpetuity. **Elizabeth Wilkinson-Singley, 3422**

   Response to Comment 3: The FEIS more closely examines potential impacts on migrating birds. The discussion of possible mitigation measures in Chapter 7 has been expanded in light of the identification of TVA's Preferred Alternative. This alternative was formulated partly to avoid or reduce potential environmental impacts associated with some of the alternatives identified in the DEIS. For example, no changes were made to the operating guides on Kentucky Reservoir—in part to avoid affecting important flats and other wildlife habitats. TVA's Record of Decision will confirm the additional mitigation measures that TVA decides to implement. Our analyses show that potential habitat changes—both increases and losses—would vary both across the alternatives and across reservoirs within alternatives.

4. Even characterizing the "Base Case" as the starting point is unfair. These lakes and reservoirs are "marketed" to the public as recreational assets. They should be operated as such, subject to minimizing adverse effects in other areas. As long as the TVA and Corps maintain shoreline control as present, any adverse effects can be mitigated to a sufficient degree. **Mark Patterson, 2900**

Response to Comment 4: There are approximately 10,995 miles of shoreline along the TVA reservoir system. Of this amount, TVA has flowage easement rights only over 21 percent. This gives TVA the authority to flood the property as necessary and to control the installation of structures, but the property owner otherwise controls use of the shoreline. Of the remaining shoreline, approximately 54 percent is "owned" by TVA, but others have rights to use or cross the property to access the water. TVA has essentially total control over the remaining 25 percent. The Corps has regulatory authority over some kinds of actions that occur on TVA-controlled property, but the Corps has no "ownership" interests. The TVA Act establishes the operating priorities of the TVA reservoir system. These are navigation, flood control, and power generation. Consistent with these purposes, TVA also operates the system to achieve other benefits, such as water quality, recreation, and water supply.

5. Mitigate loss through creation of other suitable habitat, purchase of other habitats (assuming purchase isn't a high priority habitat for other valuable resources).

Evaluate (research if necessary) use of areas and impact of habitat loss to shorebird energetics during migration. **Mary Stevens, Jackson Audubon Society, 2480**

Response to Comment 5: See Response to Comment 3. The discussion of potential impacts on migratory shorebirds and waterfowl has been supplemented in the FEIS. Purchase of compensating habitat is routinely considered by TVA in the implementation of specific actions. TVA questions the feasibility and appropriateness of this kind of mitigation approach for a region-wide proposal such as the ROS. The potential impacts on these resources would occur, if at all, slowly over a long period of time. A better approach to addressing such potential impacts is to reformulate the proposal to reduce the risk of such impacts. TVA has done this with its Preferred Alternative.

6. Our organization urges TVA to carefully consider the detrimental effects on bird populations that may result from many of the policy alternatives. We are strongly opposed to all alternatives that call for maintaining high lake levels. We further suggest that if such alternative is selected that mitigation areas be established to replace important bird habitats lost due to changes in lake level management. We are disappointed that such mitigation measures are not described in the draft EIS; their absence limits the opportunity for the public to evaluate and comment on them. **Virginia B. Reynolds, President, Tennessee ornithological Society, 3792**

Response to Comment 6: See Responses to Comments 3 and 5.

F3.6 Out of Scope

1. Glad that that miserable, wretched proposal years ago to have LBL theme parks, hotels, playgrounds was so despised that it was abandoned before USFS took LBL. **Anonymous, 3249**

Response to Comment 1: Comment noted.

2. Public should be made more aware of the potential good or bad of plants and trees they may be placing on our shorelines so as not to damage the environment over the long term. **Anonymous, 606**

Response to Comment 2: To address this issue, TVA actively works in partnership with reservoir users, other citizen groups, and local agencies to provide information on native plant species that may be used in stabilizing shorelines. TVA's Native Plant Selector web site may be of assistance for the commenter in selecting appropriate native vegetation for planting along Tennessee Valley region shorelines and stream banks: http://www.tva.com/river/landandshore/stabilization/plantsearch.htm.

3. On the shoreline on Lake Hiwassee at Bear Paw we noticed several trees that were leaning into the water. If these trees fall or fall accidentally on a boat or in the water someone could get injured. Will you please look into this for us. **Anonymous, 451**

Response to Comment 3: TVA has sent this comment to the TVA Watershed Team that is responsible for the Hiwassee Reservoir.

4. Much attention should be paid to keeping the waters protected from the human element including limited use of houseboats, camp sites with no restroom facilities, or a dumping station that boaters are encouraged to use for boats, houseboats and campsites. **Anonymous, 2376**

Response to Comment 4: TVA works cooperatively with federal and state agencies with regulatory authority over activities that affect water quality in TVA reservoirs. TVA has a number of programs that are designed to encourage more environmentally sound use of its reservoirs, including its Clean Marinas Initiative.

5. There needs to be more regulation of residential development on feeder water channels into Lake Nottely as well as the River (Nottely) itself. **Arline Hodgson, 1803**

Response to Comment 5: TVA's SMI addressed residential shoreline development along TVA reservoirs. This culminated in a 1998 FEIS and policy changes that limit future development. Local and state agencies may regulate certain development activities in areas or circumstances where TVA does not have jurisdiction.

6. I would like to see strict enforcement by TVA of its permit responsibilities for docks, marinas, wastewater treatment systems, and the like. Shoreline development above the TVA easement that impacts the easement can be regulated through the permitting process. **Barbara Garrow, 2034**

Response to Comment 6: TVA recently amended its regulations that implement Section 26a of the TVA Act (TVA's permitting regulations). These amendments should enhance TVA's ability to ensure that future development along reservoir-system shorelines is acceptable. The Section 26a regulations can be accessed and viewed on TVA's web site: http://www.tva.gov/river/26apermits/regs.htm#where.

7. A few years back there was a proposal prohibiting shoreline owners from cutting any vegetation a distance up to 6 ft from shoreline. This was opposed by many property owners. As a result of this feedback TVA abandoned this rule. I applaud TVA's willingness to listen and appreciate their soliciting of public input. **Bob Graham, 2195**

Response to Comment 7: Comment noted.

8. Houseboats- These are very detrimental to lake property. They at least need to be regulated to certain parts of the lake. i.e. the marina. **Carolyn Ippisch, 3134**

Response to Comment 8: See Response to Comment 4.

9. I think that Kentucky Dam should be staffed to enlighten visitors with personal input from former workers with enough knowledge to help them if they are visitors to the area. **Clinton Horton, 2777**

Response to Comment 9: Comment noted.

10. I urge continued and expanded support of the Boone Watershed Partnership since the water quality of the lake must begin with improved water quality of the 600+ streams that flow into the lake. **Don Cross, 282**

Response to Comment 10: Comment noted.

11. TVA police and other groups such as TDEC need a houseboat inspection program to stop sewage dumping from houseboats. The only solution is an annual inspection of all navigable houseboats and non-nav 4F structures. This step is vital to improving water quality of Boone Lake. **Don Cross, 4191**

Response to Comment 11: See Response to Comment 4.

12. The environmental situation of uncontrolled growth along the shoreline is a serious concern and must be managed to conserve the system for the whole valley. **Doug Triestram, 1768**

Response to Comment 12: See Response to Comment 5.

13. I further hope that when the board is reconstructed they decide to include at least two special members, one to represent the environmental interests and one to represent the recreational interests of land owners and users of Douglas Lake. **Drew Danko, 1026**

Response to Comment 13: Comment noted.

14. There is also a need for all regulations that cover Boone Lake to be enforced for everyone. There are persons who have cut trees and just let them fall into the lake **Fred Frazier, 264**

Response to Comment 14: TVA works in a coordinated effort with regulatory agencies that have control over such actions in order to maintain and improve water quality in its reservoir system.

15. What concerns me is the fact that some boaters are actually filling tanks or bladders provided by the boat maker, in the bottoms of their boats with several gallons of water in an effort to make the boat heavier, therefore enabling the boat to throw out a larger wake for the wake boarders to jump and do their thing, which is alright to do but not to the 2' to 3' wakes these boats are putting out. They are really washing away the shoreline, more so than the "normal"boater. Additionally, the wakes are actually dangerous for other boaters, especially pontoon boats. I have been nearly thrown overboard on more than one occasion. They really rock a boat. In summary, I think this needs attention. **Fred Overbay, 1092**

Response to Comment 15: State agencies, not TVA, regulate watercraft operation on TVA's reservoirs.

16. I think you are out of the fertilizer business now. Most other companies in the south are also out of that business. I commend you for that. **Harold Andrews, 2175**

Response to Comment 16: Comment noted.

17. This classification doesn't exactly address the problem I'd like to bring up, but it's the closest one I could find. The problem is overboard discharges from boats, both commercial and recreational. I happen to live in a marina that has pump out facilities at the dock but there are boats here dumping overboard and don't have holding tanks. Even though the marina "rules" say boaters that are overboard discharging will be asked to leave, nothing is done. What can be done by TVA to help keep our waters clean? **Harold DeHart, 2136**

Response to Comment 17: See Response to Comment 4.

18. We are very much concerned that the many small islands, as well as Seven Mile Island on Pickwick Lake, are being used as personal camping areas, resulting in the destruction of these sites. In many cases, trees have been cleared and trash is always present. Are there laws that prevent the use of the islands in this destructive manner, and who enforces them, if there are any? **Judy Kirchner, 2467**

Response to Comment 18: This has been referred to the TVA Watershed Team that is responsible for Pickwick Reservoir.

19. Three times now while I have been typing, this computer has randomly placed the curser up in the middle of the text and started typing there. I do not have time to make any other changes and will try to comment further over the internet on my computer. This is very frustrating!!! **Lamar Paris, 2416**

Response to Comment 19: We apologize for any inconvenience that this may have caused you.

20. I don't like bugs and snakes, but accept them as part of the outdoors. Too many communities are being built at the edge of our lakes and rivers and wiping out the very habitat that made the house on the lake so desirable. TVA should consider stronger restrictions for homes and communities that build on or near aquatic areas. **Larraine Nobes, 21**

Response to Comment 20: See Response to Comment 5.

21. Thank you so very much for your efforts to continue to educate the community on water quality. Several local farmers through your education have become aware of containment of animals in the streams increases water quality. The presentations were expertly completed and presented. Hats off to your staff. **Marianne O. Hatchett, 1406**

Response to Comment 21: Comment noted.

22. On a side note, I certainly would like to see the Visitor Centers at the various dams opened back up to the public, even if under some degree of tighter security. While I understand the potential devastation that could result from a terrorist attack, there should be some way that individuals that have an interest should be able to tour the facilities. **Mark Wiggins, 2283**

Response to Comment 22: TVA appreciates the public's interest in its dams and strives to accommodate that interest, consistent with security needs.

23. We do not understand why Cherokee County, or State of North Carolina and TVA/USDA allowed this residential subdivision to be created within Nantahala National Forest with only boundary surveys filed on April 1994 without any engineering data or information regarding existing soil types or data concerning road construction and storm drainage requirements, septic system perk test or possibility of well water potability including probably well depths. The developer L.B. Land & Timber Co. Inc. purchased 91.30 acres and subdivided the property into 56 lots. All lots were sold within two years and six months for between $840,000 to $1,120,000 total minimum sales value, then declared bankruptcy so the Homeowner's Association would be responsible for any problems, pretty neat deal. **Thomas L. Parker, 3996**

Response to Comment 23: This EIS focuses on the reservoir system operations policy, not issues of the sort identified in this comment. If this development resulted in potable water quality problems, appropriate agencies from the State of North Carolina should be contacted.

24. [S]ince Jan/Feb 2003 I have been trying to confirm the correct flood plain data that should be in effect for Cherokee County including raising flood level up 8'0" at July 2, 1995 and why it was suddenly raised. **Thomas L. Parker, 3989**

Response to Comment 24: This has been referred to TVA staff who are responsible for floodplain evaluations.

25. Current policy of allowing individuals to camp on lake islands and shore lines without enforced regulations or laws which protect the environment is resulting is accelerated erosion of many islands and shore lines. Individuals currently feel free to camp anywhere they please on most TVA shore lines and islands. Many of these camp sites have temporary structures, unsanitary trash littering the area, make-shift in-ground toilets or worse, and evidence of long-term occupation resulting in killing of ground vegetation through overuse or mowing and weed eating, cutting of trees, etc. This unabated abuse of precious ecologically significant sites (this should include most all river shoreline and islands) has resulted in increased island and shore line erosion and adverse environmental impact. Recommend policy change and enforcement which prohibits destructive use of our river islands and shorelines. Request a written response to this comment stating current policy and responsible enforcement organization. (Specifically, who is the enforcement authority on Pickwick Lake around the Seven Mile Island area where significant environmental damage has been observed due to camping and cutting of trees?) Also, request notification of the manner in which this comment was dispositioned, to include planned policy changes. **Tim Kirchner, 2558**

Response to Comment 25: This has been referred to the TVA Watershed Team that is responsible for Pickwick Reservoir. TVA works closely with federal and state agencies with regulatory authority over the kind of activities identified in this comment. Unfortunately, resource limitations at all levels hinder more aggressive enforcement.

26. This comment pertains to Water Safety rather than Dam Safety. The Georgia Law, "No wake at 100 feet from boat docks & etc" should be enforced for all water craft. **Tony E. Branan, 2953**

Response to Comment 26: State agencies, not TVA, regulate watercraft operation on TVA reservoirs.

27. The only constructive suggestion that I can make is that from my experience operational procedures once put in place are seldom, if ever, reviewed in light of changing conditions or environmental changes. Thus, it would seem that this study has served a very useful purpose even if no major changes are made. **Walter E. Flood, 1902**

Response to Comment 27: Comment noted.

28. We look forward to future years working closely with TVA to optimize all resources and provide more Green Power! **Wayne Gallik, 4169**

Response to Comment 28: Comment noted.

F3.7 References

Bohac, C. E. 2003. Water Supply Inventory and Needs Analysis. Tennessee Valley Authority, Navigation and Hydraulic Engineering. Draft. Chattanooga, TN. December.

Hutson, S. S., M. C. Koroa, and C. M. Murphee. 2003. Estimated Use of Water in the Tennessee River Watershed in 2000 and Projections of Water Use to 2030. U.S. Geological Survey. (Water Resources Investigation Report.) Draft. Memphis, TN.

Tennessee Valley Authority. 1998. Shoreline Management Initiative: An Assessment of Residential Shoreline Development Impacts in the Tennessee Valley. November. Norris, TN.

__________. 1999. Final Environmental Impact Statement–Use of Lands Acquired for the Columbia Dam Component of the Duck River Project. April.

_________. 1990. Lake Improvement Plan, Tennessee River and Reservoir System Operating and Planning Overview. Final Environmental Impact Statement. (TVA/RDG/EQS-91/1.)

Appendix F4

Response to Federal and State Agency Comments

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Table of Contents

List of Acronyms

ADCNR	Alabama Department of Conservation and Natural Resources
ADEM	Alabama Department of Environmental Management
AWFF	Alabama Wildlife and Freshwater Fisheries Division
Cfs	cubic feet per second
Corps/USACE	U.S. Army Corps of Engineers
DEIS	Draft Environmental Impact Statement
DOI	U.S. Department of Interior
Dsf	day-second-feet
EBCI	Eastern Band of Cherokee Indians
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
REMI	Regional Economic Model, Inc.
ROS	Reservoir Operations Study
TDEC	Tennessee Department of Environment and Conservation
THPO	Tribal Historic Preservation Officer
TVA	Tennessee Valley Authority
USFWS	U.S. Fish and Wildlife Service
WCSA	Washington County Public Service Authority

F4 Response to Federal and State Agency Comments

This section of the Comment Response Appendix contains the comments that TVA received from federal and state agencies, and TVA's responses to those comments. TVA received comments from 14 state agencies, seven federal agencies, and one tribal government. The letters (or, in two instances, e-mails) that TVA received are reproduced in this section. Responses to comments follow individual correspondence and are shown with the text of the specific comment.

Nearly all resource agencies had strong reservations about any adjustments to the existing operations policy that would adversely affect water quality—most to the extent that they supported making no changes to the existing policy, the Base Case. Good water quality is an important public value. TVA carefully studied and considered water quality as it developed alternatives and created the Preferred Alternative. TVA formulated the Preferred Alternative to avoid or reduce impacts that would substantially degrade water quality and, in fact, to enhance water quality at certain locations. However, given the inherent uncertainties with any environmental analyses, TVA has identified monitoring and mitigation measures that would help offset potential adverse impacts on water quality, should they occur.

Several of the agencies acknowledged that this EIS is programmatic but nevertheless asked that TVA consider as part of the EIS or in subsequent studies various reservoir-specific issues or needs. In its responses to each agency's comments below, TVA considered it unnecessary and inappropriate to address reservoir-specific issues in a programmatic EIS. The programmatic analyses of issues that TVA has conducted would easily be overwhelmed and lost if reservoir-specific issues were also addressed. The value of a programmatic level of review is that it allows TVA, other interested agencies, and the public to be able to consider a broader perspective for the entire TVA reservoir system that is operated as an integrated whole. It would also be very difficult—perhaps impossible—to produce a study that evaluated in detail, all of the reservoir-specific issues that may be of interest to agencies or the public. Certainly, it would take much longer and would frustrate those individuals and agencies who are looking to the ROS to address their concerns about TVA's system-wide operations policy sooner rather than later. As reservoir-specific activities are proposed by TVA, either in the implementation of any ROS decision or independent of the ROS, reservoir-specific issues would be addressed and those agencies with reservoir-specific issues would be able to raise their concerns at that time, if appropriate.

Two of the agencies commented that TVA should do a better job of explaining how it ranked identified objectives and should further delineate its summary of projected impacts (i.e., explain better what is meant by "slightly adverse" or "beneficial"). The text of the EIS has been changed to do the latter. TVA's explanation of why it prefers the Preferred Alternative that is described in the FEIS indicates how TVA ranked or weighed the values and objectives that shaped the ROS process. TVA was guided by the values and objectives endorsed by the public during the ROS process, the preferences stated by commenting agencies, the economic and environmental costs of competing actions, and the priorities established for operating the TVA system in Section 9a of the TVA Act and expressed in other legislation.

F4.1 Federal Agencies

U.S. Army Corps of Engineers Comments

September 4, 2003

Mr. David Nye
ROS Project Manager
Tennessee Valley Authority
400 West Summit Hill Drive, WT11A
Knoxville, Tennessee 37902

Dear Mr. Nye:

Thank you for the opportunity to review and comment on the draft environmental impact statement for the TVA Reservoir Operations Study. This is a consolidated response of US Army Corps of Engineers comments from the Mississippi Valley Division, the Great Lakes and Ohio River Division and their respective districts.

The Corps is a cooperating agency under NEPA guidelines and has actively participated throughout the study. Our primary concerns are:

- Navigation on the Tennessee River
- Navigation, flood control, water quality and environmental conditions on the lower Tennessee, Cumberland, Ohio and Mississippi Rivers
- Lake Barkley and the Cumberland River Basin reservoir system
- Jurisdictional limits for Section 404 permitting

These concerns were voiced in our 4 March 2002 letter to Ms. Kathryn Jackson and have been communicated to TVA staff throughout the ROS process. This is a programmatic EIS document, and our comments will reflect that. **[1]**

The Corps' greatest concerns are the ultimate effects that any changes to the operating strategies of the TVA system may have on Kentucky and Barkley Lakes, the Cumberland River system and all lands and waters downstream from those projects. Our position remains as stated in the referenced letter: "that any proposed changes (at Kentucky Lake) that would involve reduction in flood storage capacity would have to be evaluated within the context of the entire lower Ohio/Mississippi River system and would possibly entail reevaluation of the Mississippi River project flood."

The scope of the EIS was limited to the Tennessee River watershed and the TVA power service area with only limited analysis of impacts outside of this region. Broader analysis of impacts to Barkley Lake and the Cumberland River system and to areas downstream from Kentucky and Barkley Lakes along the lower Tennessee, Cumberland, Ohio and Mississippi Rivers was not performed. Specific areas of concern were mentioned above. Any change to the regulation plan at Kentucky Lake would require a like action at Barkley Lake. The Corps has not performed any studies needed to support a change and has no motivation to change the Barkley regulation plan or funding for needed studies.

Because impacts outside of the TVA region were not fully addressed, we can't adequately determine the effects of the alternatives presented. However, since all alternatives demonstrated a negative impact on one or more resource area, it is safe to assume negative impacts in one or more resource areas outside of the TVA region are likely. All alternatives had an adverse impact on flood control, and the potential for those impacts to extend through the lower Ohio and Mississippi River systems can not be ignored.

Since no preferred alternative was presented, we can not at this time make a sound technical judgment. We are also unable to determine the scope of additional study that may be needed to address impacts throughout our area of responsibility. We welcome further cooperation later in the process as TVA formulates and presents a preferred alternative. **[2]**

We appreciate the opportunity to assist in this study and to review and comment on the work presented. **[3]** The attachment contains other specific comments.

Sincerely,

W. Chris Hinton-Lee, AIA
Director
Military and Technical Directorate

Enclosures

Corps of Engineers Comments
Draft Programmatic Environmental Impact Statement

Tennessee Valley Authority
Reservoir Operations Study

1. All alternatives, except the Tailwater Recreation alternative, show more adverse impacts than beneficial impacts. And the Tailwater Recreation alternative shows "adverse" impacts for Flood Control. This either makes the case to maintain the Base alternative or accept the trade-offs for the Tailwater alternative. **[4]**

2. The Tailwater Recreation alternative is the only alternative to meet the "greater overall public value" criteria established by the ROS, with total positive benefits outweighing the adverse impacts. But it ironically reduces overall recreation benefits. **[5]**

3. Several of the alternatives show increasing mainstream winter pool elevations. This is indicated as a benefit to navigation in one of the alternatives, but not in the Commercial Navigation alternative. This seems to be an inconsistent application of navigation benefits. **[6]**

4. All but one of the alternatives is adverse to Flood Control. We need to know what part of the TN River is adversely affected and can TVA contain the flood damages within the upper or middle sections of the TN River. Otherwise it will adversely impact the Kentucky/Barkley system. As our letter states, USACE cannot endorse or implement changes to the Kentucky/Barkley system without further detailed studies. **[7]**

5. The Commercial Navigation alternative includes tailwater release changes from Barkley Dam. How is TVA able to include these operational changes as part of this alternative without EIS and operational impact studies of the Kentucky/ Barkley system and the lower Ohio and Mississippi Rivers? We cannot/ should not implement any changes that will reduce the Corps flood response capabilities or add to flooding problems on the Ohio/Mississippi Rivers. **[8]**

6. As stated in the document on page 1-13, paragraph 1.7.1; Section 9a of the TVA Act authorizes the TVA board to regulate streamflow, primarily for navigation and flood control and, when consistent with these purposes, to provide and operate facilities for the generation of electric energy. Each alternative identified in the subject report, except the base plan, impacted at least one, and in some cases several, of the primary purposes of the reservoir system. It is our position that the recommended alternative should not impact any of the primary purposes of the reservoir system or affect the Barkley pool and lower Cumberland, Tennessee, Ohio and Mississippi Rivers. **[9]**

7. The report does not address flood impacts to Kentucky Reservoir for any of the alternative plans. Based on the information presented in the meeting at the Memphis District on August 6th, a detailed model of the TVA Reservoir System has been developed that includes daily flows for the period 1903 through 2001. Analyses of changes in outflow from Pickwick Reservoir in

comparison to current conditions for any proposed plan should be detailed and documented in the report. As a result of the meeting in Memphis, TVA furnished the period of record flows for Pickwick Lake to MVD. Upon review of these flows all the proposed alternatives investigated to date will have an impact on the operation of Kentucky Lake. This would then impact the operation of Barkley Lake, which is owned and operated by the Corps of Engineers. This operational impact is unacceptable since the impacts to the areas downstream of Barkley and Kentucky Lakes have not been identified nor analyzed. For those impacts to be adequately addressed, the Lower Ohio and Mississippi Rivers would have to be studied in their entirety. Furthermore, there has not been any authority or resources granted to perform such a study. It is our recommendation that any alternative that would be defined as the preferred alternative should not impact the existing flows leaving Pickwick Lake. If an alternative is so defined, we request the appropriate documentation, which demonstrates the non-impact to the flows entering or leaving Kentucky Lake. **[10]**

8. Any increases in the guide curve for Kentucky Lake during the winter or spring would have an extremely high probability of being unacceptable to residents along the lower Ohio and Mississippi River Valleys due to a loss of flood control storage. **[11]**

9. The report does not include an alternative plan to provide a significant reduction in flood risk. Such a plan would be beneficial from a NEPA perspective, and would provide information for a purpose many consider a high priority. **[12]**

10. Changes that may benefit navigation on the lower Ohio River and Mississippi River would likely create environmental concerns, as increases in low flow elevations could alter critical habitat. All of these concerns would need to be addressed in the Environmental Impact Statement. **[13]**

11. The downstream environmental impacts in the lower Cumberland, Tennessee, Ohio and Mississippi River watersheds that occur from the proposed changes in pool operation must be fully evaluated and documented, either in this EIS or in a similar subsequent document. The potential impacts from an environmental perspective include endangered species such as the least tern and pallid sturgeon, fish and wildlife impacts, changes to riparian habitats or other ecosystem effects. **[14]**

12. Since the operational parameters of Kentucky Lake essentially requires the pool elevation to be below the easement level of elev. 365.0 by 1 June, any additional flow that enters Kentucky Lake from the proposed changes during late spring or early summer floods such as occurred in 2003, would have to be passed through the system. With all of the proposed alternatives, there would likely be some adverse impacts of additional flooding on unprotected downstream croplands during these late season floods. Therefore, on behalf of our downstream flood control constituents in the Lower Mississippi Valley, we cannot support any operational change in the TVA Lakes above Kentucky Lake that would increase flood flows into Kentucky Lake, thus impacting the operation of Kentucky/Barkley Lakes, and which would subsequently impact the areas downstream of the lakes including the Lower Ohio River and the Lower Mississippi Valley. **[15]**

13. The report has done an acceptable job of identifying and determining impacts associated with the alternatives proposed in the report. However, from a MVD Operations perspective the impacts to the operation/navigation program cannot be identified from the information presented in the report. Impacts to the operation of flood control features; flow lines, navigation depths, and dredging requirements cannot be determined from this document. Without a decision document, similar to a feasibility report or detailed project report, information needed to clearly identify impacts to the operation of MVD's operation programs is clearly absent. To determine impacts to operation/navigation programs would require a clear presentation of flow changes from a seasonal basis and magnitude to determine impacts to the Mississippi River systems and associated impacts to the Corps flood control and navigation programs. **[16]**

14. The leveed floodplain along the Lower Mississippi River consists of approximately 1.7 million acres of lands, exclusive of rivers, lakes, and other water bodies. These lands function as the natural overflow system of the Mississippi River and contain a diversity of habitats. There are over one-half million acres of developed agricultural lands, which include many small communities, rural residences, and businesses, along with over 1.1 million acres of environmentally sensitive lands, which could be impacted by any change in the operational policies of the TVA system. **[17]**

RESPONSE TO COMMENTS

1. The Corps is a cooperating agency under NEPA guidelines and has actively participated throughout the study. Our primary concerns are:

- Navigation on the Tennessee River
- Navigation, flood control, water quality and environmental conditions on the lower Tennessee, Cumberland, Ohio and Mississippi Rivers
- Lake Barkley and the Cumberland River Basin reservoir system
- Jurisdictional limits for Section 404 permitting

These concerns were voiced in our 4 March 2002 letter to Ms. Kathryn Jackson and have been communicated to TVA staff throughout the ROS process.

Response to Comment 1: TVA and the Corps have a long history of cooperating, not only on the evaluation of proposed actions affecting our common interests, but also in the operation of our interconnected reservoir systems and waterbodies. TVA appreciates the Corps' willingness to participate in the ROS EIS as a cooperating agency.

2. The Corps' greatest concerns are the ultimate effects that any changes to the operating strategies of the TVA system may have on Kentucky and Barkley Lakes, the Cumberland River system and all lands and waters downstream from those projects. Our position remains as stated in the referenced letter: "that any proposed changes (at Kentucky Lake) that would involve reduction in flood storage capacity would have to be evaluated within the context of the entire lower Ohio/Mississippi River system and would possibly entail reevaluation of the Mississippi River project flood."

The scope of the EIS was limited to the Tennessee River watershed and the TVA power service area with only limited analysis of impacts outside of this region. Broader analysis of impacts to Barkley Lake and the Cumberland River system and to areas downstream from Kentucky and Barkley Lakes along the lower Tennessee, Cumberland, Ohio and Mississippi Rivers was not performed. Specific areas of concern were mentioned above. Any change to the regulation plan at Kentucky Lake would require a like action at Barkley Lake. The Corps has not performed any studies needed to support a change and has no motivation to change the Barkley regulation plan or funding for needed studies.

Because impacts outside of the TVA region were not fully addressed, we can't adequately determine the effects of the alternatives presented. However, since all alternatives demonstrated a negative impact on one or more resource area, it is safe to assume negative impacts in one or more resource areas outside of the TVA region are likely. All alternatives had an adverse impact on flood control, and the potential for those impacts to extend through the lower Ohio and Mississippi River systems can not be ignored.

Since no preferred alternative was presented, we can not at this time make a sound technical judgment. We are also unable to determine the scope of additional study that may be needed to address impacts throughout our area of responsibility. We welcome further cooperation later in the process as TVA formulates and presents a preferred alternative.

Response to Comment 2: TVA developed an alternative that would allow Kentucky Reservoir levels to be held higher longer, while still addressing the Corps' concerns about potential impacts on its operation of Lake Barkley and areas downstream along the lower Tennessee, Cumberland, Ohio, and Mississippi Rivers. TVA thinks this may be possible by increasing releases through Kentucky Dam for a brief period. While TVA is still willing to consider this change, it was not identified as part of the Preferred Alternative in the FEIS because of the Corps's concerns. In addition, TVA responded to concerns from the U.S. Fish and Wildlife Service (USFWS) and others regarding impacts on waterfowl and shorebirds. This would eliminate any risk of unacceptable impacts on operation of Lake Barkley or on the Cumberland, Ohio, or Mississippi Rivers.

3. We appreciate the opportunity to assist in this study and to review and comment on the work presented.

Response to Comment 3: We appreciate your input to the ROS and comments on the DEIS.

4. All alternatives, except the Tailwater Recreation alternative, show more adverse impacts than beneficial impacts. And the Tailwater Recreation alternative shows "adverse" impacts for Flood Control. This either makes the case to maintain the Base alternative or accept the trade-offs for the Tailwater alternative.

Response to Comment 4: TVA has identified its Preferred Alternative in the FEIS. This alternative was formulated to capture the important benefits associated with other alternatives, while reducing or avoiding potential impacts.

5. The Tailwater Recreation alternative is the only alternative to meet the "greater overall public value" criteria established by the ROS, with total positive benefits outweighing the adverse impacts. But it ironically reduces overall recreation benefits.

Response to Comment 5: We disagree with this statement. The Tailwater Recreation Alternative would produce an increase in recreation use and associated expenditures. However, increases in power costs associated with this alternative would offset these gains, resulting in a slightly adverse impact on the regional economy. When evaluated against the performance objectives that were developed from the issues identified during the scoping phase of the study, none of the action alternatives would have a beneficial impact on all of the objectives because, under certain conditions, several of the objectives can conflict with one another. For example, extending the duration of higher summer pool levels to benefit recreation and scenic integrity has the potential to adversely affect water quality and power system reliability and cost. After extensive public review of the DEIS and additional analyses, TVA developed a Preferred Alternative. This alternative combines and adjusts elements of the alternatives identified in the DEIS to preserve desirable characteristics and to avoid or reduce adverse impacts associated with those alternatives. It would establish a balance of reservoir system operating objectives that is more responsive to changing public values and consistent with the operating priorities established by the TVA Act.

6. Several of the alternatives show increasing mainstream winter pool elevations. This is indicated as a benefit to navigation in one of the alternatives, but not in the Commercial Navigation Alternative. This seems to be an inconsistent application of navigation benefits.

Response to Comment 6: The benefit to commercial navigation of increasing channel depth in winter months was calculated for the Commercial Navigation Alternative. Likewise, a reduction in benefit to navigation under the Summer Hydropower Alternative was shown for summer months. The analysis used the shipper savings or loss as an input to a regional economic input-output model (REMI).

7. All but one of the alternatives is adverse to Flood Control. We need to know what part of the TN River is adversely affected and can TVA contain the flood damages within the upper or middle sections of the TN River. Otherwise it will adversely impact the Kentucky/Barkley system. As our letter states, USACE cannot endorse or implement changes to the Kentucky/Barkley system without further detailed studies.

Response to Comment 7: The flood risk analysis demonstrated that most of the alternatives would result in a substantial increase in flood risk at a number of critical sites in the Tennessee Valley region, including both tributary and mainstem locations. See Section 5.22. For Kentucky Reservoir, TVA conducted a detailed investigation of the effect of alternative operations policies on the volume of water discharged from Pickwick Landing Dam. This investigation included identification of the 10 largest annual and seasonal volumes discharged over 1-, 3-, 7-, 10-, 15-, and 30-day durations in the 99-year simulated period of record. For each of these events, the incremental volumes discharged into Kentucky Reservoir were compared to the Base Case. The analysis showed that it is reasonable to expect that the differences in Pickwick discharge during these large storms can be temporarily stored in the Kentucky pool.

8. The Commercial Navigation alternative includes tailwater release changes from Barkley Dam. How is TVA able to include these operational changes as part of this alternative without EIS and operational impact studies of the Kentucky/ Barkley system and the lower Ohio and Mississippi Rivers? We cannot/ should not implement any changes that will reduce the Corps flood response capabilities or add to flooding problems on the Ohio/Mississippi Rivers.

Response to Comment 8: The Preferred Alternative does not include changes in Barkley operating guides or any changes in limitations to Barkley releases.

9. As stated in the document on page 1-13, paragraph 1.7.1; Section 9a of the TVA Act authorizes the TVA board to regulate streamflow, primarily for navigation and flood control and, when consistent with these purposes, to provide and operate facilities for the generation of electric energy. Each alternative identified in the subject report, except the base plan, impacted at least one, and in some cases several, of the primary purposes of the reservoir system. It is our position that the recommended alternative should not impact any of the primary purposes of the reservoir system or affect the Barkley pool and lower Cumberland, Tennessee, Ohio and Mississippi Rivers.

Response to Comment 9: Section 9a of the TVA Act sets operating priorities for the TVA reservoir system. Consistent with those priorities, the TVA Board has discretion to adjust system operations, including achieving other collateral benefits such as recreation. TVA believes that implementation of TVA's Preferred Alternative would be fully consistent with Section 9a and within the discretion of the TVA Board. The Preferred Alternative does not include changes in operation of Kentucky Reservoir. There would be minimal, if any, risk of unacceptable impacts on operation of Lake Barkley or on the Lower Cumberland, Ohio, or Mississippi Rivers.

10. The report does not address flood impacts to Kentucky Reservoir for any of the alternative plans. Based on the information presented in the meeting at the Memphis District on August 6th, a detailed model of the TVA Reservoir System has been developed that includes daily flows for the period 1903 through 2001. Analyses of changes in outflow from Pickwick Reservoir in comparison to current conditions for any proposed plan should be detailed and documented in the report. As a result of the meeting in Memphis, TVA furnished the period of record flows for Pickwick Lake to MVD. Upon review of these flows all the proposed alternatives investigated to date will have an impact on the operation of Kentucky Lake. This would then impact the operation of Barkley Lake, which is owned and operated by the Corps of Engineers. This operational impact is unacceptable since the impacts to the areas downstream of Barkley and Kentucky Lakes have not been identified nor analyzed. For those impacts to be adequately addressed, the Lower Ohio and Mississippi Rivers would have to be studied in their entirety. Furthermore, there has not been any authority or resources granted to perform such a study. It is our recommendation that any alternative that would be defined as the preferred alternative should not impact the existing flows leaving Pickwick Lake. If an alternative is so defined, we request the appropriate documentation, which demonstrates the non-impact to the flows entering or leaving Kentucky Lake.

Response to Comment 10: See Response to Comment 7.

11. Any increases in the guide curve for Kentucky Lake during the winter or spring would have an extremely high probability of being unacceptable to residents along the lower Ohio and Mississippi River Valleys due to a loss of flood control storage.

Response to Comment 11: The Preferred Alternative does not include changes to the operating guidelines for Kentucky Reservoir.

12. The report does not include an alternative plan to provide a significant reduction in flood risk. Such a plan would be beneficial from a NEPA perspective, and would provide information for a purpose many consider a high priority.

Response to Comment 12: TVA did initially consider an alternative that would substantially reduce flood risk by holding pool levels lower, but this was deemed unreasonable because it would adversely affect other system benefits and resources in a substantial way.

13. Changes that may benefit navigation on the lower Ohio River and Mississippi River would likely create environmental concerns, as increases in low flow elevations could alter critical habitat. All of these concerns would need to be addressed in the Environmental Impact Statement.

Response to Comment 13: TVA has not proposed changes to improve navigation on the Ohio or Mississippi Rivers. TVA does not believe that any of the identified alternatives would have negatively affected critical habitats. Regardless, because of the concerns of the Corps and others, TVA decided to not alter the operating guidelines for Kentucky Reservoir as an element of the Preferred Alternative identified in the FEIS.

14. The downstream environmental impacts in the lower Cumberland, Tennessee, Ohio and Mississippi River watersheds that occur from the proposed changes in pool operation must be fully evaluated and documented, either in this EIS or in a similar subsequent document. The potential impacts from an environmental perspective include endangered species such as the least tern and pallid sturgeon, fish and wildlife impacts, changes to riparian habitats or other ecosystem effects.

Response to Comment 14: See Response to Comment 7. Potential impacts on the Tennessee River system from alternative operations policies have been appropriately assessed in the ROS EIS.

15. Since the operational parameters of Kentucky Lake essentially requires the pool elevation to be below the easement level of elev. 365.0 by 1 June, any additional flow that enters Kentucky Lake from the proposed changes during late spring or early summer floods such as occurred in 2003, would have to be passed through the system. With all of the proposed alternatives, there would likely be some adverse impacts of additional flooding on unprotected downstream croplands during these late season floods. Therefore, on behalf of our downstream flood control constituents in the Lower Mississippi Valley, we cannot support any operational change in the TVA Lakes above Kentucky Lake that would increase flood flows into Kentucky Lake, thus impacting the operation of Kentucky/Barkley Lakes, and which would subsequently impact the areas downstream of the lakes including the Lower Ohio River and the Lower Mississippi Valley.

Response to Comment 15: See Response to Comment 7.

16. The report has done an acceptable job of identifying and determining impacts associated with the alternatives proposed in the report. However, from a [Mississippi Valley Division] MVD Operations perspective the impacts to the operation/navigation program cannot be identified from the information presented in the report. Impacts to the operation of flood control features; flow lines, navigation depths, and dredging requirements cannot be determined from this document. Without a decision document, similar to a feasibility report or detailed project report, information needed to clearly identify impacts to the operation of MVD's operation programs is clearly absent. To determine impacts to operation/navigation programs would require a clear presentation of flow changes from a seasonal basis and magnitude to determine impacts to the Mississippi River systems and associated impacts to the Corps flood control and navigation programs.

Response to Comment 16: See Responses to Comments 7 and 11. Any changes on the Tennessee River system that would result in changes in Pickwick discharges could be mitigated by temporarily storing water in the Kentucky and Barkley pools—the purposes for which they were designed and constructed. Under the Preferred Alternative, there are times when the releases out of Pickwick would be increased, as well as times when the releases would be decreased. TVA acknowledges the potential for an increase or decrease in risk for flooding but believes that this risk would be minimal.

17. The leveed floodplain along the Lower Mississippi River consists of approximately 1.7 million acres of lands, exclusive of rivers, lakes, and other water bodies. These lands function as the natural overflow system of the Mississippi River and contain a diversity of habitats. There are over one-half million acres of developed agricultural lands, which include many small communities, rural residences, and businesses, along with over 1.1 million acres of environmentally sensitive lands, which could be impacted by any change in the operational policies of the TVA system.

Response to Comment 17: Comment noted.

U.S. Army Corps of Engineers [Mississippi River Commission] Comments

September 3, 2003

Mr. Glenn L. McCullough, Jr., Chairman
Tennessee Valley Authority
400 West Summit Hill Drive, ET 12A,
Knoxville, Tennessee 37902

Dear Mr. McCullough:

The Mississippi River Commission is pleased with the opportunity to work with you regarding the Reservoir Operation study that is currently being conducted by your agency. However, we must advise that any proposed change in the' operation policies of your projects could impact the projects within our jurisdiction.

We are comfortable, with the knowledge that your Board is aware of the unique relationship that our respective agencies share concerning the role that TVA Reservoirs have in reducing flood crests on the lower Ohio and Mississippi Rivers. We want to stress the importance of this relationship. We are aware that others have voiced their concerns regarding the operation of your system and that many desire to see a change in policy which would accommodate a wide-ranging set of issues covering everything from cost of power, water supply, water quality, navigation, reaction, flood risk, to economic development. We are also aware of the difficulty involved in developing a policy that sets a balance of trade-offs required to maximize the beneficial, and sometimes competing uses of water in the system. **[1]**

We are concerned that any change affecting the operation of Kentucky Lake will have serious impacts on the operation of Barkley Lake by the U.S. Army Corps of Engineers (USACE). This could, in turn, violate the flood control objectives for regulation of Kentucky-Barkley Reservoirs. The major USACE objectives concerning the proposed changes include safeguarding the Mississippi River levee system reducing the frequency of use of the Birds Point-New Madrid Floodway; and reducing the frequency and magnitude of' flooding of lands along the lower Ohio and Mississippi Rivers that are not protected by levees. **[2]**

The leveed floodplain along the Lower Mississippi River consists of approximately 1.7 million acres of land, exclusive of rivers, lakes, and other water bodies. These lands function as the natural overflow system of the Mississippi River and contain a diversity of habitats. There are over one-half million acres of developed agricultural lands, which include many small communities, rural residences, and businesses, along with over 1.1 million acres of environmentally sensitive lands, which could be impacted by any change in the operational policies of the TVA system. **[3]**

In addition, we must be certain that any proposed change in the operational policies of the TVA system do not circumvent the authority of the Flood Control Act of 1944, which grants the USACE authority to direct the operation of Kentucky Reservoir during flood control operations on the lower Ohio and Mississippi Rivers. **[4]**

The technical staff of the Mississippi Valley Division and the Mississippi River Commission are reviewing the draft Environmental Impact Statement and will provide technical comments to your agency through our sister Division, the Great Lakes and Ohio River Division, before the suspense date. **[5]**

Our agencies have maintained an outstanding relationship during previous flood control activities, as well as other operations, and we will continue to work with you in the future to assure the continue success for the benefit of the nation. **[6]**

Sincerely,

Don T. Riley
Brigadier General, U.S. Army
President Designee, Mississippi
River Commission

RESPONSE TO COMMENTS

1. The Mississippi River Commission is pleased with the opportunity to work with you regarding the Reservoir Operation study that is currently being conducted by your agency. However, we must advise that any proposed change in the' operation policies of your projects could impact the projects within our jurisdiction.

We are comfortable, with the knowledge that your Board is aware of the unique relationship that our respective agencies share concerning the role that TVA Reservoirs have in reducing flood crests on the lower Ohio and Mississippi Rivers. We want to stress the importance of this relationship. We are aware that others have voiced their concerns regarding the operation of your system and that many desire to see a change in policy which would accommodate a wide-ranging set of issues covering everything from cost of power, water supply, water quality, navigation, reaction, flood risk, to economic development. We are also aware of the difficulty involved in developing a policy that sets a balance of trade-offs required to maximize the beneficial, and sometimes competing uses of water in the system.

Response to Comment 1: TVA and the Corps have a long history of cooperating, not only on the evaluation of proposed actions affecting our common interests, but also in the operation of our interconnected reservoir systems and waterbodies. TVA appreciates the USACE's willingness to participate in the ROS EIS as a cooperating agency.

2. We are concerned that any change affecting the operation of Kentucky Lake will have serious impacts on the operation of Barkley Lake by the U.S. Army Corps of Engineers (USACE). This could, in turn, violate the flood control objectives for regulation of Kentucky-Barkley Reservoirs. The major USACE objectives concerning the proposed changes include safeguarding the Mississippi River levee system reducing the frequency of use of the Birds Point-New Madrid Floodway; and reducing the frequency and magnitude of' flooding of lands along the lower Ohio and Mississippi Rivers that are not protected by levees.

Response to Comment 2: TVA developed an alternative that would allow Kentucky Reservoir levels to be held higher longer, while still addressing the Corps' concerns about potential impacts on its operation of Lake Barkley and areas downstream along the lower Tennessee, Cumberland, Ohio, and Mississippi Rivers. TVA thinks this may be possible by increasing releases through Kentucky Dam for a brief period. While TVA is still willing to consider this change, it was not identified as part of the Preferred Alternative in the FEIS because of the Corps' concerns. This also responded to concerns of the USFWS and others regarding impacts on waterfowl and shorebirds that rely on Kentucky Reservoir habitat. This would eliminate any risk of unacceptable impacts on operation of Lake Barkley or on the Cumberland, Ohio, or Mississippi Rivers.

3. The levee floodplain along the Lower Mississippi River consists of approximately 1.7 million acres of land, exclusive of rivers, lakes, and other water bodies. These lands function as the natural overflow system of the Mississippi River and contain a diversity of habitats. There are over one-half million acres of developed agricultural lands, which include many small communities, rural residences, and businesses, along with over 1.1 million acres of environmentally sensitive lands, which could be impacted by any change in the operational policies of the TVA system.

Response to Comment 3: See Response to Comment 2.

4. In addition, we must be certain that any proposed change in the operational policies of the TVA system do not circumvent the authority of the Flood Control Act of 1944, which grants the USACE authority to direct the operation of Kentucky Reservoir during flood control operations on the lower Ohio and Mississippi Rivers.

Response to Comment 4: The Preferred Alternative does not include changes to the operating guidelines for Kentucky Reservoir.

5. The technical staff of the Mississippi Valley Division and the Mississippi River Commission are reviewing the draft Environmental Impact Statement and will provide technical comments to your agency through our sister Division, the Great Lakes and Ohio River Division, before the suspense date.

Response to Comment 5: Comment noted.

6. Our agencies have maintained an outstanding relationship during previous flood control activities, as well as other operations, and we will continue to work with you in the future to assure the continue success for the benefit of the nation.

Response to Comment 6: Comment noted.

U.S. Army Corps of Engineers (Wilmington District) Comments

August 11, 2003

Regulatory Division

Action ID 200331119

David Nye
ROS Project Manager
Tennessee Valley Authority
400 West Summit Hill Drive, WT11A
Knoxville, Tennessee 37902

Dear Mr. Nye:

Reference your request for review and comment on the Draft Programmatic Environmental Impact Statement for the Tennessee Valley Authority's (TVA) Reservoir Operations Study dated June 2003. The following comments pertain to the portion of the system within the Wilmington District's regulatory jurisdiction in North Carolina, which includes Hiwassee, Chatuge, and Fontana Reservoirs.

The various alternatives discussed in the document differ on how much reservoir levels rise and fall, when changes in the reservoir levels occur, and the amount of water flowing through the reservoir system at various times of the year. None of the alternatives discussed indicate that construction activities within waters of the United States will occur. **[1]**

Any construction, which involves the discharge of dredged and/or fill material into waters of the United States, would require Department of the Army (DA) authorization pursuant to Section 404 of the Clean Water Act prior to the initiation of the project. Additionally, Fontana Reservoir is considered navigable and is subject to regulation pursuant to Section 10 of the Rivers and Harbors Act of 1899. Section 10 jurisdiction would regulate any work in, under, or over Fontana Reservoir. **[2]**

We appreciate the opportunity to comment on the Draft Environmental Impact Statement. If you have any questions, I may be contacted at either (828) 271-7980, extension 6, or by E-mail at david.k.baker@usace.army.mil. **[3]**

Sincerely,

David K. Baker
Project Manager
Asheville Regulatory Field Office

RESPONSE TO COMMENTS

1. The various alternatives discussed in the document differ on how much reservoir levels rise and fall, when changes in the reservoir levels occur, and the amount of water flowing through the reservoir system at various times of the year. None of the alternatives discussed indicate that construction activities within waters of the United States will occur.

   Response to Comment 1: Comment noted.

2. Any construction, which involves the discharge of dredged and/or fill material into waters of the United States, would require Department of the Army (DA) authorization pursuant to Section 404 of the Clean Water Act prior to the initiation of the project. Additionally, Fontana Reservoir is considered navigable and is subject to regulation pursuant to Section 10 of the Rivers and Harbors Act of 1899. Section 10 jurisdiction would regulate any work in, under, or over Fontana Reservoir.

   Response to Comment 2: Comment noted.

3. We appreciate the opportunity to comment on the Draft Environmental Impact Statement. If you have any questions, I may be contacted at either (828) 271-7980, extension 6, or by E-mail at david.k.baker@usace.army.mil.

   Response to Comment 3: TVA and the Corps have a long history of cooperating, not only on the evaluation of proposed actions affecting our common interests, but also in the operation of our interconnected reservoir systems and waterbodies. TVA appreciates the Corps' willingness to participate in the ROS EIS as a cooperating agency.

U.S. Department of Interior (Bureau of Indian Affairs, National Park Service, and U.S. Fish and Wildlife Service) Comments

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
Post Office Box 649
Albuquerque, New Mexico 87103

September 3, 2003

ER 03/579

David Nye
Reservoir Operations Study Project Manager
Tennessee Valley Authority
400 West Summit Hill Drive, WT 11A
Knoxville, Tennessee 37902

Dear Mr. Nye:

The U.S. Department of the Interior (DOI) has reviewed the Draft Programmatic Environmental Impact Statement (DEIS) on the Reservoir Operations Study (ROS), Tennessee, Alabama, Kentucky, Georgia, Mississippi, North Carolina, and Virginia, 129 Counties. The U.S. Fish and Wildlife Service (FWS) of the DOI formally cooperated with the Tennessee Valley Authority (TVA) and the U.S. Army Corps of Engineers (Corps) in the preparation of the DEIS. The Bureau of Indian Affairs and National Park Service (NPS) of the DOI, along with FWS, served on a 17-member Interagency Team that helped guide the process. Many of the concerns of the DOI have been addressed as a result of this participation. **[1]** However, we are providing the following additional general and specific comments for your consideration as you prepare the final document.

General Comments

The DEIS, with the exception of Chapter 7, is concise and well written. **[2]** However, the programmatic approach utilized by TVA does not allow reviewers and decision makers to identify and analyze specific mitigation strategies. **[3]** Although we applaud TVA's effort in undertaking such an important evaluation of its current reservoir operations, we suggest that further, sub-basin-, reservoir-, and/or ecoregion-specific evaluations be undertaken in the near future to refine the level of resolution such that operations recommendations can be appropriately developed that account for regional resource complexities and peculiarities. A programmatic EIS should identify site- or region-specific data gaps and uncertainties**. [4]** Further study and public input should be used to make local decisions. **[5]** In our opinion, the uses of the waterway that are the most frequently supported by select segments of the public will have impacts and require mitigation; Chapter 7 does not provide us the level of information we believe will be necessary to provide reasoned and informed comments on the action alternatives. **[6]**

The DOI strongly supports TVA's implicit commitment to maintaining the achievements in water quality and habitat improvements garnered to date in its implementation of the Lake Improvement Plan and Reservoir Release Improvement Plan. However, we believe these commitments should be incorporated into the Record of Decision for this process and expressly stated in the executive summary section of the final EIS and integrated within the selected preferred alternative. **[7]**

We recommend that TVA's stated purpose, to determine the changes in the reservoir operations policy, if any, that would produce "greater public value," be refined. The phrase is poorly defined and could easily be perceived as subjective (page 1-4, section 1.2) and lacking in a commitment to provide needed resources to mitigate identified needs. TVA should work with its planning partners to develop clear, dichotomous selection criteria to define and rank "public value." These selection and ranking criteria should be guided by TVA's mission, legal and regulatory constraints and opportunities, and public input received during scoping and subsequent processes. **[8]**

In large part, this concern focuses on the terms "public" and "value." The "public" that TVA is responsible to reflects a tremendous range of perspectives, opinions, and values. We recognize that "public" includes ratepayers, shoreline property owners, reservoir users, and other stakeholders and interested parties. "Public" includes individuals and organizations that have attended workshops and meetings, responded to telephone surveys, or otherwise participated in the planning process. "Public" includes the citizens of states impacted by the TVA system of impoundments, power generation and transmission facilities, and who are indirectly affected, whether they actively participate in the planning process or not. We recognize that "public" includes all Americans, from present and future generations. Finally, we recognize that "public" means government agencies with jurisdiction by law and expertise, and American Indian tribes, particularly the Cherokee, Chickasaw, Choctaw, Shawnee, and Creek tribes, which TVA must afford government-to-government rights. The TVA planning and decision-making process should not be biased by the sheer number of comments from small segments of the public, nor by the level of passion or personalities of individuals involved in the planning process. **[9]** It is incumbent on TVA to establish unambiguous, objective selection and ranking criteria, so that reviewers and decision makers can be assured of a transparent planning and decision-making process. Public value, as used in the DEIS, is unsuitable as a planning guideline or decision-making criterion. **[10]**

A refinement of the project purpose, and the development of selection criteria, should identify the methods that TVA proposes to use to resolve competing public values. The priorities generated in public workshops should contribute to the discussion of "greater public value." Those priorities (in order) are recreation, environmental protection, flood control, cheap power and clean water. The other alternatives analyzed in the DEIS do not necessarily reflect the priorities established by workshop participants for the public resources diverted by TVA. **[11]**

We recommend TVA expand the discussion to describe cost issues associated with alternatives and mitigation measures from various perspectives. The standard Federal government economic analysis may not be a useful tool for individuals who have been educated to externalize all costs except the fees they are directly responsible for paying. In our opinion, the DEIS would be a more valuable tool for such individuals if it explained the costs of each alternative and mitigation measure and how those costs would most likely be met. In our experience, some capital improvements could create new costs, which may be assumed by ratepayers and recreational or access facility users. Some alternatives and mitigation measures could reduce operational flexibility, or create episodic shortages of power, which might mean that replacement power costs would be accrued. **[12]** Reviewers and decision makers would benefit from a DEIS that is understandable to the range of perspectives and values associated with the "public." **[13]**

For example, page 4.4-2, “Regulatory Programs and TVA Management Activities” states that TVA has made the commitment to not reverse any improvements in dissolved oxygen concentrations (DO) resulting from previous improvement programs. Yet there is no discussion of the capital investments that would be required to keep the DO levels at an acceptable level. Page 1-4, section 1.2, only states that “changes to operations that require additional capital or operating expenditures would need to be funded by either TVA or others.” **[14]**

At a minimum, we suggest TVA at least analyze the two alternatives most favored by the workshop participants and survey respondents, specifically, to extend the summer pool levels and protect the environment. The analysis should determine if mitigation can achieve an acceptable DO while making those goals compatible. Furthermore, the mitigation analysis should explain funding mechanisms that would allow the two goals to be simultaneously implemented. Likewise, if the goals and the DO levels are not compatible, the analysis should document the tradeoffs (gains and losses) associated with the approach selected. **[15]**

Because the potential influence of economics is likely to weigh heavily in determining a preferred alternative, the ROS should be careful to note that classical economic theory, upon which TVA’s economic models are based, relies on two key assumptions that are violated within ecological systems. These are the principles of substitutability and reversibility. Given DOI’s (and presumably TVA’s) interests in protecting and managing resources for this and future generations, a thorough discussion of these assumptions and their relevance to the TVA ecosystem is essential.

Substitutability implies that when one resource is diminished, it can be replaced by another similar resource. In ecological systems such as rivers, this assumption potentially fails since individual species are often closely co-evolved with their environments allowing them to exist within a relatively narrow range of physical, chemical, and biological parameters. Switching to another resource is often not an option.

Similarly, reversibility in economic theory implies that economic trends caused by a particular decision can be reversed once the decision is reversed. In ecological systems, this assumption has a high likelihood of failure. For example, relatively minute changes in ecological community structure can have permanent effects that cascade the though the community and potentially the entire ecosystem. The classic example of this phenomenon is the extirpation of a keystone species. Once this critical ecological link is extirpated, the system can never recover to its pre-extirpation state. Exacerbating the situation, the loss of a keystone species can result of the loss of additional species and/or wholesale changes in ecological functions and services. **[16]**

We recommend the DEIS discussion of the underlying limnetic patterns and processes be enhanced with more obvious cross-references. The DEIS should provide reviewers and decision makers with a comprehensive discussion of biological, chemical, and physical patterns and processes, how they are influenced by specific operational regimes, and what mitigation options are available. We are particularly concerned that the discussion about dissolved oxygen concentrations and reservoir pool elevations, on page 2-25, section 2.3.6, and elsewhere, be understood by reviewers and decision makers. Section 4.4 has a good discussion of the impacts of residence time and stratification on dissolved oxygen. Section 5.4.3 and 5.7.2 have a good discussion of DO impacts due to alternatives. However, additional clarity on the meaning of the impacts and possible solutions to the impacts is needed. This specific issue is the best example of where the public needs a greater understanding of TVA's priorities, limitations, and costs. DO is often the main limiting factor when considering extending the high summer pool levels desired by the public. **[17]**

We recommend select information in the DEIS be cited as a range of values, including error terms, variance, and other sources of uncertainty. This is particularly relevant for those parameters that may significantly influence decision making, such as hydroelectric power generation capacity. Page 2-7 (Hydropower Generation Facilities), page 3-10 (Hydro Modernization Program), and other sections of text indicate that the Base Case for the alternative comparison uses upgraded electrical capacity values for the 21 turbine units that are still in the process of being upgraded to modern standards. We recognize the need to utilize some common metric as a standard for comparison but encourage TVA to inform reviewers and decision makers about the weaknesses inherent in the selected metrics. **[18]**

Actual or firm power generation values can only be obtained with in-place units. The subject 21 units are not yet modified, or "in situ." It is common for actual power values for any given generator to be below the rated power value, due to a myriad of circumstances. With a total of 109 units, the variation between actual firm and 21 in-situ power production for the 21 units could represent a significant underestimate of power generation in the DEIS. The uncertainty associated with using rated or projected power values could have a significant impact on the comparison of alternatives, especially when power production is a determining factor. Identifying the range of values, from rated through existing in situ at various efficiencies, would, in our opinion, provide a more transparent analysis than the strict use of rated power values. **[19]**

Neither section 4.18 nor 5.18 on Cultural Resources mentions whether any American Indian tribes were consulted. The subject TVA projects are located in an area where at least five federally recognized tribes have been or are located (Cherokee, Chickasaw, Choctaw, Shawnee, and Creek) and may attach aboriginal, religious, and cultural significance. Accordingly, pursuant to section 106 of the National Historic Preservation Act (NHPA), such tribes must be consulted about cultural resources affected by these projects, including consultations regarding the identification of cultural properties, the appropriate scope of the area of potential effects, and the development of any Historic Properties Management Plan. See, e.g., 36 C.F.R. 800.2(c)(2)(B)(ii). A list of potentially affected tribes is enclosed for your use as appropriate.

Regulations implementing the NHPA contemplate that Indian tribes be provided both a meaningful and early opportunity to participate in the section 106 planning process. The regulations further require that the agency make a reasonable and good faith effort to identify historic properties that may be affected by the undertaking and gather sufficient information to evaluate the eligibility of these properties for the National Register. See, e.g., 36 C.F.R. 800.4(b). Consultation with the State Historic Preservation Officer does not satisfy this requirement. **[20]**

We recommend the DEIS enhance discussions about the relationship between the need for low temperature cooling water for power plants and the impact on warm water species by releasing cold water from Fontana Dam; mitigation options should be discussed in detail. TVA acknowledges the impacts on aquatic resources by creating a dam system in section 4.7 and notes the need for cool water used for power plant cooling in section 4.23.5, but reviewers and decision makers would benefit from a more thorough discussion of underlying issues, alternatives and implications, and mitigation strategies. The cold water released from Fontana Dam is a major inhibiting factor in the existence of native fish populations in the Little Tennessee River and the reservoir system operated by the APGI Tapoco Project as well as the Tennessee River. Fontana Dam could have an inlet tower installed to select the water from anywhere in the water column and have much greater control of the temperature of the water released. However, the release of warmer water to support native fish conflicts with cooling water needs for power plants along the Tennessee River. **[21]**

Throughout the document, TVA interchangeably refers to existing conditions or the current reservoir operations as Base Case, no-policy alternative, or no-action alternative. For clarification, we recommend TVA utilize one description for this alternative. **[22]** Specific details related to operational policy changes that may be proposed at each of TVA's facilities are needed to fully assess the impacts of the individual alternatives. For all alternatives, site-specific spatial and temporal information concerning projected water elevations and releases for each reservoir and associated tailwater is also needed to fully evaluate potential impacts to existing resources. **[23]**

Based on analyses completed to date, most of the action alternatives would produce substantially higher minimum water elevations downstream from the mainstem dams. The recreation-based alternatives would also result in higher water elevations and delayed winter pool drawdowns in the tributary reservoirs. The Equalized Summer/Winter Flood Risk Alternative would produce minimum water elevations similar to the Base Case alternative. All of the other alternatives would yield higher minimum water levels. The Commercial Navigation Alternative would result in an increase in the winter flood guides of 2 feet on the mainstem reservoirs. Recent flood risk analyses have indicated that potential delayed winter pool drawdowns would result in a 33% increase in high water occurrences at 363' MSL, a 12% increase at 362' MSL, and a 17% increase at 361' MSL, in Kentucky Reservoir. A similar evaluation performed for Wheeler Reservoir indicated a 33% decrease at 559' MSL and a 17% increase at 558' MSL. As it becomes available, we would appreciate additional information regarding flood risk analyses performed in other mainstem pools utilized for navigation. **[24]**

In general terms, most alternatives would increase reservoir retention times, which would decrease dissolved oxygen (DO) and increase chlorophyll concentrations within the reservoirs. Low DO concentrations reduce the assimilative capacities in the reservoirs and result in near anoxic conditions in the hypolimnion. Other changes in water quality parameters would be expected in the reservoirs and associated tailwater releases. Since a preferred alternative is not known at this time, it is impossible to predict, with any degree of accuracy, specific expected changes in water quality within mainstem or tributary reservoirs or tailwater reaches. **[25]**

Water quality modeling to date indicates that most changes in currently observed (Base Case) DO patterns would be minor, with the exception of the Tailwater Habitat Alternative. More water volume with average DO concentrations less than 2 mg/l would be expected. This potential change would be especially problematic downstream of Wilson Dam. Modeling also indicated potential changes in DO patterns within Kentucky and Chickamauga Reservoirs. Minor temporal changes in DO patterns (more hours with DO concentrations less than 2 mg/l) would be expected with implementation of Reservoir Recreation Alternative A downstream of Guntersville Dam and Reservoir Recreation Alternative B downstream of Pickwick Dam. All of the action alternatives would produce higher average water temperatures in the Hiwassee River.

Conversely, all of the action alternatives would produce substantially lower average temperatures below TVA facilities on the Holston River. **[26]**

The DEIS does not include a thorough discussion of potential changes to flow regimes and water quality downstream of Kentucky Dam. Due to the significance of the mussel and fishery resources downstream of Kentucky Dam, we believe a detailed analysis of the potential effects of the preferred alternative is warranted in the final EIS. The DEIS also does not include a thorough discussion of potential changes to flow regimes and water quality in Lake Barkley (Cumberland River). Due to the hydrological connection to Kentucky Reservoir, we believe this evaluation is warranted in the final EIS in order to evaluate potential effects to existing operations at Cross Creeks National Wildlife Refuge (NWR). **[27]**

Given the vast degree of uncertainty associated with the influence of dam operations on river resources (e.g., native assemblages of aquatic species, economic resources), we strongly encourage TVA to establish an adaptive management process as an integral component of its operations. In a letter to TVA dated June 7, 2002, the NPS proposed the following adaptive management measures:

Develop and apply an ongoing ***adaptive management*** *approach to river operations that balances cultural, economic, and environmental resources uses and values.*

Rationale: Adaptive management of river operations entails making periodic incremental adjustments to operating procedures (e.g., release schedules, reservoir levels, instream flows, etc.) based on ongoing monitoring and analysis (Primack, R.B. 1998. Essentials of Conservation Biology, Second Edition. Sinauer Associates Publishers. Sunderland, MA.). The intent of adaptive management is to optimize the management capacity of TVA and all of its stakeholders. The application of adaptive management can increase the effectiveness of management decisions while thereby reducing associated long-term management costs (Johnson, B.L. 1999. The role of adaptive management as an operational approach for resource management agencies. Conservation Ecology **3**(2): 8. [online] URL: http://www.consecol.org/vol3/iss2/art8.).

Suggested components of an adaptive management alternative may include:

- Establish a multi-stakeholder Adaptive River Operation Council (AROC): The AROC would consist of TVA personnel, representatives of associated agencies, technical experts from the social and natural environments, and other stakeholders such as watershed organizations, homeowner groups, and industrial interests. The goal of the AROC would be to host periodic meetings and workshops to design and evaluate monitoring and modeling efforts, detect resource trends, and suggest site-specific incremental operational changes to the TVA Board of Directors. For example, the AROC might meet annually to evaluate and assess trends of previously collected field data and new modeling results. In some cases, smaller working groups consisting of a subset of AROC members could develop recommended incremental alterations to propose to the broader council and ultimately the Board.

- Develop an Adaptive River Operation Monitoring Program. The AROMP would use ongoing TVA water quality and biological monitoring, and if needed, be broadened to incorporate system-wide resource objectives and public concerns. The AROMP might also entail computer modeling. **[28]**

Since the DEIS does not state a preferred alternative, the DOI suggests the notion of a blended alternative. A blended alternative should seek a balance in all public values (including those of future generations), but it should especially account for resource protection where the greatest amount of uncertainty and irreversible consequence reside. A blended alternative can best service the public value of this and future generations through long-term adaptive management and the ability to function on a site-specific basis. Alternatives Reservoir Recreation A and B along with Tailwater Recreation and Tailwater Habitat appear to collectively offer the greatest amount of public values as depicted by Table ES-01. An adaptive, long-term blending of these alternatives with site-specific flexibility is likely to produce a high degree of public value. **[29]**

Specific Editorial Comments

Executive Summary, pages ES-13 to ES-20, and Table ES-02, Summary of Impacts by Policy Alternative: Without specific technical analyses for a preferred alternative or proposed policy change, these general representations should be qualified as projections that require further technical evaluation. To the average reader, a simplification of a diverse reservoir system can misrepresent realistic impacts that may occur within individual reservoirs. **[30]** The evaluation of wildlife under the terrestrial ecology category (Page ES-16) is too broad and does not recognize the potential for specific adverse effects to a variety of wildlife species. Specific groups of wildlife species (e.g., waterfowl, wading birds, reptiles, and amphibians) should be addressed separately. **[31]**

Section 3.3, Alternatives Evaluated in Detail, Table 3.3-01, pages 3-6 and 3-7: Reservoir Recreation Alternative A is grouped with the Base Case on this page, followed by the introduction of a column heading entitled "Policy Alternatives" on the next page (and all remaining pages of this table). This suggests that Reservoir Recreation Alternative A is not a policy alternative. **[32]**

Section 3.3, Alternatives Evaluated in Detail, Table 3.3-01, page 3-6, Base Case, first bullet under column entitled "Reservoir Operating Guidelines:" For clarification and consistency, we suggest changing the wording from "and restrict drawdown during June and July" to AY and continue to restrict drawdown until August 1." **[33]**

Section 3.3, Alternatives Evaluated in Detail, Table 3.3-01, page 3-6, Reservoir Recreation Alternative A, third bullet under column entitled "Reservoir Operating Guidelines:" For clarification, we suggest changing the wording from "Begin unrestricted TR drawdown on Labor Day" to "Delay unrestricted TR drawdown to Labor Day." **[34]**

Section 3.3, Alternatives Evaluated in Detail, Table 3.3-01, page 3-6, Reservoir Recreation Alternative A, fifth bullet under column entitled "Reservoir Operating Guidelines:" Insert "winter" into the phrase "Raise MR flood guides." **[35]**

Section 3.3.3, Alternatives Evaluated in Detail, Reservoir Recreation Alternative B, page 3-13, 4th full paragraph: It appears that both Reservoir Recreation Alternative B and A result in higher winter reservoir levels on tributary reservoirs, relative to the Base Case. Please clarify the discussion. **[36]**

Section 3.3, Alternatives Evaluated in Detail, pages 3-14 and throughout: Comparison statements throughout this section need to be more explicit: reduce/increase relative to Base Case, the Alternative previously discussed, or both? **[37]**

Section 3.3.8, Alternatives Evaluated in Detail, Tailwater Habitat Alternative, page 3-18, last two paragraphs: The last full paragraph on this page (beginning "Under the Tailwater Habitat Alternative") states that this alternative will result in more variable flows, whereas the following paragraph (beginning with the subheading "Achievement and Objectives") states that this alternative will increase stability in tailwater flows. These statements appear to contradict one another. **[38]**

Section 3.5.2, Reservoir Operations Policy Alternatives, Table 3.5-01: The "$" symbol should be used consistently throughout the table to denote monetary figures (it is not used in the row entitled "Lowering the cost of transporting materials on the commercial waterway," although the footnote indicates that the figures in each cell in this row are in millions of dollars). **[39]**

Section 3.5, Reservoir Operations Policy Alternatives, Aquatic Plants, Page 3-30, Table 3.5-02: We recommend that you include a footnote to this table in order to make it clear that this category includes an assessment of invasive aquatic plants. **[40]**

Section 3.5, Reservoir Operations Policy Alternatives, Terrestrial Ecology, Page 3-31, Table 3.5-02: Note that impacts to Wildlife differ from Migratory Shorebirds and Plant Communities (these latter two resource areas are affected similarly by the proposed set of alternatives). Is this because the category “Plant Communities” is actually focused upon impacts to lowland or wetland, communities? If so, this should be clarified as a footnote to the table. **[41]**

Section 3.5, Reservoir Operations Policy Alternatives, Page 3-37, 1st paragraph, 1st sentence: This section is unclear. The previous paragraph states that Reservoir Recreation Alternative B and the Tailwater Habitat Alternative would have the most adverse impact on water quality. It seems the intent of this sentence to state that these two alternatives (Reservoir Recreation Alternative A and the Tailwater Recreation Alternative) would impact water quality more on the mainstem (than the tributary) reservoirs but that these impacts would still be less than Reservoir Recreation Alternative B and/or the Tailwater Habitat Alternative. **[42]**

Section 3.5, Page 3-37, 2nd paragraph: Enhance the discussion of how the increased erosion anticipated under the Tailwater Habitat Alternative would affect aquatic organisms, including federally threatened and endangered species. **[43]**

Section 3.5, Page 3-37, 3rd paragraph, last sentence: We suggest that the discussion of Reservoir Recreation Alternative B be re-written for proper emphasis of the issue. Reservoir Recreation Alternative B would result in more adverse impacts than the other alternatives, largely due to extending the summer reservoir levels into late summer and early fall, which would inundate flats at times when these habitats are normally exposed and able to provide important habitat to migratory waterfowl and shorebirds. **[44]**

Section 4.7, Aquatic Resources, throughout: A more detailed evaluation of potential changes in available spawning and nursery habitat as a result of implementation of the various alternatives is needed. The relationship between various wetland vegetative types, their position in the landscape, and aquatic species productivity is not discussed adequately. **[45]**

Section 4.8, Wetlands, throughout: Typographical error: “THE TVA” should be changed to AThe TVA.” **[46]**

Section 4.8, Wetlands, page 4.8-6, Table 4.8-02: The invested agency for the Swan Creek Dewatering Unit should be the Alabama Department of Conservation and Natural Resources. **[47]**

Section 4.8, Wetlands, page 4.8-12, 1st paragraph, last sentence: Hyperlink error: The location of the report referenced by the first hyperlink in the series (http://ncseonline.orgY.) appears to have changed; typing in this full link produces an error message that the page cannot be found. **[48]**

Section 4.8, Wetlands, page 4.8-13, 2nd paragraph, last sentence: Hyperlink error: The location of the report referenced by the first hyperlink in the series (http://hydra.gsa.govY.) also appears to have changed; typing in this link produces a “re-direct” message indicating that the information is now found within the www.gsa.gov website. **[49]**

Section 4.8, Wetlands, page 4.8-13, last paragraph, last few sentences: The statements describing the unique biological resources associated with wetland habitats directly parallel the content of Sections 4.10 (Terrestrial Ecology), Section 4.7 (Aquatic Resources), and 4.13 (Threatened and Endangered Species). The interdependency of these resources should be emphasized via a reference to these sections. In particular, globally imperiled wetland plant communities known or with potential to occur within the study area are listed in Section 4.10, Table 4.10-01 (page 4.10-3). **[50]**

Section 4.9, Aquatic Plants, page 4.9-2, Table 4.9-01: For consistency, the taxonomic authority should either be given for all or none of the species listed. **[51]**

Section 4.9, Aquatic Plants, page 4.9-3, last paragraph: We do not dispute that natural environmental variation (in weather, water flow, nutrient cycling, light availability) "tend(s) to surpass the effect of reservoir operational activities." However, as worded, this paragraph in the DEIS implies that changes in reservoir operations would be expected to produce little change in the coverage of aquatic plant species relative to these more natural (i.e., unpredictable) sources of environmental variation. However, some of the proposed alternatives may, through direct manipulation of water levels, also indirectly generate the very conditions that have been observed to affect the coverage of these species (as described in this paragraph B i.e., "higher stream flows, high turbidity, cold water temperatures"), especially in the tailwater regions. **[52]**

Section 4.10.5, Terrestrial Ecology, page 4.10-9, 1st paragraph: It is stated that "potential changes in bottomland hardwood forest, scrub-shrub wetlands, emergent wetlands, aquatic vegetation, flats, and other communities potentially affected by reservoir levels **could** affect terrestrial wildlife populations." The word "could" should be replaced with "would." When changes as significant as those addressed in this document are implemented, certain wildlife populations (e.g., shorebirds and waterfowl) will be significantly impacted. **[53]**

Section 4.10.5, Terrestrial Ecology, page 4.10-9, 4th paragraph: It is stated that "flats, isolated pools, and shallow water are created by current drawdown regimes in early August." This is correct for many reservoirs but not all. The drawdown on Kentucky and Barkley Reservoirs starts in early July. This date is significant as it provides adequate shorebird habitat during the peak migration period to provide habitat for early migrating waterfowl (e.g., blue-winged teal) and to produce the annual plants (forage) needed by wintering waterfowl. **[54]**

Section 4.10, Terrestrial Ecology, page 4.10-6, 1st paragraph, 1st sentence: "Tables 4.10-01 and 4.10-02 present the names, global ranks, and distribution of the imperiled lowland communities." In this sentence "lowland" should be changed to "wetland," since the term "lowland" (as being applied in the DEIS) encompasses more community types than would be expected in NatureServe's subset of "wetland" communities (from which this table was created). **[55]**

Section 4.10, Terrestrial Ecology, page 4.10-8, 2nd and last paragraphs: The discussion of "Future Trends" under Upland Plant Communities (last paragraph) also applies to the anticipated Future Trends for Lowland Plant Communities (2nd paragraph). **[56]**

Section 4.11, Invasive Terrestrial and Aquatic Animals and Terrestrial Plants, throughout: The information provided in the DEIS is not of sufficient detail for evaluation of the rationale for focusing upon those species of invasive terrestrial animals and plants specifically named in the discussion. The discussion in the DEIS should clarify whether or not those species mentioned are those which pose the greatest threat throughout the Tennessee Valley or are specifically those that pose the greatest risk with respect to changes in reservoir operation policies. **[57]**

Section 4.13, Threatened and Endangered Species, page 4.13-1, 3rd paragraph: The phrase "reservoir-like reservoirs" appears to contain a typographical error. **[58]**

Section 4.14, Managed Areas and Ecologically Sensitive Sites, page 4.14-9, Table 4.14-02: Swan Creek Wildlife Management Area (WMA) and Mallard-Fox Creek WMA should be identified as managed areas and/or ecologically significant sites within Wheeler Reservoir. **[59]**

Section 4.14, Managed Areas and Ecologically Sensitive Sites, page 4.14-16, 1st paragraph: The Alabama cavefish is not located on Wheeler NWR. It is endemic to Key Cave NWR. Key Cave NWR is managed by Wheeler NWR staff. The correct scientific name for the species is *Speoplatyrhinus poulsoni*. **[60]**

Section 4.14, Managed Areas and Ecologically Sensitive Sites, page 4.14-16: Significant stands of water tupelo (*Nyssa aquatica*) forested wetlands occur within Wheeler Reservoir on Wheeler NWR. The Beaverdam Creek Swamp National Natural Landmark in Limestone County, Alabama, contains approximately 530 acres of water tupelo. Approximately 20% of the area is permanently flooded and contains a mature, pure stand of water tupelo. The remainder of the area is intermittently flooded and is dominated by water tupelo and black gum (*Nyssa sylvatica*).

Pure tupelo swamps of this size and integrity are quite rare and its significance led to its designation as a National Natural Landmark. This information should also be included and referenced in Appendix D5, page D5-5. **[61]**

Section 4.17, Prime Farmland, Table 4.17-03: Footnote No. 2 should be Natural Resources Conservation Service. **[62]**

Section 5.8.5, Wetlands, page 5.8-5, 3rd paragraph: Under a discussion of Reservoir Recreation Alternative B and the Tailwater Recreation Alternative, it is stated that "the increase in winter pool elevations could interfere with wetlands with controlled water levels on Kentucky, Wheeler, and Douglas Reservoirs." This sentence stands alone without any additional qualification. We recommend that the following specific information be included in this discussion: 1) a list of managed wetlands potentially impacted (e.g., Camden and Barkley WMAs, Tennessee NWR, Wheeler NWR); 2) the potential increased impacts of flooding, such as the increased cost to upgrade and repair infrastructure and the additional threats to wildlife habitat (e.g., agricultural crop production, bottomland hardwoods, moist-soil management units); and 3) the potential impacts to public recreation activities (i.e., hunting, fishing, bird watching) that occur on these areas. **[63]**

Section 5.8.8, Wetlands, page 5.8-8, 2nd paragraph: Under a discussion of the Commercial Navigation Alternative, the potential for a loss of flats due to the rise in the minimum winter pool level of mainstem reservoirs is not included. The mudflat wetland habitat type is extremely important to waterfowl, bald and golden eagles, gulls, terns, and many other species of migratory birds. The DOI does not concur with the conclusion that there will be overall positive effects on mainstem reservoirs. **[64]**

Section 5.10.4, Terrestrial Ecology, page 5.10-3, 1st paragraph: Under a discussion of the Commercial Navigation Alternative, it is stated that "the area inundated by water would increase, potentially creating additional shallow-water foraging habitat for waterfowl and wading birds." Why would an equal amount of shallow-water habitat not be available under the Base Case Alternative? The shallow-water area should be essentially equal but at a lower elevation. The result of raising the winter pool is not a gain in shallow-water habitat. It is a loss of mudflat habitat. **[65]**

Section 5.10.6, Terrestrial Ecology, page 5.10-5, 3rd paragraph: Under a discussion of wildlife communities, it is stated that "although flats would not be available to most shorebirds migrating during late summer or early fall, extended high water levels could benefit early-migrating waterfowl such as blue-winged teal and wood ducks." We recommend that blue-winged teal (*Anas discors*) be removed from this sentence. Mudflats are a preferred habitat for blue-winged teal, where they forage on seeds of various grasses and sedges. It is unlikely that they will utilize the woody habitats that are flooded during summer pool. **[66]**

Section 5.10.8, Terrestrial Ecology, page 5.10-6, 6th paragraph: Under a discussion of the Summary of Impacts, it is stated that “except for the Summer Hydropower Alternative, changes in operations under all policy alternatives would result in limited effects on most waterfowl, semi-aquatic mammals, and non-game wildlife, as they would adapt to changing conditions.” This statement is repeated in other sub-sections of the Terrestrial Ecology Section. While we agree this statement is generally true, how they adapt may not be desirable to resource managers and the public. It has been determined from data collected during waterfowl surveys conducted on Tennessee NWR over the last 7 years that over 50% of the waterfowl use on the refuge occurs on the reservoir. The resultant adaptations may include reduced localized populations of both migratory and resident wildlife. Waterfowl and other migratory birds may adapt to a significant habitat change by migrating to other areas or utilizing undesirable habitat(s). The overall loss of mudflats will result in a lower local carrying capacity for waterfowl. It is also stated that “due to the anticipated decrease in flats habitat, shorebirds would be adversely affected during fall migration periods under these alternatives.” We recommend that waterfowl also be added to this sentence. **[67]**

Section 5.13, Threatened and Endangered Species, throughout: The level of discussion provided in the DEIS makes it difficult to identify and compare anticipated impacts to specific species of protected plants or animals, or populations of these species, within and among the various policy alternatives proposed. While a site-specific analysis may be beyond the scope of this broad overview of the entire set of proposed alternatives, we expect that it will be presented for the preferred alternative in the final EIS. For example, the potential for adverse affects to the green pitcher plant (*Sarracenia oreophila*) has been identified under the Summer Hydropower Alternative, but from the discussion, it is not possible to determine whether TVA anticipates similar affects to this species under the other alternatives proposed. Further, although adverse impacts to this species are identified under that alternative, the magnitude of these impacts is unclear. The discussion should address whether individual plants, an entire population, or the entire species be adversely impacted by this alternative. **[68]**

Section 5.13.2, Threatened and Endangered Species, pages 5.13-11 to 5.13-12, 5th paragraph: It is stated that “bald eagles and gray bats could be benefitted by Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Commercial Navigation Alternative, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative to the extent that each alternative would increase the size of reservoir pools and increase the numbers of food items (mostly fish and waterfowl for the eagles and adult aquatic insects for gray bats).” Eagles are commonly observed on the flats feeding on stranded fish and dead waterfowl. This suggests that the mudflats may be an important habitat component of the bald eagle (*Haliaeetus leucocephalus*) in the ROS area. We also question TVA’s conclusion that raising the pool levels during the fall and winter will increase waterfowl numbers. In fact, we believe that increasing pool levels in fall and winter would likely have the opposite effect. Any increase in the production of adult aquatic insects would likely be minor. Potential adverse effects, however slight, to the gray bats’ foraging habitats do not appear to have been considered. **[69]**

Section 5.13.2, Threatened and Endangered Species, page 5.13-12, 3rd paragraph: The evaluation of potential impacts to the federally endangered least tern (*Sterna antillarum*) should not be limited to nesting habitat. Least terns have been observed resting and feeding on flats on Kentucky Reservoir during fall migration. **[70]**

Section 5.22.2, Flood Control, page 5.22-1, 3rd paragraph: It is stated that “the analysis for flood risk did not consider areas downstream of Savannah, Tennessee.” We recommend that other areas on Kentucky and Barkley Reservoirs be included in the flood risk analysis. Although we appreciate receiving additional limited information regarding potential flood risk on Tennessee NWR and Wheeler NWR since the publication of the DEIS, we believe additional evaluations are warranted for Cross Creeks NWR

(Barkley Reservoir) and the numerous State WMA's throughout the Tennessee Valley. Additional evaluations of Tennessee NWR and Wheeler NWR would also appear to be warranted. **[71]**

Section 6.2.7, Cumulative Impacts, page 6-5, 3rd paragraph: It is stated that "these changes may have the potential to cause some adverse impacts on federally listed threatened and endangered species; however, the level of impact would be small and not significant enough to jeopardize the continued existence of these species." Under the Base Case alternative, populations of certain federally listed species will likely continue to decline in numbers and health. There are certain species listed as endangered (e.g., turgid blossom pearlymussel) that are likely extinct; no observations have been reported since the early 1900's. We believe TVA's conclusion regarding cumulative impacts to federally endangered and threatened species is premature and without factual foundation since no preferred alternative has been selected or analyzed in detail. We recommend analysis. Appropriate conclusions and supporting analysis should be submitted in a clearly labeled biological assessment (BA) concurrent with the final EIS. **[72]**

Table D1-01: Typographical error. It is Fort Loudoun, but the location is Loudon County not Loudoun County. **[73]**

Specific Resource Category Comments

Endangered Species

We recommend that you clearly address how the alternatives consider the requirements of section 7(a)(1) and 7(a)(2) of the Endangered Species Act (ESA). These parts of section 7 of the ESA include the requirement to evaluate the potential for jeopardy, as well as the mandate that federal agencies further the conservation of federally listed species. We are generally concerned with the management of water releases from specific reservoirs, the impact of hypolimnetic discharges on federally listed mussel and fish species, and the impact of scouring on tailwater habitats. These issues are especially problematic below Kentucky, Wilson, Douglas, Cherokee, Fontana, and Tims Ford Reservoirs. While we appreciate the proposed mitigation of the current minimum flow regime in the Appalachia cut-off, we do not believe that this mitigation proposal should be limited to all alternatives except the Base Case. We would expect TVA to pursue those potential improvements regardless of a preferred alternative for the ROS. **[74]**

We anticipate a detailed BA as part of the final EIS which will evaluate the effects of the preferred alternative and the Base Case. The BA should include a complete description of the selected alternative, the effects of those actions associated with the ROS, and a determination of effect to listed species at a site-specific level. We have appreciated the ongoing dialogue with

TVA staff regarding the approach to the preparation of the BA, as well as our preferred approach in preparing the required biological opinion. **[75]**

Migratory Birds on Tennessee NWR , Cross Creeks NWR, and Wheeler NWR

Tennessee NWR and Wheeler NWR are designated Globally Important Bird Areas and could be significantly affected by several of the identified alternatives. The Tennessee NWR bird checklist shows 10 waders and bitterns and over 30 shorebirds that could be affected by a change in habitat availability (http://tennesseerefuge.fws.gov/tnbirds.pdf). Undoubtedly, other

changes will occur elsewhere in the Tennessee Valley as well, yet these effects are poorly understood. The cumulative effects of proposed changes in the pool levels of various reservoirs on bird usage, primarily roosting and foraging, are unknown and will be extremely difficult to ascertain.

During fall migration, thousands of shorebirds utilize the mudflats on Kentucky, Barkley, and Wheeler Reservoirs. The average peak fall migration of shorebirds is around mid-August. Typically, during this period of the year, shorebird habitat is extremely limited due to dry conditions and dense vegetation that has developed through the summer adjacent to the reservoirs and other impounded waters. For this reason, the fall drawdown of Kentucky and Barkley Reservoirs is extremely important. Since most shorebird species prefer habitats that are open and away from dense cover, the water level needs to be low enough to expose flats that are not covered by woody vegetation. On Kentucky and Barkley Reservoirs, the elevation of summer pool is 359' MSL and woody vegetation typically extends down to elevation 357.5' MSL. For adequate mudflat habitat to be available, the pool elevation needs to be around 356.5' MSL. Under the existing operation schedules for these reservoirs, this level is usually reached during mid to late August.

Blue-winged teal are the first migrating waterfowl to arrive. The Tennessee Valley is along one of two major migration corridors for this species. This migration route extends from Manitoba to Florida. They first arrive during early August, with the peak period of migration occurring around mid-September. Like shorebirds, blue-winged teal heavily utilize the mudflats on the reservoirs for feeding and loafing. They commonly feed on the seeds of sedges, grasses, and smartweed that were deposited on the flats in previous years, as well as on insects and mollusks that may be present. During the migration period, it is important for extensive mudflats with an abundant source of food to be present on Kentucky, Barkley, and Wheeler Reservoirs. The existing management of these reservoirs provides excellent habitat at the appropriate time of the year for blue-winged teal to utilize during migration. The drawdown also coincides with a special early duck season that provides recreational opportunities to a large number of hunters, many of which hunt on the mudflats of the reservoirs.

Traditionally, migrant Canada geese (*Branta canadensis*) from the Southern James Bay Population (SJBP) would winter in large numbers within the Tennessee Valley. The December populations of SJBP geese in Tennessee prior to 1990 averaged over 40,000. The portion of the population that migrates into the Tennessee Valley has sharply declined to a present December

average of less than 10,000 SJBP geese in Tennessee. Even though the overall population level of the SJBP has stabilized, the decline in the numbers that migrate to the Tennessee Valley continues. Migrant geese first arrive on Tennessee NWR around September 20, and generally will remain within the vicinity of the Refuge until late winter. At this time of year, typically the only habitat available are the flats associated with the reservoir. Geese browse the new growth of annual grasses and sedges that occur on these flats. The existing fall drawdown schedule for Kentucky, Barkley, and Wheeler Reservoirs provides mudflat habitat for these early migrants.

Several of the ROS alternatives would result in a significant loss of mudflat habitat on Kentucky, Barkley and Wheeler Reservoirs. Delays in the fall drawdown would eliminate or significantly reduce the quantity and quality of mudflat habitat available on these reservoirs to shorebirds and early migrating waterfowl.

Reservoir Recreation Alternative A will extend the summer elevation through August 1 with only a 1-foot drop by September 1. Specific drawdown dates are not determined for the Tailwater Habitat Alternative, but the DEIS specifically mentions that the impacts on flats under this alternative would be similar to those of the Reservoir Recreation Alternative A. These two alternatives will likely result in a complete loss of mudflat habitat during the peak shorebird fall migration. The description of these alternatives in the DEIS does not provide elevation information beyond September 1. Without a projected water elevation for mid-September when the peak blue-winged teal migration occurs and SJBP of Canada geese first arrive, the quantity of habitat that will be available is unknown. However, we expect the quality to be degraded due to the delay in germination of annual plants on the flats.

Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, and the Tailwater Recreation Alternative extend the summer elevation of Kentucky and Barkley Reservoirs through September 1. We anticipate these alternatives would result in a complete loss of desirable mudflat habitat during most of the fall shorebird and blue-winged teal migration period. Habitat for SJBP geese will be extremely limited and the quality will be degraded due to the delay in germination of annual plants on the flats.

The anticipated impacts of the alternatives that delay the fall drawdown are 1) a complete loss of fall mudflat habitat for the majority of shorebirds that migrate through the area; 2) a significant-to- complete loss of fall mudflat habitat for blue-winged teal; and 3) a significant loss or degradation of fall mudflat habitat for early migrating SJBP of Canada geese. Local population declines of shorebirds, blue-winged teal, and SJBP geese that migrate into the area are expected if the fall drawdown of Kentucky, Barkley, and Wheeler Reservoirs is delayed.

Approximately 300,000 ducks and geese, 100 bald eagles, and tens-of-thousands of other wetland-dependent migratory birds typically occur on Tennessee and Cross Creeks National Wildlife Refuges during the peak wintering period. It has been determined from our data collected during waterfowl surveys over the past 7 years that 56% of the duck use and 48% of the goose use on Tennessee NWR occurs on Kentucky Reservoir as compared to the use that occurs in our intensively managed waterfowl impoundments. Under the current reservoir operation policy, the winter pool elevation of Kentucky and Barkley Reservoirs is 354' MSL. This level fluctuates throughout the winter depending upon several factors but is largely influenced by rainfall. During most of the winter, extensive mudflats with important food resources are available for migratory birds.

Large numbers of waterfowl concentrate on the flats of the refuges to rest and feed. Canada geese and wigeon (*Anas americana*) browse on the annual plants that germinate each year during the late summer and fall drawdown period. Mudflats are the preferred habitat for green-winged teal (*Anas crecca*) within this area. When large expanses of flats are present, the majority of teal on the refuges will occur within this habitat. Greenwings forage on the seeds of annual plants that have been deposited on the flats in previous years, as well as insects and mollusks.

Bald eagles are regularly observed on the flats of Tennessee NWR and Wheeler NWR scavenging the carcasses of fish and waterfowl. As the drawdown occurs, fish occasionally get trapped in shallow waters and become an easy source of food for eagles. Gulls, terns, and wading birds utilize the flats of the reservoirs in large numbers throughout the drawdown and winter pool periods. The flats are primarily used for resting areas and are typically adjacent to shallow-water feeding sites.

We anticipate the alternatives that delay the fall drawdown (Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Equalized Summer/Winter Flood Risk Alternative, Tailwater Habitat Alternative, and the Tailwater Recreation Alternative) would significantly impact the amount and quality of forage produced by annual plants that germinate on the flats. Canada geese, wigeon, and green-winged teal are the waterfowl species that likely will be impacted the most because they are more dependant upon the vegetation grown on the flats.

The Commercial Navigation Alternative raises the minimum winter pool level 2 feet, from elevation 354' MSL to 356' MSL. This increase would permanently eliminate a large portion of the flats that occur on the refuge. The vast mudflats and shallow water areas that occur near the mouth of the Duck River on

Tennessee NWR frequently support in excess of 50,000 ducks and geese. We expect that much of this important habitat would be flooded too deep for puddle ducks if winter pool levels are raised 2 feet. Under this alternative, the overall loss of winter mudflats would have significant negative impacts on several waterfowl species, primarily geese and puddle ducks. Bald eagles, gulls, terns, and wading birds would also suffer a significant loss in habitat. **[76]**

Migratory Birds in the Remainder of the Tennessee Valley

We are concerned about the potential for impacts to migratory birds by several of the alternatives described in the DEIS. Our primary concern is that all of the identified alternatives, except the "no action" alternative, would produce adverse impacts to habitats used by migrating shorebirds, especially foraging habitat areas of wading birds. This discussion and our recommendations are based on the premise that dam removal and river restoration are outside the scope of this study. Our comments and concerns would differ if this premise is inaccurate.

If an alternative other than the Base Case (no action) is selected and implemented, pool levels would be significantly altered during the peak shorebird migration period. Depending on precipitation and other factors, pool levels would be low, but most times too high to provide the kind of habitat available for them in most normal years. Either way, changes in current TVA operations policy would greatly reduce or potentially eliminate this habitat type for migrating shorebirds, as well as for resident and migrant waders that utilize these areas for foraging and roosting/resting. This is a significant change in the current operation and represents an unquantified impact on the birds that use these resources at this time of year. Reduction in

habitat availability in the Tennessee Valley would require the birds currently utilizing this resource to locate and exploit a resource base in other areas. Little of the type and quality of this habitat exists in the region. This is especially true for the eastern part of the Tennessee Valley where limited suitable alternative habitat is available at this time of year (Chuck Nicholson, TVA, personal communication). Until baseline information is obtained, an unknown and perhaps unmitigable effect would be produced. Therefore, before any action other than the Base Case is considered for implementation, specific spatial and temporal information is needed for evaluation.

Unfortunately, we do not have comprehensive survey information for shorebirds across the TVA reservoir system. We do, however, know of several "hot-spots" such as Musick Campground on South Holston Reservoir, Rankin Bottoms on Douglas Reservoir, Savannah Bay on Chickamauga Reservoir, and Pace Point and Britton Ford areas on Kentucky Reservoir (which are within Tennessee NWR). In the past, notable numbers of shorebirds have also been reported from other sites such as the Town Creek area on Wilson Reservoir and the Swan Creek area on Wheeler Reservoir. These areas support from dozens to thousands of shorebirds during late summer-early fall during years of "normal" rainfall and reservoir operation. Typically, the lakes are being slowly drawn down during this time, providing expanses of moist mudflats coincident with the peak fall shorebird migration. Common species include killdeer (*Charadrius vociferus*), semipalmated plovers (*Charadrius semipalmatus*), greater yellowlegs (*Tringa melanoleuca*), lesser yellowlegs (*Tringa flavipes*), solitary sandpipers (*Tringa solitaria*), spotted sandpipers (*Actitis macularia*), pectoral sandpipers (*Calidris melanotos*), short-billed dowitchers (*Limnodromus griseus*), long-billed dowitchers (*Limnodromus scolopaceus*), least sandpipers (*Calidris minutilla*), Western sandpipers (*Calidris mauri*), and semipalmated sandpipers (*Calidris pusilla*). Other regularly occurring but less numerous species include black-bellied plovers (*Pluvialis squatarola*), stilt sandpipers (*Micropalama himantopus*), ruddy turnstones (*Arenaria interpres*), and other peeps. An occasional godwit and phalarope may also be encountered. Many of these areas also support large numbers of herons and egrets during late summer. Great blue herons (*Ardea herodias*) and great egrets (*Casmerodius albus*) are most numerous, and total counts are frequently in the hundreds.

There are significant data gaps that have not been addressed in the DEIS that need attention before informed decision-making and selection of an appropriate alternative can be completed. With regard to migratory birds and resident birds that use specific habitat areas for foraging and roosting, changes in habitat availability and quality will strongly correlate with changes in bird behavior, migration, foraging, resting, and energy expense during passage through and use of these habitats in the Tennessee Valley. We recommend that TVA address the following issues and information gaps before selection of a preferred alternative:

1. All known data on species occurrence, numbers, and current usage of late-season habitats should be compiled in lieu of comprehensive surveys for shorebird and wading bird use over the entire project area. Such a comprehensive picture of late-season habitats would allow for the evaluation of the overall impact of the various alternatives relative to the availability of other potential sites which would not be affected by changes in reservoir operations policy. This synthesis of information would provide a better means to understand the impact of the various alternatives on migratory birds.

2. Assess the theoretical potential for reservoir habitat loss and shorebird use with each alternative by modeling (Geographic Information System) effects of pool levels on habitat loss during the seasons most heavily utilized by shorebirds and waders, throughout the region.

3. Assess the potential to mitigate effects of potential loss of habitat through:

    a. Creation of other suitable habitats.

    b. Purchase of other suitable habitats.

    c. Purchase and conversion of unsuitable habitat to suitable habitat (assuming the purchase isn't a high priority habitat for other valuable wildlife resources).

4. Evaluate the potential to avoid impact to certain high quality areas (e.g., Rankin Bottoms), and nominate these areas as Important Bird Areas.

5. Develop research programs to determine utilization of areas and impact of habitat loss to shorebird energetics during migration.

6. Develop a mitigation plan for loss of habitats. **[77]**

National Wildlife Refuge Infrastructure and Existing Habitat

There are over 10,000 acres of managed waters within dozens of impoundments on Tennessee NWR, Cross Creeks NWR, and Wheeler NWR. Management emphasis in these impoundments is primarily focused on waterfowl, but many other wildlife species benefit from this valuable wetland habitat. During early spring, prior to the reservoirs being raised to summer pool, the water level in most of these impoundments is lowered to produce various foods for waterfowl. A variety of habitats is provided in these impoundments, including agricultural crops, moist soil vegetation, and forested wetlands. Many of the impoundments are situated at a low elevation and do not have mechanical pumping capabilities. On these impoundments the water has to be removed when the reservoir is at winter pool. Even some of the impoundments with pumping capabilities are managed by gravity drawdown to reduce costs associated with their management.

The Commercial Navigation Alternative would raise the winter pool level 2 feet from elevation 354' MSL to 356' MSL on Kentucky Reservoir and from 554' MSL to 556' MSL on Wheeler Reservoir. This increase would greatly reduce the acreage that can be managed on all three refuges, especially on Cross Creeks NWR. Tennessee NWR and Wheeler NWR have pumping capabilities within several impoundments, but with an increase in the reservoir winter pool elevation, pumping costs would increase substantially or managed habitat acreage would be substantially reduced.

All of the managed impoundments on these refuges are subject to flooding. Spring floods are common and occur in most years. Management strategies on the refuges have adapted to this situation, and good quality waterfowl habitat is produced in spite of spring flooding. Early summer floods (June) are less common and do have adverse impacts on the quality and quantity of waterfowl habitats, especially the agricultural crops. Late summer and fall floods are very rare, but when they occur the impacts on these habitats generally result in a total loss of food production for the year. Winter floods are uncommon and usually only occur after January. The impacts from winter flooding to waterfowl foods have been limited in the past, but an early winter flood could cause most of the habitats to be unavailable to waterfowl due to the water depth. Floods in any season would cause significant damage to refuge infrastructure (e.g., levees, water control structures, roads, etc.).

All of the alternatives addressed in the DEIS would increase the risk and potential impacts of flooding on Tennessee NWR, Cross Creeks NWR, and Wheeler NWR above that of the Base Case. Depending on the preferred alternative and precipitation patterns in the Tennessee Valley, flooding risks may also be substantially increased on Wheeler NWR. To varying degrees and during different seasons of the year, each alternative would reduce flood storage within the Tennessee Valley System. Insufficient information is provided in the DEIS to determine the significance of the increased flood risk. When a preferred alternative is selected (if other than the Base Case), a detailed analysis of the flood risk for each refuge should be conducted so that an adequate assessment of the impacts can be made.

The scrub/shrub and forested wetlands that ring Kentucky, Barkley, and Wheeler Reservoirs provide important habitats for many species of fish, mammals, amphibians, reptiles, birds, and insects. These wetlands vary from narrow bands along the shoreline to extensive forests within the creek bottoms. From May to July, several thousands of acres of buttonbush (*Cephalanthus occidentalis*) and willow (*Salix* spp.) thickets are shallowly flooded while the reservoirs are at summer pool. Outside the summer pool period, primarily during the winter and spring, these wooded wetlands periodically flood during heavy rainfall events.

When the scrub/shrub and forested wetlands are flooded, waterfowl use these habitats extensively. Wood ducks require dense cover as brood habitat. The willow-buttonbush thickets provide an excellent overhead cover and at the same time are open enough at the water surface to allow the wood duck broods to move easily and feed on the numerous invertebrates that are present. These woody wetland thickets also provide valuable spawning and nursery habitat for a variety of fish and invertebrate species. During the winter and early spring when these habitats flood, mallards (*Anas platyrhynchos*), black ducks (*Anas rubripes*), and wood ducks move into these newly flooded areas to take advantage of a wide variety of food resources.

Many other species of birds utilize this riparian zone for nesting, foraging, and migration stopover habitat. Heron rookeries occur on islands and in bald cypress (*Taxodium distichum*) sloughs in several locations on Tennessee and Wheeler NWRs. The prothonotary warbler (*Protonotaria citrea*), a Partners In Flight

(PIF) priority species within the Central Hardwoods and East Gulf Coastal Plains Bird Conservation Regions, is a relatively common breeding bird within the riparian zones of Kentucky, Barkley, and Wheeler Reservoirs. This warbler is limited to bottomland habitats and nests in cavities that are located over or very close to water.

The alternatives that delay the fall drawdown (Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Equalized Summer/Winter Flood Risk Alternative, Tailwater Habitat Alternative, and the Tailwater Recreation Alternative) are expected to have significant negative impacts on the scrub/shrub and forested wetlands along Kentucky, Barkley, and Wheeler Reservoirs. Depending on the preferred alternative and precipitation patterns within the Tennessee Valley, these impacts may also be expected to occur on Wheeler Reservoir. Extending the duration that these habitats are inundated during the growing season would dramatically shrink the willow-buttonbush, water tupelo, and bald-cypress plant communities and alter the plant composition of the bottomland hardwoods. The loss of the woody vegetation that is currently inundated at summer pool would negatively impact aquatic organism productivity. We anticipate that the productivity of the local wood duck populations and the quantity and quality of this wintering waterfowl habitat would also be reduced. We expect that the woody plant communities in this zone would be replaced by emergent aquatic plants that would not provide suitable spawning and nursery habitat, wood duck brood cover, or foraging areas for wintering waterfowl. In many cases, these emergent aquatic plant communities may be dominated by invasive exotic species such as alligatorweed (*Achyranthes philoxeroides*) and *Phragmites*.

Shoreline erosion is a major problem along Kentucky, Barkley, and Wheeler Reservoirs. The results are a loss of riparian and upland habitats and decreased water quality. Shoreline stabilization has become a high priority for Tennessee, Cross Creeks, and Wheeler NWRs to protect upland habitats and important archeological sites and to stabilize river islands. We are currently partnering with TVA to stabilize several sites on Tennessee NWR and anticipate this project to continue indefinitely. Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Tailwater Habitat Alternative, and Tailwater Recreation Alternative are listed in the DEIS as having the potential to accelerate the rate of shoreline erosion. **[78]**

Units of the National Park System

The DOI, through the NPS, is mandated by Congress to oversee issues relating to our national parks, particularly "…to conserve the scenery and the natural and historic objects and the wildlife therein, and provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of this and future generations…" (National Park Service Organic Act of 1916). Several units of the National Park System, including Great Smoky Mountain National Park (GRSM), Chickamauga-Chattanooga National Military Park, Shiloh National Military Park, Natchez Trace Parkway, and the Trail of Tears National Historic Trail are, or could be, affected by TVA's reservoir operations. For example, GRSM continues to be negatively affected by airborne emissions from TVA's fossil generation, among other regional sources. Should hydro generation be altered such that fossil generation is increased, the air quality and related ecosystem problems in GRSM could be exacerbated. Bank erosion and other impacts associated with archeology and biota within the riparian corridor that result from hydrologic alterations (e.g., ramping) are issues of concern for all park units adjacent to TVA waters. Units of the National Park System are *not* currently listed in the ROS. Potential impacts to these units should be thoroughly evaluated and included in the final EIS. **[79]**

In addition, a host of other federal laws, such as the Wild and Scenic Rivers Act, PL 90-542 and the Outdoor Recreation Act, PL 88-29, provide NPS with a mandate to look beyond the boundaries of the national parks in the interest of protecting the public's interests in river and outdoor recreation resources.

In general, NPS has an interest in protecting and promoting natural resources, recreational opportunities, aesthetics, and historical and archeological resources. More specific to TVA operations, NPS interests lie in recreational access/facilities, instream flows for recreation and aquatic habitat conservation, riparian corridor protection, and natural streambank stability. **[80]**

The NPS manages wetlands in compliance with Director's Order #77-1 which establishes standards and requirements for implementing E.O. 11990 and in compliance with Section 404 of the Clean Water Act. In following DO #77-1 the NPS is responsible for documenting any adverse impacts to wetland habitats including explanations on the final preferred alternative which will result in wetland losses or degradation. Therefore, the NPS should continue to be an integral part of the Interagency team to develop the final EIS and consideration should be given to direct, indirect and cumulative impacts to wetland habitats within and adjacent to NPS lands.

According to the ROS, approximately 183,000 acres of wetlands are within the projected groundwater influence area of the TVA reservoir system, therefore, there is the strong likelihood that wetlands associated with the operational changes of TVA reservoirs may significantly affect these aquatic habitats found on NPS lands within the Tennessee River system.

The DEIS identifies isolated wetlands as one type which is especially sensitive to groundwater alterations which could occur due to operational changes by TVA. The document also states that these wetlands have lost protection under the CWA due to the recent Supreme Court case decision (SWANCC 2000); however, the SWANCC decision was based on the definition of navigable waters and NPS defines wetlands based on the various parameters of soil, vegetation and hydrology as described in the U.S. Fish and Wildlife Services' *"Classification of Wetlands and Deepwater Habitats of the United States"* (FWS/PBS-79-31). The NPS guidance (Director's Order #77-1) which establishes requirements for the protection of wetlands, therefore, includes more wetland habitat types than those defined by the Corps including the protection of "isolated" wetland habitats. Wetland delineations on NPS lands must meet the requirements of the CWA, Section 404 and NPS wetland protection policies as required by Director's Order #77-1. The SWANCC decision eliminates many of the wetland types which will, however, continue to receive protection under the National Park Service definition of wetland habitats. Additionally, indirect adverse impacts to wetland habitat can result in increased flood risks and changes in visitor use due to alterations of water levels in upstream reservoirs which are located on adjacent rivers to park lands. **[81]**

Project Minimum Flows, Tailwater Fisheries, and Mussels

Since the minimum flow regimes provided at certain tributary reservoir tailwaters were derived using FWS techniques, we point out that the techniques were intended to provide common ground for negotiated flow regimes and are not necessarily the cutting edge of river restoration science. The methodologies have deficiencies which must be understood by users, such as the rudimentary nature of minimum flow calculations, and the vintage of some techniques and curves. We suggest that with some additional refinements, science-based minimum flows within these tailwaters could render additional benefits to the tailwater aquatic and terrestrial communities. Elsewhere within the Tennessee Valley, the FWS has initiated the development of minimum flow regimes which offer seasonally-variable flows reflective of natural run-off characteristics. We also plan to measure aquatic and riparian responses to these events. These minimum flow regimes are more refined in terms of magnitude, duration, and timing of minimum flows, as well as peak flows, so that they may offer periodic pulses for sediment transport, trigger ecological processes, and serve as behavioral cues. **[82]**

We recommend the development of a process to consider and/or reconsider in detail the minimum flow regime at specific tributary and mainstem tailwaters necessary to enhance aquatic and riparian systems, within system constraints (i.e., navigation, flood control, power generation, and recreation). This process should include the formation of an interdisciplinary team of scientists familiar with the tailwater systems and techniques for developing continuous minimum flow regimes. Key considerations should include timing of flows, magnitude, rate of change, and water quality (e.g., DO, thermal characteristics, etc.). **[83]**

We recommend the development and refinement of minimum flow regimes for the specific objective of benefiting tailwater fisheries and aquatic communities at tributary and mainstem reservoirs. There are remnants of significant natural communities which would benefit from this process in the tailwaters of Chatuge, Nottely, Cherokee, Douglas, and Blue Ridge Reservoirs. Since many of the existing minium flow regimes are measured as a daily average, rather than instantaneous flow, we believe that significant benefits would accrue from refinements that provide continuous flows for aquatic and riparian communities. Additionally, we would like to develop a beneficial minimum flow regime for the bypassed reaches of stream at Appalachia and the Ocoee Reservoirs. **[84]**

The FWS has initiated a multi-year study of the effects of stream regulation on freshwater mussels, and we welcome the opportunity to include some of the TVA tributary and mainstem project tailwaters within the experimental design. The objective of this study is to develop methodologies necessary to evaluate the impacts of flow regime changes on these mussel populations. Freshwater mussels are the most critically endangered faunal group in the United States. The construction and operation of TVA dams have and continue to adversely affect many freshwater mussel populations, and in part, these facilities have been responsible for the extinction of several species. Although water quality and temperature of the discharges have and continue to impact some mussel populations, there is a growing body of evidence that altered hydrographs are the primary cause for the decline and endangerment of many species. In order to protect and enhance the remaining populations of mussels in the Tennessee Valley, we believe there is an urgent need to provide adequate flows. The ROS provides a unique opportunity to evaluate flow regimes necessary to sustain healthy mussel populations; however, there is no empirically based method for determining a flow regime suitable for mussels. We suggest a study conducted over a 5-year period which monitors behavioral and physiological attributes might provide the best means of evaluating the effects of changes in flow regimes on mussel populations. There are also opportunities for TVA to assist in an expanded study through funding and aquatic sampling at select TVA tailwaters. **[85]**

It is unclear why hydroturbine ramping rates are not included in a comprehensive study of reservoir operations. Rapid ramping rates cause severe erosion, potentially impacting archeological and ecological resources. **[86]**

Reservoir Fisheries

The metrics utilized in the DEIS evaluation of aquatic resources focused on DO, temperature, and reservoir hydrodynamics. As concluded in the DEIS, no policy alternative represents a clear

benefit to reservoir aquatic resources. Based on water quality modeling performed to date, some degradation of the existing aquatic resources could be expected for several of the alternatives. The DEIS did not make a strong correlation between contiguous, adjacent, and peripheral wetland habitat types and sport fishery productivity. Many of these areas have the potential to change, due to increased water levels, and there could be significant effects to sport fishery spawning and nursery areas. The continued expansion of invasive aquatic emergent vegetation and non-native fish populations is also problematic for spawning and nursery wetland habitats. **[87]**

The alternatives that delay the fall drawdown (Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Equalized Summer/Winter Flood Risk Alternative, Tailwater Habitat Alternative, and the Tailwater Recreation Alternative) are expected to have significant negative impacts on the scrub/shrub and forested wetlands along Kentucky, Barkley, and Wheeler Reservoirs.

Extending the duration that these habitats are inundated during the growing season will dramatically shrink the willow-buttonbush, water tupelo, and bald-cypress plant communities and alter the plant composition of the bottomland hardwoods. It is expected that the woody plant communities in this zone will be replaced by emergent aquatic plants. In many cases, these emergent aquatic plant communities may be dominated by invasive exotic species such as alligatorweed and *Phragmites*. We believe the final EIS should fully evaluate the potential changes in reservoir wetland habitat type associated with the preferred alternative. Those results should be considered in addition to the metrics evaluated in the DEIS and any refinement to the water quality model(s) once a preferred alternative is selected. **[88]**

Aquatic Enhancement and Mitigation Opportunities

Investigate additional fish and mussel restoration efforts at tributary and mainstem tailwaters. There are opportunities to restore native fishes and fisheries through reintroductions at several tailwaters. TVA and the FWS have been involved with several successful reintroduction efforts. We encourage the continued involvement by TVA in these efforts. **[89]**

Enhance cold/cool-water tailwaters. We recommend enhancement of aquatic conditions for native aquatic communities by provision of warmer water during summer, with less rapid daily fluctuations, and better oxygenation. Where increased water temperatures are not practical, measures could include cooperation with other agencies and organizations to enhance nearby streams that were fragmented by the construction and operation of TVA Reservoirs. These streams have experienced limited colonization and smaller population sizes of their aquatic communities. Although the Fontana and Tims Ford projects provide a significant challenge in this regard, we recognize the significant impairments their deep, cold water releases and drastic fluctuations impose on the Lower Little Tennessee River and Elk River, respectively. The dominating effects of the operation of the Fontana and Tims Ford projects have tremendous implications for our ability to recover several listed species of fish and mussels. We expect TVA to continue to cooperate in the recovery of listed species where it can and to work with us to identify measures to overcome the continued impairment of the Lower Little Tennessee River and Elk River. **[90]**

Although the scope of the DEIS does not include facilities on the Duck River, we believe significant potential for improvement exists in the Normandy tailwaters. This is due in part to the existing multi-port release mechanism and the questionable condition of the managed trout fishery below Normandy Dam. **[91]**

Provide fishways. There are opportunities to allow for upstream and downstream passage of fishes to enhance fish populations at mainstem and tributary reservoirs. The need for fishways for species such as lake sturgeon (*Acipenser fulvescens*), black buffalo (*Ictiobus niger*), smallmouth buffalo (*Ictiobus bubalus*), freshwater drum (*Aplodinotus grunniens*), sauger (*Stizostedion canadense*), walleye (*Stizostedion vitreum*), paddlefish (*Polyodon spathula*), and river redhorse (*Moxostoma carinatum*) could be estimated from cooperative review of existing and future fish sampling from seasons when species congregate at tailwaters, as well as presence/absence data from historical spawning areas. We recommend a systematic approach to providing efficient and timely fish passage at TVA facilities. **[92]**

Develop an advanced schedule for decommissioning and dam removal. We recommend that TVA begin to identify and prioritize its dams/reservoirs for eventual removal. It is never too early to project a schedule for removal of these facilities and to plan for restoration of the natural riverine conditions of the Tennessee Valley. Parameters to consider are relative length of reaches potentially restored by dam removal(s), value of and alternate sources of energy provided by the hydroelectric generation capacity, connectivity/fragmentation of the river system, and the benefit to species and natural communities. For TVA developments with the least storage capacity, least generation capacity, and fewest reservoir-dependent neighbors, a tentative time line and plan for removal could be developed. It is important to begin limiting future dependency on these reservoirs sooner than later, reversing trends toward more dependency on their presence, while emphasizing alternate uses of a riverine ecosystem. **[93]**

Maintain Ecological Staffing. We recognize the value of TVA's professional staff in guiding and implementing the ROS. We encourage you to maintain adequate staffing and funding in these areas, with a focus on continuity, science, and professionalism. Based on the above considerations, the DOI encourages TVA to maintain its existing policy and conditions within the system by selection of the Base Case alternative presented in the DEIS. TVA has made a substantial investment in improving water quality and habitat conditions within its reservoirs and tailwaters over the years, and we believe that those improvements could be substantially compromised by a majority of the other alternatives. **[94]**

We appreciate the opportunity to comment on this DEIS. We trust that our comments will be of use as you prepare the final document and that you will continue to involve DOI bureaus in your ongoing planning activities. If you need additional information, please feel free to contact Gregory Hogue, Regional Environmental Officer in Atlanta, Georgia, at (404) 331-4524 or myself at (505) 766-3565.

Sincerely,

Stephen R. Spencer
Acting Regional Environmental Officer

Enclosure

Federally-recognized tribes potentially affected by TVA operations in Tennessee, Alabama, Kentucky, Georgia, Mississippi, North Carolina and Virginia.

Cherokee Nation
PO Box 948
Chadwick Smith, Principal Chief
Tahlequah, OK 74465

United Keetoowah Band of Cherokee Indians
PO Box 746
Dallas Proctor, Chief
Tahlequah, OK 74465

Eastern Band of Cherokee Indians
Qualla Boundary
PO Box 455
Leon Jones, Principal Chief
Cherokee, NC 28719

Chickasaw Nation
PO Box 1548
Bill Anoatubby, Governor
Ada, OK 74821

Muscogee (Creek) Nation
PO Box 580
R. Perry Beaver, Principal Chief
Okmulgee, OK 74447

Poarch Creek Indians
5811 Jack Springs Road
Eddie L. Tullis, Chairman
Atmore, AL 36502

Eastern Shawnee Tribe of Oklahoma
PO Box 350
Charles D. Enyart, Chief
Seneca, MO 64865

Shawnee Tribe
PO Box 189
Ron Sparkman, Chairman
Miami, OK 74355

Absentee-Shawnee Tribe of Indians of Oklahoma
2025 S. Gordon Cooper Drive
James "Lee" Edwards, Jr., Governor
Shawnee, OK 74801

For additional information, contact Kurt Chandler, Bureau of Indian Affairs, Eastern States Regional Office, Nashville, Tennessee, (615) 467-1677

RESPONSE TO COMMENTS

1. The Bureau of Indian Affairs and National Park Service (NPS) of the DOI, along with FWS, served on a 17-member Interagency Team that helped guide the process. Many of the concerns of the DOI have been addressed as a result of this participation.

Response to Comment 1: One of TVA's objectives in establishing the referenced Interagency Team was to provide interested federal and state agencies with an opportunity to participate in guiding and influence the ROS, and its associated analyses. TVA appreciates the acknowledgement that the DOI found its involvement on the team useful.

2. However, we are providing the following additional general and specific comments for your consideration as you prepare the final document. …The DEIS, with the exception of Chapter 7, is concise and well written.

Response to Comment 2: Comment noted. A concise, well-written document was one of TVA's goals for the ROS EIS.

3. However, the programmatic approach utilized by TVA does not allow reviewers and decision makers to identify and analyze specific mitigation strategies.

Response to Comment 3: Because the ROS EIS is a programmatic review of alternative operations policies for TVA's entire integrated reservoir system, mitigation measures are appropriately scaled to a reservoir-system level. Further delineation of feasible system-wide mitigation measures is now possible with the identification of TVA's Preferred Alternative, and this has been done in the FEIS.

4. Although we applaud TVA's effort in undertaking such an important evaluation of its current reservoir operations, we suggest that further, sub-basin-, reservoir-, and/or ecoregion-specific evaluations be undertaken in the near future to refine the level of resolution such that operations recommendations can be appropriately developed that account for regional resource complexities and peculiarities. A programmatic EIS should identify site- or region-specific data gaps and uncertainties.

Response to Comment 4: As suggested, more reservoir- or site-specific analyses would be undertaken in the future, as appropriate. This would be done if any ROS decision results in discrete proposed actions at the reservoir- or site-specific level, or when actions independent of the ROS are proposed. Such future proposals would either tier from or reference the ROS EIS.

5. Further study and public input should be used to make local decisions.

Response to Comment 5: See Response to Comment 4. The ROS EIS provides TVA a sound basis for making reservoir-system level decisions, including implementation of any operations policy changes approved by the TVA Board across the affected reservoirs. If discrete actions are proposed on specific reservoirs in the future, TVA would conduct additional analyses and seek public input, as appropriate.

6. In our opinion, the uses of the waterway that are the most frequently supported by select segments of the public will have impacts and require mitigation; Chapter 7 does not provide us the level of information we believe will be necessary to provide reasoned and informed comments on the action alternatives.

Response to Comment 6: See Response to Comment 3. TVA agrees that many of the operational changes preferred by those commenting on the DEIS would result in adverse environmental impacts and should be mitigated. As suggested later by DOI, TVA developed the Preferred Alternative to reduce or avoid the adverse impacts associated with the alternatives presented in the DEIS. Additional information about mitigation has been provided in Chapter 7...

7. The DOI strongly supports TVA's implicit commitment to maintaining the achievements in water quality and habitat improvements garnered to date in its implementation of the Lake Improvement Plan and Reservoir Release Improvement Plan. However, we believe these commitments should be incorporated into the Record of Decision for this process and expressly stated in the executive summary section of the final EIS and integrated within the selected preferred alternative.

Response to Comment 7: TVA is committed to maintaining water quality and other improvements that resulted from its 1990 Lake Improvement Plan. TVA committed to those actions in the Record of Decision that finalized the process for that EIS. The Preferred Alternative identified in the FEIS reflects TVA's ongoing commitment.

8. We recommend that TVA's stated purpose, to determine the changes in the reservoir operations policy, if any, that would produce "greater public value," be refined. The phrase is poorly defined and could easily be perceived as subjective (page 1-4, section 1.2) and lacking in a commitment to provide needed resources to mitigate identified needs. TVA should work with its planning partners to develop clear, dichotomous selection criteria to define and rank "public value." These selection and ranking criteria should be guided by TVA's mission, legal and regulatory constraints and opportunities, and public input received during scoping and subsequent processes.

Response to Comment 8: From the beginning of the ROS and the scoping of the EIS, TVA identified greater public value as its objective for proposing changes to its reservoir system operations policy. TVA agrees that "public value" is inherently subjective because it encompasses a wide range of perspectives and opinions held by the diverse group of stakeholders that benefit from the operation of the reservoir system. This is why TVA has aggressively sought input on values from the broadest possible range of the public and interested federal and state agencies. As discussed in Appendix F1 under "Introduction to the Comment Response Appendix," TVA used a variety of techniques to achieve this. TVA expressly sought and received numerous comments about values, frequently with expressed or implicit statements of preference among identified values. These statements help describe the meaning of public value in ways that will contribute directly to decision making. TVA's efforts to objectively weigh and rank identified values is expressed by the formulation of its Preferred Alternative presented in the FEIS. As with most matters concerning public policy, the final decision to be made is subjective, and decision makers must take staff recommendations, public input, and other factors into consideration in their efforts to serve the public interest in the best way possible.

9. In large part, this concern focuses on the terms "public" and "value." The "public" that TVA is responsible to reflects a tremendous range of perspectives, opinions, and values. We recognize that "public" includes ratepayers, shoreline property owners, reservoir users, and other stakeholders and interested parties. "Public" includes individuals and organizations that have attended workshops and meetings, responded to telephone surveys, or otherwise participated in the planning process. "Public" includes the citizens of states impacted by the TVA system of impoundments, power generation and transmission facilities, and who are indirectly affected, whether they actively participate in the planning process or not. We recognize that "public" includes all Americans, from present and future generations. Finally, we recognize that "public" means government agencies with jurisdiction by law and expertise, and American Indian tribes, particularly the Cherokee, Chickasaw, Choctaw, Shawnee, and Creek tribes, which TVA must afford government-to-government rights. The TVA planning and decision-making process should not be biased by the sheer number of comments from small segments of the public, nor by the level of passion or personalities of individuals involved in the planning process.

Response to Comment 9: See Response to Comment 8 and "Introduction to the Comment Response Appendix" in Appendix F1. TVA agrees that the public has many perspectives and interests. It includes those who chose to participate in the ROS EIS process and those who did not; private citizens, and public agencies. TVA used a qualitative approach that was guided more by the merits of the comments made than the numbers of comments.

10. It is incumbent on TVA to establish unambiguous, objective selection and ranking criteria, so that reviewers and decision makers can be assured of a transparent planning and decision-making process. Public value, as used in the DEIS, is unsuitable as a planning guideline or decision-making criterion.

Response to Comment 10: See Response to Comment 8. We disagree that public value is an inappropriate planning criteria. Public value is discernible and has been repeatedly articulated by those commenting during the scoping and DEIS processes. In comments from its representatives on the Interagency Team and its comments here, DOI has itself expressed its views about values. Objective criteria were established and used in the ROS process. The results of these efforts are reflected in TVA's Preferred Alternative. For example, because all of the action alternatives evaluated in DEIS would result in unacceptable increases in flood risk, combined elements of TVA's Preferred Alternative were incrementally adjusted to meet the flood risk evaluation criterion described in Section 5.22.

11. A refinement of the project purpose, and the development of selection criteria, should identify the methods that TVA proposes to use to resolve competing public values. The priorities generated in public workshops should contribute to the discussion of "greater public value." Those priorities (in order) are recreation, environmental protection, flood control, cheap power and clean water. The other alternatives analyzed in the DEIS do not necessarily reflect the priorities established by workshop participants for the public resources diverted by TVA.

Response to Comment 11: The statements of, and preferences among, values that were made during scoping and the DEIS review process were part of TVA's discussion of public values with interested members of the public and other agencies. The values identified by DOI in this comment were among the values identified during the EIS process. The values and associated objectives were used to formulate the alternatives presented and analyzed in the DEIS. TVA's preferred alternative expresses how TVA weighed the identified public values.

12. We recommend TVA expand the discussion to describe cost issues associated with alternatives and mitigation measures from various perspectives. The standard Federal government economic analysis may not be a useful tool for individuals who have been educated to externalize all costs except the fees they are directly responsible for paying. In our opinion, the DEIS would be a more valuable tool for such individuals if it explained the costs of each alternative and mitigation measure and how those costs would most likely be met. In our experience, some capital improvements could create new costs, which may be assumed by ratepayers and recreational or access facility users. Some alternatives and mitigation measures could reduce operational flexibility, or create episodic shortages of power, which might mean that replacement power costs would be accrued.

Response to Comment 12: The cost impact of alternative operations policies on TVA's power system was identified in the DEIS. This information has been expanded in the FEIS and now includes mitigation cost estimates as requested.

13. Reviewers and decision makers would benefit from a DEIS that is understandable to the range of perspectives and values associated with the "public."

Response to Comment 13: TVA agrees that both the public and decision makers benefit from an understandable discussion of values. Although we believe that the ROS Scoping Document and the DEIS explain how the major public issues reflecting underlying values were used to develop a set of performance objectives to evaluate the policy alternatives, we further clarified the discussion in the FEIS. For example, Table 1.6-03 was added to better define the performance objectives.

14. For example, page 4.4-2, "Regulatory Programs and TVA Management Activities" states that TVA has made the commitment to not reverse any improvements in dissolved oxygen (DO) concentrations resulting from previous improvement programs. Yet there is no discussion of the capital investments that would be required to keep the DO levels at an acceptable level. Page 1-4, section 1.2, only states that "changes to operations that require additional capital or operating expenditures would need to be funded by either TVA or others."

Response to Comment 14: See Response to Comment 12 and Table 5.23-03.

15. At a minimum, we suggest TVA at least analyze the two alternatives most favored by the workshop participants and survey respondents, specifically, to extend the summer pool levels and protect the environment. The analysis should determine if mitigation can achieve an acceptable DO while making those goals compatible. Furthermore, the mitigation analysis should explain funding mechanisms that would allow the two goals to be simultaneously implemented. Likewise, if the goals and the DO levels are not compatible, the analysis should document the tradeoffs (gains and losses) associated with the approach selected.

Response to Comment 15: The alternatives presented in the DEIS did analyze the impacts of extending summer pool levels on water quality, other environmental factors, the regional economy, and system operating objectives. TVA designed the alternatives that were evaluated in detail in the DEIS to reflect the broad range of issues and recommendations that were identified during scoping. This enabled a determination of the full range of associated potential impacts. Results of the analyses were then used to determine which elements of the alternatives would and would not meet evaluation criteria that were established for the primary system operating objectives, such as reducing the risk of floods. TVA developed its Preferred Alternative in order to maintain flood risk at acceptable levels, while preserving desirable characteristics that were associated with the other alternatives. Generally, descriptions of the mitigation measures that TVA would implement and how the costs of these measures would be funded are included in the Record of Decision.

16. Because the potential influence of economics is likely to weigh heavily in determining a preferred alternative, the ROS should be careful to note that classical economic theory, upon which TVA's economic models are based, relies on two key assumptions that are violated within ecological systems. These are the principles of substitutability and reversibility. Given DOI's (and presumably TVA's) interests in protecting and managing resources for this and future generations, a thorough discussion of these assumptions and their relevance to the TVA ecosystem is essential.

Substitutability implies that when one resource is diminished, it can be replaced by another similar resource. In ecological systems such as rivers, this assumption potentially fails since individual species are often closely co-evolved with their environments allowing them to exist within a relatively narrow range of physical, chemical, and biological parameters. Switching to another resource is often not an option.

Similarly, reversibility in economic theory implies that economic trends caused by a particular decision can be reversed once the decision is reversed. In ecological systems, this assumption has a high likelihood of failure. For example, relatively minute changes in ecological community structure can have permanent effects that cascade the though the community and potentially the entire ecosystem. The classic example of this phenomenon is the extirpation of a keystone species. Once this critical ecological link is extirpated, the system can never recover to its pre-extirpation state. Exacerbating the situation, the loss of a keystone species can result of the loss of additional species and/or wholesale changes in ecological functions and services.

Response to Comment 16: TVA has taken steps to ensure that these two assumptions are not applied in the context of ecological systems. An inherent risk of assigning monetary values to the identified environmental impacts is that some readers might assume that TVA was suggesting that it could buy substitutes for affected ecosystems or pay to reverse such impacts. .Rather than assigning monetary values, TVA preferred to state environmental costs in their natural metrics, such as increases or decreases in DO, and did so in the ROS analyses.

17. We recommend the DEIS discussion of the underlying limnetic patterns and processes be enhanced with more obvious cross-references. The DEIS should provide reviewers and decision makers with a comprehensive discussion of biological, chemical, and physical patterns and processes, how they are influenced by specific operational regimes, and what mitigation options are available. We are particularly concerned that the discussion about dissolved oxygen concentrations and reservoir pool elevations, on page 2-25, section 2.3.6, and elsewhere, be understood by reviewers and decision makers. Section 4.4 has a good discussion of the impacts of residence time and stratification on dissolved oxygen. Section 5.4.3 and 5.7.2 have a good discussion of DO impacts due to alternatives. However, additional clarity on the meaning of the impacts and possible solutions to the impacts is needed. This specific issue is the best example of where the public needs a greater understanding of TVA's priorities, limitations, and costs. DO is often the main limiting factor when considering extending the high summer pool levels desired by the public.

Response to Comment 17: Additional information about mitigation measures has been added to Chapter 7 in the FEIS. See Response to Comment 3. TVA agrees that DO is often a limiting factor when considering higher lake levels. Reducing potential water quality impacts was one of the primary drivers in the formulation of TVA's Preferred Alternative. Additional cross-references have been included in the FEIS.

18. We recommend select information in the DEIS be cited as a range of values, including error terms, variance, and other sources of uncertainty. This is particularly relevant for those parameters that may significantly influence decision making, such as hydroelectric power generation capacity. Page 2-7 (Hydropower Generation Facilities), page 3-10 (Hydro Modernization Program), and other sections of text indicate that the Base Case for the alternative comparison uses upgraded electrical capacity values for the 21 turbine units that are still in the process of being upgraded to modern standards. We recognize the need to utilize some common metric as a standard for comparison but encourage TVA to inform reviewers and decision makers about the weaknesses inherent in the selected metrics.

Response to Comment 18: TVA readily acknowledges that uncertainties are associated with all of the ROS analyses—particularly the computer-program-driven analyses, which provide the backbone for most of the ROS analyses. The appendices to the EIS (both Draft and Final) describe the models and identify their more important limitations. For example, TVA noted that the Weekly Scheduling Model, which provides the analytical foundation for most of the ROS analyses, produces only average weekly discharges. As explained in the model description appendix, this limitation for ROS water quality modeling required TVA to estimate hourly discharges with a different computer program. These limitations were described textually and were not always mathematically characterized. For most readers, textual explanations are more informative than mathematical characterizations. However, detailed box plots showing the variability of results were included in Appendix C.8. Appendix C also identified assumptions and limitations of other important analyses. To further aid the reader in understanding uncertainties, additional graphical depictions of probability ranges associated with resulting reservoir elevations have been included in Appendix C in the FEIS.

19. Actual or firm power generation values can only be obtained with in-place units. The subject 21 units are not yet modified, or "in situ." It is common for actual power values for any given generator to be below the rated power value, due to a myriad of circumstances. With a total of 109 units, the variation between actual firm and 21 in-situ power production for the 21 units could represent a significant underestimate of power generation in the DEIS. The uncertainty associated with using rated or projected power values could have a significant impact on the comparison of alternatives, especially when power production is a determining factor. Identifying the range of values, from rated through existing in situ at various efficiencies, would, in our opinion, provide a more transparent analysis than the strict use of rated power values.

Response to Comment 19: Although some uncertainty accompanies projecting unit generation levels, the experience of being well into the modernization of its hydroelectric units increases TVA's confidence in its projections. To the extent that the projections may be in error, the error would have been applied across all alternatives and would therefore not affect their relative comparisons.

20. Neither section 4.18 nor 5.18 on Cultural Resources mentions whether any American Indian tribes were consulted. The subject TVA projects are located in an area where at least five federally recognized tribes have been or are located (Cherokee, Chickasaw, Choctaw, Shawnee, and Creek) and may attach aboriginal, religious, and cultural significance. Accordingly, pursuant to section 106 of the National Historic Preservation Act (NHPA), such tribes must be consulted about cultural resources affected by these projects, including consultations regarding the identification of cultural properties, the appropriate scope of the area of potential effects, and the development of any Historic Properties Management Plan. See, e.g., 36 C.F.R. 800.2(c)(2)(B)(ii). A list of potentially affected tribes is enclosed for your use as appropriate.

Regulations implementing the NHPA contemplate that Indian tribes be provided both a meaningful and early opportunity to participate in the section 106 planning process. The regulations further require that the agency make a reasonable and good faith effort to identify historic properties that may be affected by the undertaking and gather sufficient information to evaluate the eligibility of these properties for the National Register. See, e.g., 36 C.F.R. 800.4(b). Consultation with the State Historic Preservation Officer does not satisfy this requirement.

Response to Comment 20: TVA has invited 17 federally recognized Indian tribes to be consulting parties in the process that addresses effects on historic properties, consistent with Section 106 of the National Historic Preservation Act. TVA is executing an agreement with the seven Tennessee Valley region State Historic Preservation Officers and other consulting parties, outlining the actions TVA would take to avoid or mitigate adverse effects on historic properties associated with the Preferred Alternative.

21. We recommend the DEIS enhance discussions about the relationship between the need for low temperature cooling water for power plants and the impact on warm water species by releasing cold water from Fontana Dam; mitigation options should be discussed in detail. TVA acknowledges the impacts on aquatic resources by creating a dam system in section 4.7 and notes the need for cool water used for power plant cooling in section 4.23.5, but reviewers and decision makers would benefit from a more thorough discussion of underlying issues, alternatives and implications, and mitigation strategies. The cold water released from Fontana Dam is a major inhibiting factor in the existence of native fish populations in the Little Tennessee River and the reservoir system operated by the APGI Tapoco Project as well as the Tennessee River. Fontana Dam could have an inlet tower installed to select the water from anywhere in the water column and have much greater control of the temperature of the water released. However, the release of warmer water to support native fish conflicts with cooling water needs for power plants along the Tennessee River.

Response to Comment 22: Changes have been made in the FEIS to address this issue (see Sections 4.7 and 5.7).

22. Throughout the document, TVA interchangeably refers to existing conditions or the current reservoir operations as Base Case, no-policy alternative, or no-action alternative. For clarification, we recommend TVA utilize one description for this alternative.

Response to Comment 22: Changes have been made to improve the use of consistent terminology throughout the FEIS.

23. Specific details related to operational policy changes that may be proposed at each of TVA's facilities are needed to fully assess the impacts of the individual alternatives. For all alternatives, site-specific spatial and temporal information concerning projected water elevations and releases for each reservoir and associated tailwater is also needed to fully evaluate potential impacts to existing resources.

Response to Comment 23: The ROS analyses do contain detailed information about the potential effect of the alternatives on reservoir-specific parameters, such as elevations and flows. TVA makes additional technical information available on request. Most readers would have little use for such details and are more interested in a broader perspective on issues that interest them specifically. The ROS EIS contains the latter. However, the appendices provide additional details, including box plots and tables that show estimated elevations on a weekly basis across reservoirs by each alternative (see Appendix C). Additional details also have been provided in the FEIS for TVA's Preferred Alternative.

24. Based on analyses completed to date, most of the action alternatives would produce substantially higher minimum water elevations downstream from the mainstem dams. The recreation-based alternatives would also result in higher water elevations and delayed winter pool drawdowns in the tributary reservoirs. The Equalized Summer/Winter Flood Risk Alternative would produce minimum water elevations similar to the Base Case alternative. All of the other alternatives would yield higher minimum water levels. The Commercial Navigation Alternative would result in an increase in the winter flood guides of 2 feet on the mainstem reservoirs. Recent flood risk analyses have indicated that potential delayed winter pool drawdowns would result in a 33% increase in high water occurrences at 363' MSL, a 12% increase at 362' MSL, and a 17% increase at 361' MSL, in Kentucky Reservoir. A similar evaluation performed for Wheeler Reservoir indicated a 33% decrease at 559' MSL and a 17% increase at 558' MSL. As it becomes available, we would appreciate additional information regarding flood risk analyses performed in other mainstem pools utilized for navigation.

Response to Comment 24: Additional information about flood risk has been provided in the FEIS. Substantial additional data exist that support the summary data provided in the EIS. TVA makes this information available on request.

25. In general terms, most alternatives would increase reservoir retention times, which would decrease dissolved oxygen (DO) and increase chlorophyll concentrations within the reservoirs. Low DO concentrations reduce the assimilative capacities in the reservoirs and result in near anoxic conditions in the hypolimnion. Other changes in water quality parameters would be expected in the reservoirs and associated tailwater releases. Since a preferred alternative is not known at this time, it is impossible to predict, with any degree of accuracy, specific expected changes in water quality within mainstem or tributary reservoirs or tailwater reaches.

Response to Comment 25: As noted by DOI in Comment 26, TVA modeled potential water quality changes associated with each of the alternatives and summarized the results in the EIS. This was also done in the FEIS for TVA's Preferred Alternative. TVA believes that these results are reasonably accurate. To the extent that the projections may be in error, the error would have been applied across all alternatives and therefore would not affect their relative comparisons.

26. Water quality modeling to date indicates that most changes in currently observed (Base Case) DO patterns would be minor, with the exception of the Tailwater Habitat Alternative. More water volume with average DO concentrations less than 2 mg/l would be expected. This potential change would be especially problematic downstream of Wilson Dam. Modeling also indicated potential changes in DO patterns within Kentucky and Chickamauga Reservoirs. Minor temporal changes in DO patterns (more hours with DO concentrations less than 2 mg/l) would be expected with implementation of Reservoir Recreation Alternative A downstream of Guntersville Dam and Reservoir Recreation Alternative B downstream of Pickwick Dam. All of the action alternatives would produce higher average water temperatures in the Hiwassee River. Conversely, all of the action alternatives would produce substantially lower average temperatures below TVA facilities on the Holston River.

Response to Comment 26: This summary identifies some of the general effects of the alternatives on various water quality characteristics. The intent of examining a fairly wide range of alternatives in the DEIS was to be able to identify when and where different possible operations policies would adversely affect water quality and other characteristics of the river system. These results identified components and limits that contributed to the formulation of the Preferred Alternative.

27. The DEIS does not include a thorough discussion of potential changes to flow regimes and water quality downstream of Kentucky Dam. Due to the significance of the mussel and fishery resources downstream of Kentucky Dam, we believe a detailed analysis of the potential effects of the preferred alternative is warranted in the final EIS. The DEIS also does not include a thorough discussion of potential changes to flow regimes and water quality in Lake Barkley (Cumberland River). Due to the hydrological connection to Kentucky Reservoir, we believe this evaluation is warranted in the final EIS in order to evaluate potential effects to existing operations at Cross Creeks National Wildlife Refuge (NWR).

Response to Comment 27: Under the Preferred Alternative, TVA did not anticipate substantial changes in average flow conditions below Kentucky Reservoir. Consequently, mussel resources were expected to respond as they would under the Base Case. TVA's Preferred Alternative does not include changes in Barkley operating guides; therefore, no need for changes in the management of the Cross Creeks National Wildlife Refuge is anticipated.

28. Given the vast degree of uncertainty associated with the influence of dam operations on river resources (e.g., native assemblages of aquatic species, economic resources), we strongly encourage TVA to establish an adaptive management process as an integral component of its operations. In a letter to TVA dated June 7, 2002, the NPS proposed the following adaptive management measures:

Develop and apply an ongoing ***adaptive management*** *approach to river operations that balances cultural, economic, and environmental resources uses and values.*

Rationale: Adaptive management of river operations entails making periodic incremental adjustments to operating procedures (e.g., release schedules, reservoir levels, and instream flows) based on ongoing monitoring and analysis (Primack 1998). The intent of adaptive management is to optimize the management capacity of TVA and all of its stakeholders. The application of adaptive management can increase the effectiveness of management decisions while thereby reducing associated long-term management costs (Johnson, B. L. 1999. The role of adaptive management as an operational approach for resource management agencies. Conservation Ecology **3**(2): 8. [online] URL: http://www.consecol.org/vol3/iss2/art8.).

Suggested components of an adaptive management alternative may include:

Establish a multi-stakeholder Adaptive River Operation Council (AROC): The AROC would consist of TVA personnel, representatives of associated agencies, technical experts from the social and natural environments, and other stakeholders such as watershed organizations, homeowner groups, and industrial interests. The goal of the AROC would be to host periodic meetings and workshops to design and evaluate monitoring and modeling efforts, detect resource trends, and suggest site-specific incremental operational changes to the TVA Board of Directors. For example, the AROC might meet annually to evaluate and assess trends of previously collected field data and new modeling results. In some cases, smaller working groups consisting of a subset of AROC members could develop recommended incremental alterations to propose to the broader council and ultimately the Board.

Develop an Adaptive River Operation Monitoring Program. The AROMP would use ongoing TVA water quality and biological monitoring, and if needed, be broadened to incorporate system-wide resource objectives and public concerns. The AROMP might also entail computer modeling.

Response to Comment 28: As discussed in Chapter 3, TVA believes that it already uses an adaptive management approach because of the inherent flexibility of its operating guidelines, the routine extensive monitoring of reservoir system parameters, and its ability to react to monitoring results by appropriately adjusting operations within the guidelines. TVA expects to continue this approach regardless of any decisions that are made as a result of the ROS. TVA always welcomes suggestions for improving operations and freely shares the monitoring data that are collected.

29. Since the DEIS does not state a preferred alternative, the DOI suggests the notion of a blended alternative. A blended alternative should seek a balance in all public values (including those of future generations), but it should especially account for resource protection where the greatest amount of uncertainty and irreversible consequence reside. A blended alternative can best service the public value of this and future generations through long-term adaptive management and the ability to function on a site-specific basis. Alternatives Reservoir Recreation A and B along with Tailwater Recreation and Tailwater Habitat appear to collectively offer the greatest amount of public values as depicted by Table ES-01. An adaptive, long-term blending of these alternatives with site-specific flexibility is likely to produce a high degree of public value.

Response to Comment 29: As suggested, TVA has developed a Preferred Alternative that combines desirable features of the alternatives identified in the DEIS. It is agreed that implementing this Preferred Alternative—with sufficient site-specific flexibility (adaptability)—is likely to improve the public value of TVA's reservoir system without resulting in unacceptable environmental impacts.

30. Executive Summary, pages ES-13 to ES-20, and Table ES-02, Summary of Impacts by Policy Alternative: Without specific technical analyses for a preferred alternative or proposed policy change, these general representations should be qualified as projections that require further technical evaluation. To the average reader, a simplification of a diverse reservoir system can misrepresent realistic impacts that may occur within individual reservoirs.

Response to Comment 30: The FEIS contains TVA's Preferred Alternative and associated analyses of that alternative. TVA has continued to use general representations of impacts because it is believed that this best allows most readers to easily compare and understand the implications of the alternatives. Specific technical analyses provide further details for these general representations; some of the details of these analyses are provided in the appendices. See Responses to Comments 18 and 23.

31. The evaluation of wildlife under the terrestrial ecology category (Page ES-16) is too broad and does not recognize the potential for specific adverse effects to a variety of wildlife species. Specific groups of wildlife species (e.g., waterfowl, wading birds, reptiles, and amphibians) should be addressed separately.

Response to Comment 31: Initially, it was planned that the Executive Summary would summarize impacts for a broad variety of wildlife; however, because there was a greater potential for impacts on shorebirds than other species, they were highlighted in the Executive Summary. As noted in the EIS, the alternatives would result in both beneficial and adverse impacts on wildlife. These impacts are addressed in Section 5.10.

32. Section 3.3, Alternatives Evaluated in Detail, Table 3.3-01, pages 3-6 and 3-7: Reservoir Recreation Alternative A is grouped with the Base Case on this page, followed by the introduction of a column heading entitled "Policy Alternatives" on the next page (and all remaining pages of this table). This suggests that Reservoir Recreation Alternative A is not a policy alternative.

Response to Comment 32: This has been changed in the FEIS.

33. Section 3.3, Alternatives Evaluated in Detail, Table 3.3-01, page 3-6, Base Case, first bullet under column entitled "Reservoir Operating Guidelines:" For clarification and consistency, we suggest changing the wording from "and restrict drawdown during June and July" to "and continue to restrict drawdown until August 1."

Response to Comment 33: This has been changed in the FEIS.

34. Section 3.3, Alternatives Evaluated in Detail, Table 3.3-01, page 3-6, Reservoir Recreation Alternative A, third bullet under column entitled "Reservoir Operating Guidelines:" For clarification, we suggest changing the wording from "Begin unrestricted TR drawdown on Labor Day" to "Delay unrestricted TR drawdown to Labor Day."

Response to Comment 34: Additional information has been included in the FEIS to better explain this concept.

35. Section 3.3, Alternatives Evaluated in Detail, Table 3.3-01, page 3-6, Reservoir Recreation Alternative A, fifth bullet under column entitled "Reservoir Operating Guidelines:" Insert "winter" into the phrase "Raise MR flood guides."

Response to Comment 35: This change has been made in the FEIS.

36. Section 3.3.3, Alternatives Evaluated in Detail, Reservoir Recreation Alternative B, page 3-13, 4th full paragraph: It appears that both Reservoir Recreation Alternative B and A result in higher winter reservoir levels on tributary reservoirs, relative to the Base Case. Please clarify the discussion.

Response to Comment 36: Additional information has been included in the FEIS to better explain this concept.

37. Section 3.3, Alternatives Evaluated in Detail, pages 3-14 and throughout: Comparison statements throughout this section need to be more explicit: reduce/increase relative to Base Case, the Alternative previously discussed, or both?

Response to Comment 37: Additional information has been included in the FEIS to better explain this concept.

38. Section 3.3.8, Alternatives Evaluated in Detail, Tailwater Habitat Alternative, page 3-18, last two paragraphs: The last full paragraph on this page (beginning "Under the Tailwater Habitat Alternative") states that this alternative will result in more variable flows, whereas the following paragraph (beginning with the subheading "Achievement and Objectives") states that this alternative will increase stability in tailwater flows. These statements appear to contradict one another.

Response to Comment 38: Additional information has been included in the FEIS to better explain this concept.

39. Section 3.5.2, Reservoir Operations Policy Alternatives, Table 3.5-01: The "$" symbol should be used consistently throughout the table to denote monetary figures (it is not used in the row entitled "Lowering the cost of transporting materials on the commercial waterway," although the footnote indicates that the figures in each cell in this row are in millions of dollars).

Response to Comment 39: This has been changed in the FEIS.

40. Section 3.5, Reservoir Operations Policy Alternatives, Aquatic Plants, Page 3-30, Table 3.5-02: We recommend that you include a footnote to this table in order to make it clear that this category includes an assessment of invasive aquatic plants.

Response to Comment 40: The footnote has been added in the FEIS.

41. Section 3.5, Reservoir Operations Policy Alternatives, Terrestrial Ecology, Page 3-31, Table 3.5-02: Note that impacts to Wildlife differ from Migratory Shorebirds and Plant Communities (these latter two resource areas are affected similarly by the proposed set of alternatives). Is this because the category "Plant Communities" is actually focused upon impacts to lowland or wetland, communities? If so, this should be clarified as a footnote to the table.

Response to Comment 41: The focus was on both upland and lowland plant communities. Because the policy alternatives involve the timing and duration of fluctuating water levels, effects on lowland plant communities are more widespread and of greater magnitude than those on upland plant communities.

42. Section 3.5, Reservoir Operations Policy Alternatives, Page 3-37, 1st paragraph, 1st sentence: This section is unclear. The previous paragraph states that Reservoir Recreation Alternative B and the Tailwater Habitat Alternative would have the most adverse impact on water quality. It seems the intent of this sentence to state that these two alternatives (Reservoir Recreation Alternative A and the Tailwater Recreation Alternative) would impact water quality more on the mainstem (than the tributary) reservoirs but that these impacts would still be less than Reservoir Recreation Alternative B and/or the Tailwater Habitat Alternative.

Response to Comment 42: The commenter's interpretation of the content of these sentences is correct. To eliminate possible confusion, the sentences have been reworded in the FEIS.

43. Section 3.5, Page 3-37, 2nd paragraph: Enhance the discussion of how the increased erosion anticipated under the Tailwater Habitat Alternative would affect aquatic organisms, including federally threatened and endangered species.

Response to Comment 43: In the FEIS, this paragraph has been expanded to include additional information from revisions made in Section 5.16 (Shoreline Erosion), Section 5.7 (Aquatic Resources), and Section 5.13 (Threatened and Endangered Species).

44 Section 3.5, Page 3-37, 3rd paragraph, last sentence: We suggest that the discussion of Reservoir Recreation Alternative B be re-written for proper emphasis of the issue. Reservoir Recreation Alternative B would result in more adverse impacts than the other alternatives, largely due to extending the summer reservoir levels into late summer and early fall, which would inundate flats at times when these habitats are normally exposed and able to provide important habitat to migratory waterfowl and shorebirds.

Response to Comment 44: The public and other agencies commenting on the identified alternatives appear to understand the elements of the identified alternatives. Nevertheless, TVA further clarified descriptions throughout the FEIS.

45. Section 4.7, Aquatic Resources, throughout: A more detailed evaluation of potential changes in available spawning and nursery habitat as a result of implementation of the various alternatives is needed. The relationship between various wetland vegetative types, their position in the landscape, and aquatic species productivity is not discussed adequately.

Response to Comment 45: Additional discussion of fish spawning requirements has been added to the FEIS.

46. Section 4.8, Wetlands, throughout: Typographical error: "THE TVA" should be changed to "The TVA."

Response to Comment 46: This typographical error has been corrected in the FEIS.

47. Section 4.8, Wetlands, page 4.8-6, Table 4.8-02: The invested agency for the Swan Creek Dewatering Unit should be the Alabama Department of Conservation and Natural Resources.

Response to Comment 47: Table 4.8-02 in the FEIS has been changed to reflect that the Alabama Department of Conservation and Natural Resources is the correct invested agency at the Swan Creek Dewatering Unit.

48. Section 4.8, Wetlands, page 4.8-12, 1st paragraph, last sentence: Hyperlink error: The location of the report referenced by the first hyperlink in the series (http://ncseonline.orgY.) appears to have changed; typing in this full link produces an error message that the page cannot be found.

Response to Comment 48: Text has been changed in Section 4.8 to indicate the authors of the referenced document and the date the document was published. The full citation of the report with an updated hyperlink has been added to Chapter 10.

49. Section 4.8, Wetlands, page 4.8-13, 2nd paragraph, last sentence: Hyperlink error: The location of the report referenced by the first hyperlink in the series (http://hydra.gsa.gov.) also appears to have changed; typing in this link produces a "re-direct" message indicating that the information is now found within the www.gsa.gov website.

Response to Comment 49: See Response to Comment 48.

50. Section 4.8, Wetlands, page 4.8-13, last paragraph, last few sentences: The statements describing the unique biological resources associated with wetland habitats directly parallel the content of Sections 4.10 (Terrestrial Ecology), Section 4.7 (Aquatic Resources), and 4.13 (Threatened and Endangered Species). The interdependency of these resources should be emphasized via a reference to these sections. In particular, globally imperiled wetland plant communities known or with potential to occur within the study area are listed in Section 4.10, Table 4.10-01 (page 4.10-3).

Response to Comment 50: Appropriate references have been inserted into Section 4.8. Text has been added to reference additional related discussions in Section 4.7 (Aquatic Resources), Section 4.10 (Terrestrial Resources), Section 4.13, (Threatened and Endangered Species), and Section 4.14 (Managed Areas and Ecologically Significant Sites).

51. Section 4.9, Aquatic Plants, page 4.9-2, Table 4.9-01: For consistency, the taxonomic authority should either be given for all or none of the species listed.

Response to Comment 51: Taxonomic authority is no longer included for the species listed.

52. Section 4.9, Aquatic Plants, page 4.9-3, last paragraph: We do not dispute that natural environmental variation (in weather, water flow, nutrient cycling, light availability) "tend(s) to surpass the effect of reservoir operational activities." However, as worded, this paragraph in the DEIS implies that changes in reservoir operations would be expected to produce little change in the coverage of aquatic plant species relative to these more natural (i.e., unpredictable) sources of environmental variation. However, some of the proposed alternatives may, through direct manipulation of water levels, also indirectly generate the very conditions that have been observed to affect the coverage of these species (as described in this paragraph B i.e., "higher stream flows, high turbidity, cold water temperatures"), especially in the tailwater regions.

Response to Comment 52: The analysis of impacts on aquatic plants focused on changes in elevation and duration of inundation. Although changes in flow, turbidity, and temperature can affect coverage of aquatic plants, the changes in these parameters that would occur as a result of the alternatives are expected to be on a smaller scale than changes caused by natural hydrologic and climatic events. Aquatic plants are absent or minimal for several miles downstream of most TVA mainstem dams due to a lack of habitat (e.g., embayments and inlets) and the high flows associated with spill events and hydropower generation.

53 Section 4.10.5, Terrestrial Ecology, page 4.10-9, 1st paragraph: It is stated that "potential changes in bottomland hardwood forest, scrub-shrub wetlands, emergent wetlands, aquatic vegetation, flats, and other communities potentially affected by reservoir levels could affect terrestrial wildlife populations." The word "could" should be replaced with "would." When changes as significant as those addressed in this document are implemented, certain wildlife populations (e.g., shorebirds and waterfowl) will be significantly impacted.

Response to Comment 53: Changes were made in the FEIS.

54. <u>Section 4.10.5, Terrestrial Ecology, page 4.10-9, 4th paragraph</u>: It is stated that "flats, isolated pools, and shallow water are created by current drawdown regimes in early August." This is correct for many reservoirs but not all. The drawdown on Kentucky and Barkley Reservoirs starts in early July. This date is significant as it provides adequate shorebird habitat during the peak migration period to provide habitat for early migrating waterfowl (e.g., blue-winged teal) and to produce the annual plants (forage) needed by wintering waterfowl.

Response to Comment 54: Changes were made in the FEIS.

55. <u>Section 4.10, Terrestrial Ecology, page 4.10-6, 1st paragraph, 1st sentence</u>: "Tables 4.10-01 and 4.10-02 present the names, global ranks, and distribution of the imperiled lowland communities…" In this sentence "lowland" should be changed to "wetland," since the term "lowland" (as being applied in the DEIS) encompasses more community types than would be expected in NatureServe's subset of "wetland" communities (from which this table was created).

Response to Comment 55: Comment noted. Changes were not made because lowland, in this context, included more than wetlands.

56. <u>Section 4.10, Terrestrial Ecology, page 4.10-8, 2nd and last paragraphs</u>: The discussion of "Future Trends" under Upland Plant Communities (last paragraph) also applies to the anticipated Future Trends for Lowland Plant Communities (2nd paragraph).

Response to Comment 56: Future trends for these two plant communities are similar. Declines are partly attributed to the direct impacts of various land uses, such as timber harvesting, agriculture, and urban and rural development, and partly to associated impacts from increases in invasive exotic species. Trends for lowland communities are addressed in Section 4.8, Wetlands.

57. Section 4.11, Invasive Terrestrial and Aquatic Animals and Terrestrial Plants, throughout: The information provided in the DEIS is not of sufficient detail for evaluation of the rationale for focusing upon those species of invasive terrestrial animals and plants specifically named in the discussion. The discussion in the DEIS should clarify whether or not those species mentioned are those which pose the greatest threat throughout the Tennessee Valley or are specifically those that pose the greatest risk with respect to changes in reservoir operation policies.

Response to Comment 57: The rationale for choosing to focus on the species addressed was mistakenly presented in Section 5.11 in the DEIS. The appropriate changes were made in the FEIS.

58. Section 4.13, Threatened and Endangered Species, page 4.13-1, 3rd paragraph: The phrase "reservoir-like reservoirs" appears to contain a typographical error.

Response to Comment 58: The error has been corrected in the FEIS.

59. Section 4.14, Managed Areas and Ecologically Sensitive Sites, page 4.14-9, Table 4.14-02: Swan Creek Wildlife Management Area (WMA) and Mallard-Fox Creek WMA should be identified as managed areas and/or ecologically significant sites within Wheeler Reservoir.

Response to Comment 59: Table 4.14-02 in the DEIS was originally intended to list a sample of the various managed areas and ecologically significant sites in the ROS study area. To avoid confusion, the table has been deleted from the FEIS.

60. Section 4.14, Managed Areas and Ecologically Sensitive Sites, page 4.14-16, 1st paragraph: The Alabama cavefish is not located on Wheeler NWR. It is endemic to Key Cave NWR. Key Cave NWR is managed by Wheeler NWR staff. The correct scientific name for the species is *Speoplatyrhinus poulsoni*.

Response to Comment 60: Corrections were made to Section 4.14 in the FEIS.

61. Section 4.14, Managed Areas and Ecologically Sensitive Sites, page 4.14-16: Significant stands of water tupelo (Nyssa aquatica) forested wetlands occur within Wheeler Reservoir on Wheeler NWR. The Beaverdam Creek Swamp National Natural Landmark in Limestone County, Alabama, contains approximately 530 acres of water tupelo. Approximately 20% of the area is permanently flooded and contains a mature, pure stand of water tupelo. The remainder of the area is intermittently flooded and is dominated by water tupelo and black gum (Nyssa sylvatica). Pure tupelo swamps of this size and integrity are quite rare and its significance led to its designation as a National Natural Landmark. This information should also be included and referenced in Appendix D5, page D5-5.

Response to Comment 61: Potential impacts on this community type are discussed in Section 5.10.

62. Section 4.17, Prime Farmland, Table 4.17-03: Footnote No. 2 should be Natural Resources Conservation Service.

Response to Comment 62: This footnote was corrected in the FEIS.

63. Section 5.8.5, Wetlands, page 5.8-5, 3rd paragraph: Under a discussion of Reservoir Recreation Alternative B and the Tailwater Recreation Alternative, it is stated that "the increase in winter pool elevations could interfere with wetlands with controlled water levels on Kentucky, Wheeler, and Douglas Reservoirs." This sentence stands alone without any additional qualification. We recommend that the following specific information be included in this discussion: 1) a list of managed wetlands potentially impacted (e.g., Camden and

Barkley WMAs, Tennessee NWR, Wheeler NWR); 2) the potential increased impacts of flooding, such as the increased cost to upgrade and repair infrastructure and the additional threats to wildlife habitat (e.g., agricultural crop production, bottomland hardwoods, moist-soil management units); and 3) the potential impacts to public recreation activities (i.e., hunting, fishing, bird watching) that occur on these areas.

Response to Comment 63: Section 4.8.2 contains a concise discussion that lists reservoirs with wetlands with controlled water levels, a discussion of issues related to management of these areas, and some of the implications that increased winter pool levels might have on infrastructure and management. Table 4.8-02 contains a list of each managed wetland by reservoir. Section 5.8 contains a description of potential adverse impacts on reservoirs with managed wetlands. Section 5.10 (Terrestrial Ecology) and Section 5.14 (Managed Areas and Ecologically Significant Sites) contain additional discussion of potential impacts on wetlands with artificially controlled water levels.

64. Section 5.8.8, Wetlands, page 5.8-8, 2nd paragraph: Under a discussion of the Commercial Navigation Alternative, the potential for a loss of flats due to the rise in the minimum winter pool level of mainstem reservoirs is not included. The mudflat wetland habitat type is extremely important to waterfowl, bald and golden eagles, gulls, terns, and many other species of migratory birds. The DOI does not concur with the conclusion that there will be overall positive effects on mainstem reservoirs.

Response to Comment 64: As stated in Section 5.8, the Commercial Navigation Alternative does not differ substantially from the Base Case. The Commercial Navigation Alternative would not affect summer pool duration of mainstem reservoirs; therefore, it would not affect the exposure of flats for migrating birds during late summer and fall. The Commercial Navigation Alternative would increase summer pool duration on five tributary reservoirs (Hiwassee, Nottely, Fontana, Douglas, and Watauga). These increases would delay exposure of flats in late summer between 1 and 4 weeks. Douglas Lake has the largest amount of flats of the five affected reservoirs. Summer drawdown would be delayed up to 3 weeks under the Commercial Navigation Alternative.

As described in Section 5.8, the Commercial Navigation Alternative could increase winter pool levels from 1.5 to 1.7 feet over the Base Case on seven mainstem reservoirs. The increase in winter pool levels on affected mainstem reservoirs would primarily reduce exposure of flats during winter months. The positive effects of the Commercial Navigation Alternative on other wetlands habitat on mainstem reservoirs would help to offset the adverse effects of this alternative on flats.

65. Section 5.10.4, Terrestrial Ecology, page 5.10-3, 1st paragraph: Under a discussion of the Commercial Navigation Alternative, it is stated that "the area inundated by water would increase, potentially creating additional shallow-water foraging habitat for waterfowl and wading birds." Why would an equal amount of shallow-water habitat not be available under the Base Case Alternative? The shallow-water area should be essentially equal but at a lower elevation. The result of raising the winter pool is not a gain in shallow-water habitat. It is a loss of mudflat habitat.

Response to Comment 65: This alternative would result in more shallow-water surface area during winter than under the Base Case. The paragraph originally stated that there would be an overall reduction of flats under this alternative. TVA adjusted the text in the FEIS to better present the information.

66. Section 5.10.6, Terrestrial Ecology, page 5.10-5, 3rd paragraph: Under a discussion of wildlife communities, it is stated that "although flats would not be available to most shorebirds migrating during late summer or early fall, extended high water levels could benefit early-migrating waterfowl such as blue-winged teal and wood ducks." We recommend that blue-winged teal (*Anas discors*) be removed from this sentence. Mudflats are a preferred habitat for blue-winged teal, where they forage on seeds of various grasses and sedges. It is unlikely that they will utilize the woody habitats that are flooded during summer pool.

Response to Comment 66: Appropriate changes were made to the FEIS.

67. Section 5.10.8, Terrestrial Ecology, page 5.10-6, 6tth paragraph: Under a discussion of the Summary of Impacts, it is stated that "except for the Summer Hydropower Alternative, changes in operations under all policy alternatives would result in limited effects on most waterfowl, semi-aquatic mammals, and non-game wildlife, as they would adapt to changing conditions." This statement is repeated in other sub-sections of the Terrestrial Ecology Section. While we agree this statement is generally true, how they adapt may not be desirable to resource managers and the public. It has been determined from data collected during waterfowl surveys conducted on Tennessee NWR over the last 7 years that over 50% of the waterfowl use on the refuge occurs on the reservoir. The resultant adaptations may include reduced localized populations of both migratory and resident wildlife. Waterfowl and other migratory birds may adapt to a significant habitat change by migrating to other areas or utilizing undesirable habitat(s). The overall loss of mudflats will result in a lower local carrying capacity for waterfowl. It is also stated that "due to the anticipated decrease in flats habitat, shorebirds would be adversely affected during fall migration periods under these alternatives." We recommend that waterfowl also be added to this sentence.

Response to Comment 67: Appropriate changes were made to the FEIS.

68. Section 5.13, Threatened and Endangered Species, throughout: The level of discussion provided in the DEIS makes it difficult to identify and compare anticipated impacts to specific species of protected plants or animals, or populations of these species, within and among the various policy alternatives proposed. While a site-specific analysis may be beyond the scope of this broad overview of the entire set of proposed alternatives, we expect that it will be presented for the preferred alternative in the final EIS. For example, the potential for adverse affects to the green pitcher plant (*Sarracenia oreophila*) has been identified under the Summer Hydropower Alternative, but from the discussion, it is not possible to determine whether TVA anticipates similar affects to this species under the other alternatives proposed. Further, although adverse impacts to this species are identified under that alternative, the magnitude of these impacts is unclear. The discussion should address whether individual plants, an entire population, or the entire species be adversely impacted by this alternative.

Response to Comment 68: A site-specific analysis for each of the 526 federal- and state-listed endangered, threatened, or otherwise protected species is outside the scope of this programmatic EIS. However, TVA has conducted species-specific analyses with regard to the Preferred Alternative for 59 federal-listed or identified candidate species. The results of those analyses are summarized in Section 5.13 in the FEIS. If a decision is made to change reservoir operations, it is anticipated that monitoring and adaptive response will be an important component of the implementation plan.

69. Section 5.13.2, Threatened and Endangered Species, pages 5.13-11 to 5.13-12, 5th paragraph: It is stated that "bald eagles and gray bats could be benefited by Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, the Commercial Navigation Alternative, the Tailwater Recreation Alternative, and the Tailwater Habitat Alternative to the extent that each alternative would increase the size of reservoir pools and increase the numbers of food items (mostly fish and waterfowl for the eagles and adult aquatic insects for gray bats)." Eagles are commonly observed on the flats feeding on stranded fish and dead waterfowl. This suggests that the mudflats may be an important habitat component of the bald eagle (*Haliaeetus leucocephalus*) in the ROS area. We also question TVA's conclusion that raising the pool levels during the fall and winter will increase waterfowl numbers. In fact, we believe that increasing pool levels in fall and winter would likely have the opposite effect. Any increase in the production of adult aquatic insects would likely be minor. Potential adverse effects, however slight, to the gray bats' foraging habitats do not appear to have been considered.

Response to Comment 69: The effects of the alternatives on flats and other shoreline habitats were an important component of the terrestrial ecology evaluation. The EIS section has been revised to better address the subject. In addition, TVA prepared a Biological Assessment and has received a Biological Opinion (Appendix G) from the USFWS that specifically addresses the potential for impacts on federal-protected species such as the bald eagle and gray bat. Sections 4.13 and 5.13 were modified in the FEIS in order to be consistent with relevant parts of the Biological Assessment, Biological Opinion, and Terrestrial Ecology sections.

70. Section 5.13.2, Threatened and Endangered Species, page 5.13-12, 3rd paragraph: The evaluation of potential impacts to the federally endangered least tern (*Sterna antillarum*) should not be limited to nesting habitat. Least terns have been observed resting and feeding on flats on Kentucky Reservoir during fall migration.

Response to Comment 70: See Response to Comment 69. Potential impacts on the least tern have been addressed in TVA's Biological Assessment and the USFWS Biological Opinion. Sections 4.13 and 5.13 were appropriately modified in the FEIS to summarize these analyses.

71. Section 5.22.2, Flood Control, page 5.22-1, 3rd paragraph: It is stated that "the analysis for flood risk did not consider areas downstream of Savannah, Tennessee." We recommend that other areas on Kentucky and Barkley Reservoirs be included in the flood risk analysis. Although we appreciate receiving additional limited information regarding potential flood risk on Tennessee NWR and Wheeler NWR since the publication of the DEIS, we believe additional evaluations are warranted for Cross Creeks NWR (Barkley Reservoir) and the numerous State WMA's throughout the Tennessee Valley. Additional evaluations of Tennessee NWR and Wheeler NWR would also appear to be warranted.

Response to Comment 71: While the area downstream of Savannah was not included in the flood risk simulation model, TVA did evaluate the likely impact of changes in Pickwick discharges on Kentucky and Barkley pool levels. The analysis demonstrated that it is reasonable to expect that changes in Pickwick discharges associated with the implementation of any of the alternatives considered could be accommodated in Kentucky and Barkley Reservoirs. Temporary, minor increases in pool levels would result under TVA's Preferred Alternative. For the 10 largest historical events that have occurred during the March through May season, the average total increase in Pickwick discharge volumes over a 30-day period for the Preferred Alternative was about 156,000 day-second-feet (dsf). For June and July, the average increase is about 11,800 dsf. These volumes can easily be stored as required in Kentucky and Barkley Reservoirs without aggravating downstream flooding conditions.

72. Section 6.2.7, Cumulative Impacts, page 6-5, 3rd paragraph: It is stated that "these changes may have the potential to cause some adverse impacts on federally listed threatened and endangered species; however, the level of impact would be small and not significant enough to jeopardize the continued existence of these species." Under the Base Case alternative, populations of certain federally listed species will likely continue to decline in numbers and health. There are certain species listed as endangered (e.g., turgid blossom pearly mussel) that are likely extinct; no observations have been reported since the early 1900's. We believe TVA's conclusion regarding cumulative impacts to federally endangered and threatened species is premature and without factual foundation since no preferred alternative has been selected or analyzed in detail. We recommend analysis. Appropriate conclusions and supporting analysis should be submitted in a clearly labeled biological assessment (BA) concurrent with the final EIS.

Response to Comment 72: The FEIS contains analyses of TVA's Preferred Alternative, including potential impacts on listed species. These analyses include TVA's Biological Assessment that was submitted to USFWS for review. The USFWS review of that Biological Assessment is contained in their Biological Opinion (Appendix G) for the ROS. Section 6.2.8, which addresses cumulative impacts for threatened and endangered species, has been revised as appropriate to incorporate input provided by USFWS in the Biological Opinion, as well as other relevant information developed as a result of public and agency comments on the DEIS.

73. Table D1-01: Typographical error. It is Fort Loudoun, but the location is Loudon County not Loudoun County.

Response to Comment 73: This has been corrected in the FEIS.

74. We recommend that you clearly address how the alternatives consider the requirements of section 7(a)(1) and 7(a)(2) of the Endangered Species Act (ESA). These parts of section 7 of the ESA include the requirement to evaluate the potential for jeopardy, as well as the mandate that federal agencies further the conservation of federally listed species. We are generally concerned with the management of water releases from specific reservoirs, the impact of hypolimnetic discharges on federally listed mussel and fish species, and the impact of scouring on tailwater habitats. These issues are especially problematic below Kentucky, Wilson, Douglas, Cherokee, Fontana, and Tims Ford Reservoirs. While we appreciate the proposed mitigation of the current minimum flow regime in the Apalachia cut-off, we do not believe that this mitigation proposal should be limited to all alternatives except the Base Case. We would expect TVA to pursue those potential improvements regardless of a preferred alternative for the ROS.

Response to Comment 74: TVA prepared and submitted a Biological Assessment to USFWS that contains analyses of potential impacts of TVA's Preferred Alternative on listed species. The USFWS Biological Opinion on this project is provided as Appendix G to this EIS. As indicated in the Biological Assessment and the Biological Opinion, the minimum flow augmentation at Apalachia Dam is included in the Preferred Alternative.

75. We anticipate a detailed BA as part of the final EIS which will evaluate the effects of the preferred alternative and the Base Case. The BA should include a complete description of the selected alternative, the effects of those actions associated with the ROS, and a determination of effect to listed species at a site-specific level. We have appreciated the ongoing dialogue with TVA staff regarding the approach to the preparation of the BA, as well as our preferred approach in preparing the required biological opinion.

Response to Comment 75: See Responses to Comments 71, 72, and 74. TVA appreciates the willingness of USFWS biologists to facilitate this large consultation effort.

76. Migratory Birds on Tennessee NWR , Cross Creeks NWR, and Wheeler NWR

Tennessee NWR and Wheeler NWR are designated Globally Important Bird Areas and could be significantly affected by several of the identified alternatives. The Tennessee NWR bird checklist shows 10 waders and bitterns and over 30 shorebirds that could be affected by a change in habitat availability (http://tennesseerefuge.fws.gov/tnbirds.pdf). Undoubtedly, other changes will occur elsewhere in the Tennessee Valley as well, yet these effects are poorly understood. The cumulative effects of proposed changes in the pool levels of various reservoirs on bird usage, primarily roosting and foraging, are unknown and will be extremely difficult to ascertain.

During fall migration, thousands of shorebirds utilize the mudflats on Kentucky, Barkley, and Wheeler Reservoirs. The average peak fall migration of shorebirds is around mid-August. Typically, during this period of the year, shorebird habitat is extremely limited due to dry conditions and dense vegetation that has developed through the summer adjacent to the reservoirs and other impounded waters. For this reason, the fall drawdown of Kentucky and Barkley Reservoirs is extremely important. Since most shorebird species prefer habitats that are open and away from dense cover, the water level needs to be low enough to expose flats that are not covered by woody vegetation. On Kentucky and Barkley Reservoirs, the elevation of summer pool is 359' MSL and woody vegetation typically extends down to elevation 357.5' MSL. For adequate mudflat habitat to be available, the pool elevation needs to be around 356.5' MSL. Under the existing operation schedules for these reservoirs, this level is usually reached during mid to late August.

Blue-winged teal are the first migrating waterfowl to arrive. The Tennessee Valley is along one of two major migration corridors for this species. This migration route extends from Manitoba to Florida. They first arrive during early August, with the peak period of migration occurring around mid-September. Like shorebirds, blue-winged teal heavily utilize the mudflats on the reservoirs for feeding and loafing. They commonly feed on the seeds of sedges, grasses, and smartweed that were deposited on the flats in previous years, as well as on insects and mollusks that may be present. During the migration period, it is important for extensive mudflats with an abundant source of food to be present on Kentucky, Barkley, and Wheeler Reservoirs. The existing management of these reservoirs provides excellent habitat at the appropriate time of the year for blue-winged teal to utilize during migration. The drawdown also coincides with a special early duck season that provides recreational opportunities to a large number of hunters, many of which hunt on the mudflats of the reservoirs.

Traditionally, migrant Canada geese (*Branta canadensis*) from the Southern James Bay Population (SJBP) would winter in large numbers within the Tennessee Valley. The December populations of SJBP geese in Tennessee prior to 1990 averaged over 40,000. The portion of the population that migrates into the Tennessee Valley has sharply declined to a present December average of less than 10,000 SJBP geese in Tennessee. Even though the overall population level of the SJBP has stabilized, the decline in the numbers that migrate to the Tennessee Valley continues. Migrant geese first arrive on Tennessee NWR around September 20, and generally will remain within the vicinity of the Refuge until late winter. At this time of year, typically the only habitat available are the flats associated with the reservoir. Geese browse the new growth of annual grasses and sedges that occur on these flats. The existing fall drawdown schedule for Kentucky, Barkley, and Wheeler Reservoirs provides mudflat habitat for these early migrants.

Several of the ROS alternatives would result in a significant loss of mudflat habitat on Kentucky, Barkley and Wheeler Reservoirs. Delays in the fall drawdown would eliminate or significantly reduce the quantity and quality of mudflat habitat available on these reservoirs to shorebirds and early migrating waterfowl.

Reservoir Recreation Alternative A will extend the summer elevation through August 1 with only a 1-foot drop by September 1. Specific drawdown dates are not determined for the Tailwater Habitat Alternative, but the DEIS specifically mentions that the impacts on flats under this alternative would be similar to those of the Reservoir Recreation Alternative A. These two alternatives will likely result in a complete loss of mudflat habitat during the peak shorebird fall migration. The description of these alternatives in the DEIS does not provide elevation information beyond September 1. Without a projected water elevation for mid-September when the peak blue-winged teal migration occurs and SJBP of Canada geese first arrive, the quantity of habitat that will be available is unknown. However, we expect the quality to be degraded due to the delay in germination of annual plants on the flats.

Reservoir Recreation Alternative B, the Equalized Summer/Winter Flood Risk Alternative, and the Tailwater Recreation Alternative extend the summer elevation of Kentucky and Barkley Reservoirs through September 1. We anticipate these alternatives would result in a complete loss of desirable mudflat habitat during most of the fall shorebird and blue-winged teal migration period. Habitat for SJBP geese will be extremely limited and the quality will be degraded due to the delay in germination of annual plants on the flats.

The anticipated impacts of the alternatives that delay the fall drawdown are 1) a complete loss of fall mudflat habitat for the majority of shorebirds that migrate through the area; 2) a significant-to- complete loss of fall mudflat habitat for blue-winged teal; and 3) a significant loss or degradation of fall mudflat habitat for early migrating SJBP of Canada geese. Local population declines of shorebirds, blue-winged teal, and SJBP geese that migrate into the area are expected if the fall drawdown of Kentucky, Barkley, and Wheeler Reservoirs is delayed.

Approximately 300,000 ducks and geese, 100 bald eagles, and tens-of-thousands of other wetland-dependent migratory birds typically occur on Tennessee and Cross Creeks National Wildlife Refuges during the peak wintering period. It has been determined from our data collected during waterfowl surveys over the past 7 years that 56% of the duck use and 48% of the goose use on Tennessee NWR occurs on Kentucky Reservoir as compared to the use that occurs in our intensively managed waterfowl impoundments. Under the current reservoir operation policy, the winter pool elevation of Kentucky and Barkley Reservoirs is 354' MSL. This level fluctuates throughout the winter depending upon several factors but is largely influenced by rainfall. During most of the winter, extensive mudflats with important food resources are available for migratory birds.

Large numbers of waterfowl concentrate on the flats of the refuges to rest and feed. Canada geese and wigeon (*Anas americana*) browse on the annual plants that germinate each year during the late summer and fall drawdown period. Mudflats are the preferred habitat for green-winged teal (*Anas crecca*) within this area. When large expanses of flats are present, the majority of teal on the refuges will occur within this habitat. Greenwings forage on the seeds of annual plants that have been deposited on the flats in previous years, as well as insects and mollusks.

Bald eagles are regularly observed on the flats of Tennessee NWR and Wheeler NWR scavenging the carcasses of fish and waterfowl. As the drawdown occurs, fish occasionally get trapped in shallow waters and become an easy source of food for eagles. Gulls, terns, and wading birds utilize the flats of the reservoirs in large numbers throughout the drawdown and winter pool periods. The flats are primarily used for resting areas and are typically adjacent to shallow-water feeding sites.

We anticipate the alternatives that delay the fall drawdown (Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Equalized Summer/Winter Flood Risk Alternative, Tailwater Habitat Alternative, and the Tailwater Recreation Alternative) would significantly impact the amount and quality of forage produced by annual plants that germinate on the flats. Canada geese, wigeon, and green-winged teal are the waterfowl species that likely will be impacted the most because they are more dependant upon the vegetation grown on the flats.

The Commercial Navigation Alternative raises the minimum winter pool level 2 feet, from elevation 354' MSL to 356' MSL. This increase would permanently eliminate a large portion of the flats that occur on the refuge. The vast mudflats and shallow water areas that occur near the mouth of the Duck River on Tennessee NWR frequently support in excess of 50,000 ducks and geese. We expect that much of this important habitat would be flooded too deep for puddle ducks if winter pool levels are raised 2 feet. Under this alternative, the overall loss of winter mudflats would have significant negative impacts on several waterfowl species, primarily geese and puddle ducks. Bald eagles, gulls, terns, and wading birds would also suffer a significant loss in habitat.

Response to Comment 76: TVA appreciates this background information and the comments regarding migratory birds. The discussion of migratory birds has been expanded in the FEIS.

77. Migratory Birds in the Remainder of the Tennessee Valley

We are concerned about the potential for impacts to migratory birds by several of the alternatives described in the DEIS. Our primary concern is that all of the identified alternatives, except the “no action” alternative, would produce adverse impacts to habitats used by migrating shorebirds, especially foraging habitat areas of wading birds. This discussion and our recommendations are based on the premise that dam removal and river restoration are outside the scope of this study. Our comments and concerns would differ if this premise is inaccurate.

If an alternative other than the Base Case (no action) is selected and implemented, pool levels would be significantly altered during the peak shorebird migration period. Depending on precipitation and other factors, pool levels would be low, but most times too high to provide the kind of habitat available for them in most normal years. Either way, changes in current TVA operations policy would greatly reduce or potentially eliminate this habitat type for migrating shorebirds, as well as for resident and migrant waders that utilize these areas for foraging and roosting/resting. This is a significant change in the current operation and represents an unquantified impact on the birds that use these resources at this time of year. Reduction in habitat availability in the Tennessee Valley would require the birds currently utilizing this resource to locate and exploit a resource base in other areas. Little of the type and quality of this habitat exists in the region. This is especially true for the eastern part of the Tennessee Valley where limited suitable alternative habitat is available at this time of year (Chuck Nicholson, TVA, personal communication). Until baseline information is obtained, an unknown and perhaps unmitigable effect would be produced. Therefore, before any action other than the Base Case is considered for implementation, specific spatial and temporal information is needed for evaluation.

Unfortunately, we do not have comprehensive survey information for shorebirds across the TVA reservoir system. We do, however, know of several “hot-spots” such as Musick Campground on South Holston Reservoir, Rankin Bottoms on Douglas Reservoir, Savannah Bay on Chickamauga Reservoir, and Pace Point and Britton Ford areas on Kentucky Reservoir (which are within Tennessee NWR). In the past, notable numbers of shorebirds have also been reported from other sites such as the Town Creek area on Wilson Reservoir and the Swan Creek area on Wheeler Reservoir. These areas support from dozens to thousands of shorebirds during late summer-early fall during years of “normal” rainfall and reservoir operation. Typically, the lakes are being slowly drawn down during this time, providing expanses of moist mudflats coincident with the peak fall shorebird migration. Common species include killdeer (*Charadrius vociferus*), semipalmated plovers (*Charadrius semipalmatus*), greater yellowlegs (*Tringa melanoleuca*), lesser yellowlegs (*Tringa flavipes*), solitary sandpipers (*Tringa solitaria*), spotted sandpipers (*Actitis macularia*), pectoral sandpipers (*Calidris melanotos*), short-billed dowitchers (*Limnodromus griseus*), long-billed dowitchers (*Limnodromus scolopaceus*), least sandpipers (*Calidris minutilla*), Western sandpipers (*Calidris mauri*), and semipalmated sandpipers (*Calidris pusilla*). Other regularly occurring but less numerous species include black-bellied plovers (*Pluvialis squatarola*), stilt sandpipers (*Micropalama himantopus*), ruddy turnstones (*Arenaria interpres*), and other peeps. An occasional godwit and phalarope may also be encountered. Many of these areas also support large numbers of herons and egrets during late summer. Great blue herons (*Ardea herodias*) and great egrets (*Casmerodius albus*) are most numerous, and total counts are frequently in the hundreds.

There are significant data gaps that have not been addressed in the DEIS that need attention before informed decision-making and selection of an appropriate alternative can be completed. With regard to migratory birds and resident birds that use specific habitat areas for foraging and roosting, changes in habitat availability and quality will strongly correlate with changes in bird behavior, migration, foraging, resting, and energy expense during passage through and use of these habitats in the Tennessee Valley. We recommend that TVA address the following issues and information gaps before selection of a preferred alternative:

1. All known data on species occurrence, numbers, and current usage of late-season habitats should be compiled in lieu of comprehensive surveys for shorebird and wading bird use over the entire project area. Such a comprehensive picture of late-season habitats would allow for the evaluation of the overall impact of the various alternatives relative to the availability of other potential sites which would not be affected by changes in reservoir operations policy. This synthesis of information would provide a better means to understand the impact of the various alternatives on migratory birds.
2. Assess the theoretical potential for reservoir habitat loss and shorebird use with each alternative by modeling (Geographic Information System) effects of pool levels on habitat loss during the seasons most heavily utilized by shorebirds and waders, throughout the region.
3. Assess the potential to mitigate effects of potential loss of habitat through:
    a. Creation of other suitable habitats.
    b. Purchase of other suitable habitats.

c. Purchase and conversion of unsuitable habitat to suitable habitat (assuming the purchase isn't a high priority habitat for other valuable wildlife resources).

4. Evaluate the potential to avoid impact to certain high quality areas (e.g., Rankin Bottoms), and nominate these areas as Important Bird Areas.
5. Develop research programs to determine utilization of areas and impact of habitat loss to shorebird energetics during migration.
6. Develop a mitigation plan for loss of habitats.

Response to Comment 77: In part to address these concerns, TVA formulated its Preferred Alternative to largely leave unchanged operations on Kentucky and Barkley Reservoirs. Consequently, under the preferred alternative, there would be no noticeable effects on wildlife resources at these reservoirs or on Kentucky Reservoir's important flats. With regard to other specific sites throughout the Tennessee Valley region, the Preferred Alternative would not affect shorebird and wading bird resources on Chickamauga Reservoir and would have only limited impacts on shorebird and wading bird populations on Douglas Reservoir. The extension of summer pool levels on most mainstem reservoirs, however, would delay development of flats on Wheeler and Pickwick Reservoirs. Although existing operations limit the use of flats on these reservoirs until the latter half of the migratory season, an extended summer pool would aggravate this situation. TVA is considering several options to address these impacts (see Chapter 7).

78. <u>National Wildlife Refuge Infrastructure and Existing Habitat</u>

There are over 10,000 acres of managed waters within dozens of impoundments on Tennessee NWR, Cross Creeks NWR, and Wheeler NWR. Management emphasis in these impoundments is primarily focused on waterfowl, but many other wildlife species benefit from this valuable wetland habitat. During early spring, prior to the reservoirs being raised to summer pool, the water level in most of these impoundments is lowered to produce various foods for waterfowl.

A variety of habitats is provided in these impoundments, including agricultural crops, moist soil vegetation, and forested wetlands. Many of the impoundments are situated at a low elevation and do not have mechanical pumping capabilities. On these impoundments the water has to be removed when the reservoir is at winter pool. Even some of the impoundments with pumping capabilities are managed by gravity drawdown to reduce costs associated with their management.

The Commercial Navigation Alternative would raise the winter pool level 2 feet from elevation 354' MSL to 356' MSL on Kentucky Reservoir and from 554' MSL to 556' MSL on Wheeler Reservoir. This increase would greatly reduce the acreage that can be managed on all three refuges, especially on Cross Creeks NWR. Tennessee NWR and Wheeler NWR have pumping capabilities within several impoundments, but with an increase in the reservoir winter pool elevation, pumping costs would increase substantially or managed habitat acreage would be substantially reduced.

All of the managed impoundments on these refuges are subject to flooding. Spring floods are common and occur in most years. Management strategies on the refuges have adapted to this situation, and good quality waterfowl habitat is produced in spite of spring flooding. Early summer floods (June) are less common and do have adverse impacts on the quality and quantity of waterfowl habitats, especially the agricultural crops. Late summer and fall floods are very rare, but when they occur the impacts on these habitats generally result in a total loss of food production for the year. Winter floods are uncommon and usually only occur after January. The impacts from winter flooding to waterfowl foods have been limited in the past, but an early winter flood could cause most of the habitats to be unavailable to waterfowl due to the water depth. Floods in any season would cause significant damage to refuge infrastructure (e.g., levees, water control structures, roads, etc.).

All of the alternatives addressed in the DEIS would increase the risk and potential impacts of flooding on Tennessee NWR, Cross Creeks NWR, and Wheeler NWR above that of the Base Case. Depending on the preferred alternative and precipitation patterns in the Tennessee Valley, flooding risks may also be substantially increased on Wheeler NWR. To varying degrees and during different seasons of the year, each alternative would reduce flood storage within the Tennessee Valley System. Insufficient information is provided in the DEIS to determine the significance of the increased flood risk. When a preferred alternative is selected (if other than the Base Case), a detailed analysis of the flood risk for each refuge should be conducted so that an adequate assessment of the impacts can be made.

The scrub/shrub and forested wetlands that ring Kentucky, Barkley, and Wheeler Reservoirs provide important habitats for many species of fish, mammals, amphibians, reptiles, birds, and insects. These wetlands vary from narrow bands along the shoreline to extensive forests within the creek bottoms. From May to July, several thousands of acres of buttonbush (*Cephalanthus occidentalis*) and willow (*Salix* spp.) thickets are shallowly flooded while the reservoirs are at summer pool. Outside the summer pool period, primarily during the winter and spring, these wooded wetlands periodically flood during heavy rainfall events.

When the scrub/shrub and forested wetlands are flooded, waterfowl use these habitats extensively. Wood ducks require dense cover as brood habitat. The willow-buttonbush thickets provide an excellent overhead cover and at the same time are open enough at the water surface to allow the wood duck broods to move easily and feed on the numerous invertebrates that are present. These woody wetland thickets also provide valuable spawning and nursery habitat for a variety of fish and invertebrate species. During the winter and early spring when these habitats flood, mallards (*Anas platyrhynchos*), black ducks (*Anas rubripes*), and wood ducks move into these newly flooded areas to take advantage of a wide variety of food resources.

Many other species of birds utilize this riparian zone for nesting, foraging, and migration stopover habitat. Heron rookeries occur on islands and in bald cypress (*Taxodium distichum*) sloughs in several locations on Tennessee and Wheeler NWRs. The prothonotary warbler (*Protonotaria citrea*), a Partners In Flight (PIF) priority species within the Central Hardwoods and East Gulf Coastal Plains Bird Conservation Regions, is a relatively common breeding bird within the riparian zones of Kentucky, Barkley, and Wheeler Reservoirs. This warbler is limited to bottomland habitats and nests in cavities that are located over or very close to water.

The alternatives that delay the fall drawdown (Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Equalized Summer/Winter Flood Risk Alternative, Tailwater Habitat Alternative, and the Tailwater Recreation Alternative) are expected to have significant negative impacts on the scrub/shrub and forested wetlands along Kentucky, Barkley, and Wheeler Reservoirs. Depending on the preferred alternative and precipitation patterns within the Tennessee Valley, these impacts may also be expected to occur on Wheeler Reservoir. Extending the duration that these habitats are inundated during the growing season would dramatically shrink the willow-buttonbush, water tupelo, and bald-cypress plant communities and alter the plant composition of the bottomland hardwoods. The loss of the woody vegetation that is currently inundated at summer pool would negatively impact aquatic organism productivity. We anticipate that the productivity of the local wood duck populations and the quantity and quality of this wintering waterfowl habitat would also be reduced. We expect that the woody plant communities in this zone would be replaced by emergent aquatic plants that would not provide suitable spawning and nursery habitat, wood duck brood cover, or foraging areas for wintering waterfowl. In many cases, these emergent aquatic plant communities may be dominated by invasive exotic species such as alligatorweed (*Achyranthes philoxeroides*) and *Phragmites*.

Shoreline erosion is a major problem along Kentucky, Barkley, and Wheeler Reservoirs. The results are a loss of riparian and upland habitats and decreased water quality. Shoreline stabilization has become a high priority for Tennessee, Cross Creeks, and Wheeler NWRs to protect upland habitats and important archeological sites and to stabilize river islands. We are currently partnering with TVA to stabilize several sites on Tennessee NWR and anticipate this project to continue indefinitely. Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Tailwater Habitat Alternative, and Tailwater Recreation Alternative are listed in the DEIS as having the potential to accelerate the rate of shoreline erosion.

Response to Comment 78: Specific managed areas that could be affected are addressed in Section 4.14 and the possible effects on various features of such areas are analyzed in greater detail in discipline-specific sections—including Section 4.8 (Wetlands), Section 4.10 (Terrestrial Ecology), and Section 4.13 (Threatened and Endangered Species). Additional information about potential flooding in national wildlife refuges has been added to the FEIS.

79. The DOI, through the NPS, is mandated by Congress to oversee issues relating to our national parks, particularly "…to conserve the scenery and the natural and historic objects and the wildlife therein, and provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of this and future generations…" (National Park Service Organic Act of 1916). Several units of the National Park System, including Great Smoky Mountain National Park (GRSM), Chickamauga-Chattanooga National Military Park, Shiloh National Military Park, Natchez Trace Parkway, and the Trail of Tears National Historic Trail are, or could be, affected by TVA's reservoir operations. For example, GRSM continues to be negatively affected by airborne emissions from TVA's fossil generation, among other regional sources. Should hydro generation be altered such that fossil generation is increased, the air quality and related ecosystem problems in GRSM could be exacerbated. Bank erosion and other impacts associated with archeology and biota within the riparian corridor that result from hydrologic alterations (e.g., ramping) are issues of concern for all park units adjacent to TVA waters. Units of the National Park System are *not* currently listed in the ROS. Potential impacts to these units should be thoroughly evaluated and included in the final EIS.

Response to Comment 79: While some alternatives would result in slightly more fossil generation and others less, TVA does not believe that these slight potential emission changes would result in a substantial change in air quality (see Section 5.2). TVA's ongoing emissions control programs for nitrogen oxides and sulfur dioxide would continue to reduce TVA's impact on regional air quality.

Ramping rates would not increase under any of the alternatives. However, selection of any of the action alternatives would likely result in a minor increase in erosion rates in some areas. Based on an analysis of representative areas, TVA believes that similar effects, described in Section 5.16, would be experienced by units of the national park system.

80. In addition, a host of other federal laws, such as the Wild and Scenic Rivers Act, PL 90-542 and the Outdoor Recreation Act, PL 88-29, provide NPS with a mandate to look beyond the boundaries of the national parks in the interest of protecting the public's interests in river and outdoor recreation resources. In general, NPS has an interest in protecting and promoting natural resources, recreational opportunities, aesthetics, and historical and archeological resources. More specific to TVA operations, NPS interests lie in recreational access/facilities, instream flows for recreation and aquatic habitat conservation, riparian corridor protection, and natural streambank stability.

Response to Comment 80: Comment noted.

81. The NPS manages wetlands in compliance with Director's Order #77-1 which establishes standards and requirements for implementing E.O. 11990 and in compliance with Section 404 of the Clean Water Act. In following DO #77-1 the NPS is responsible for documenting any adverse impacts to wetland habitats including explanations on the final preferred alternative which will result in wetland losses or degradation. Therefore, the NPS should continue to be an integral part of the Interagency team to develop the final EIS and consideration should be given to direct, indirect and cumulative impacts to wetland habitats within and adjacent to NPS lands.

According to the ROS, approximately 183,000 acres of wetlands are within the projected groundwater influence area of the TVA reservoir system, therefore, there is the strong likelihood that wetlands associated with the operational changes of TVA reservoirs may significantly affect these aquatic habitats found on NPS lands within the Tennessee River system.

The DEIS identifies isolated wetlands as one type which is especially sensitive to groundwater alterations which could occur due to operational changes by TVA. The document also states that these wetlands have lost protection under the CWA due to the recent Supreme Court case decision (SWANCC 2000); however, the SWANCC decision was based on the definition of navigable waters and NPS defines wetlands based on the various parameters of soil, vegetation and hydrology as described in the U.S. Fish and Wildlife Services' *"Classification of Wetlands and Deepwater Habitats of the United States"* (FWS/OBS-79-31). The NPS guidance (Director's Order #77-1) which establishes requirements for the protection of wetlands, therefore, includes more wetland habitat types than those defined by the Corps including the protection of "isolated" wetland habitats. Wetland delineations on NPS lands must meet the requirements of the CWA, Section 404 and NPS wetland protection policies as required by Director's Order #77-1. The SWANCC decision eliminates many of the wetland types which will, however, continue to receive protection under the National Park Service definition of wetland habitats. Additionally, indirect adverse impacts to wetland habitat can result in increased flood risks and changes in visitor use due to alterations of water levels in upstream reservoirs which are located on adjacent rivers to park lands.

Response to Comment 81: National Wetland Inventory maps, which were developed by the USFWS using the Cowardin system (FWS/OBS-79-31), are the source of the wetland acreage data used in the EIS. The reference to the SWANCC decision was intended to identify the resulting loss of federal regulatory protection for certain types of wetlands and the associated increased risk of impacts.

For additional information on managed areas and ecologically significant sites and recreation, please see Sections 5.14 and 5.24.

82. Since the minimum flow regimes provided at certain tributary reservoir tailwaters were derived using FWS techniques, we point out that the techniques were intended to provide common ground for negotiated flow regimes and are not necessarily the cutting edge of river restoration science. The methodologies have deficiencies which must be understood by users, such as the rudimentary nature of minimum flow calculations, and the vintage of some techniques and curves. We suggest that with some additional refinements, science-based minimum flows within these tailwaters could render additional benefits to the tailwater aquatic and terrestrial communities. Elsewhere within the Tennessee Valley, the FWS has initiated the development of minimum flow regimes which offer seasonally-variable flows reflective of natural run-off characteristics. We also plan to measure aquatic and riparian responses to these events. These minimum flow regimes are more refined in terms of magnitude, duration, and timing of minimum flows, as well as peak flows, so that they may offer periodic pulses for sediment transport, trigger ecological processes, and serve as behavioral cues.

Response to Comment 82: In the late 1980s and early 1990s, TVA performed a variety of studies and consulted with several agencies—including USFWS and user groups—during the process of determining appropriate minimum flows downstream from the tributary dams. A concise description of the steps involved in this process was presented in an engineering technical article:

"We selected target minimum flows in a trade-off evaluation that considers four factors: (1) visual observation of flow tests, which shows what actually happens to the river at particular flow rates; (2) computer-modeled incremental physical changes with increased flow; (3) professional judgment of the benefits to aquatic life; and (4) assessment of impacts to recreation, upstream reservoir pools, and annual power production. The resulting minimum flow we chose ranged from 50% to 150% of the unregulated seven-day, 10-year low flow."

TVA worked closely with state water quality and resource management agencies throughout this process. The goal was to select minimum flow levels that would maximize benefits and minimize adverse effects for a wide variety of biological, recreational, water quality, and power production interests.

83. We recommend the development of a process to consider and/or reconsider in detail the minimum flow regime at specific tributary and mainstem tailwaters necessary to enhance aquatic and riparian systems, within system constraints (i.e., navigation, flood control, power generation, and recreation). This process should include the formation of an interdisciplinary team of scientists familiar with the tailwater systems and techniques for developing continuous minimum flow regimes. Key considerations should include timing of flows, magnitude, rate of change, and water quality (e.g., DO, thermal characteristics, etc.).

Response to Comment 83: The ROS is a programmatic review of the operations policy and is not intended to examine specific operations at specific facilities. TVA is committed to improving the quality of tailwaters, however, and is open to partnerships and recommendations that advance that goal. TVA would certainly want to participate on any inter-disciplinary team that undertakes a site-specific study of minimum flow needs.

84. We recommend the development and refinement of minimum flow regimes for the specific objective of benefiting tailwater fisheries and aquatic communities at tributary and mainstem reservoirs. There are remnants of significant natural communities which would benefit from this process in the tailwaters of Chatuge, Nottely, Cherokee, Douglas, and Blue Ridge Reservoirs. Since many of the existing minimum flow regimes are measured as a daily average, rather than instantaneous flow, we believe that significant benefits would accrue from refinements that provide continuous flows for aquatic and riparian communities. Additionally, we would like to develop a beneficial minimum flow regime for the bypassed reaches of stream at Appalachia and the Ocoee Reservoirs.

Response to Comment 84: See Responses to Comments 82 and 83. A minimum flow of 25 cubic feet per second (cfs) below Apalachia Dam was identified as an element of all of the ROS policy alternatives, including TVA's preferred alternative. However, providing continuous flows may not appropriately mimic natural flows. Before deciding to do this, further site-specific evaluations would be needed, as suggested by DOI in preceding comments.

TVA uses modeling to continue to evaluate minimum flow regimes for the benefit of tailwater fisheries and aquatic communities. Tailwater minimum flows are maintained at most TVA projects by routine pulsing. At some point downstream from dams, pulsed flows attenuate into a continuous minimum flow; however, the point of minimum flow attenuation varies by project. For projects with weir dams (like Chatuge), minimum flow is instantaneous at the weir dam; for larger, shallower tailwaters, the attenuation point may be further downstream. In the pulse-affected reaches of Chatuge and Cherokee tailwaters, cold summer-water temperatures are probably the limiting factor for aquatic communities. At Douglas Dam, pulsing proved to be more biologically beneficial for providing a greater minimum flow than releasing a continuous but smaller minimum flow.

85. The FWS has initiated a multi-year study of the effects of stream regulation on freshwater mussels, and we welcome the opportunity to include some of the TVA tributary and mainstem project tailwaters within the experimental design. The objective of this study is to develop methodologies necessary to evaluate the impacts of flow regime changes on these mussel populations. Freshwater mussels are the most critically endangered faunal group in the United States. The construction and operation of TVA dams have and continue to adversely affect many freshwater mussel populations, and in part, these facilities have been responsible for the extinction of several species. Although water quality and temperature of the discharges have and continue to impact some mussel populations, there is a growing body of evidence that altered hydrographs are the primary cause for the decline and endangerment of many species. In order to protect and enhance the remaining populations of mussels in the Tennessee Valley, we believe there is an urgent need to provide adequate flows. The ROS provides a unique opportunity to evaluate flow regimes necessary to sustain healthy mussel populations; however, there is no empirically based method for determining a flow regime suitable for mussels. We suggest a study conducted over a 5-year period which monitors behavioral and physiological attributes might provide the best means of evaluating the effects of changes in flow regimes on mussel populations. There are also opportunities for TVA to assist in an expanded study through funding and aquatic sampling at select TVA tailwaters.

Response to Comment 85: TVA has funded and provided sampling data for previous tailwater mussel studies, and would certainly be interested in cooperating in future studies.

86. It is unclear why hydroturbine ramping rates are not included in a comprehensive study of reservoir operations. Rapid ramping rates cause severe erosion, potentially impacting archeological and ecological resources.

Response to Comment 86: Changing ramping rates were included as an element of the Tailwater Habitat Alternative. Under the Preferred Alternative, ramping rates were not changed from the Base Case.

87. The metrics utilized in the DEIS evaluation of aquatic resources focused on DO, temperature, and reservoir hydrodynamics. As concluded in the DEIS, no policy alternative represents a clear benefit to reservoir aquatic resources. Based on water quality modeling performed to date, some degradation of the existing aquatic resources could be expected for several of the alternatives. The DEIS did not make a strong correlation between contiguous, adjacent, and peripheral wetland habitat types and sport fishery productivity. Many of these areas have the potential to change, due to increased water levels, and there could be significant effects to sport fishery spawning and nursery areas. The continued expansion of invasive aquatic emergent vegetation and non-native fish populations is also problematic for spawning and nursery wetland habitats.

Response to Comment 87: See Section 4.7.2. The control of invasive species is increasingly challenging to all agencies managing natural resources in this area (see Section 5.11).

88. The alternatives that delay the fall drawdown (Reservoir Recreation Alternative A, Reservoir Recreation Alternative B, Equalized Summer/Winter Flood Risk Alternative, Tailwater Habitat Alternative, and the Tailwater Recreation Alternative) are expected to have significant negative impacts on the scrub/shrub and forested wetlands along Kentucky, Barkley, and Wheeler Reservoirs.

Extending the duration that these habitats are inundated during the growing season will dramatically shrink the willow-buttonbush, water tupelo, and bald-cypress plant communities and alter the plant composition of the bottomland hardwoods. It is expected that the woody plant communities in this zone will be replaced by emergent aquatic plants. In many cases, these emergent aquatic plant communities may be dominated by invasive exotic species such as alligatorweed and *Phragmites*. We believe the final EIS should fully evaluate the potential changes in reservoir wetland habitat type associated with the preferred alternative. Those results should be considered in addition to the metrics evaluated in the DEIS and any refinement to the water quality model(s) once a preferred alternative is selected.

Response to Comment 88: Delayed drawdown alternatives are expected to result in impacts on some forested and scrub/shrub wetlands (see Section 5.8).

89. **Investigate additional fish and mussel restoration efforts at tributary and mainstem tailwaters**. There are opportunities to restore native fishes and fisheries through reintroductions at several tailwaters. TVA and the FWS have been involved with several successful reintroduction efforts. We encourage the continued involvement by TVA in these efforts.

Response to Comment 89: Comment noted.

90. **Enhance cold/cool-water tailwaters.** We recommend enhancement of aquatic conditions for native aquatic communities by provision of warmer water during summer, with less rapid daily fluctuations, and better oxygenation. Where increased water temperatures are not practical, measures could include cooperation with other agencies and organizations to enhance nearby streams that were fragmented by the construction and operation of TVA

Reservoirs. These streams have experienced limited colonization and smaller population sizes of their aquatic communities. Although the Fontana and Tims Ford projects provide a significant challenge in this regard, we recognize the significant impairments their deep, cold water releases and drastic fluctuations impose on the Lower Little Tennessee River and Elk River, respectively. The dominating effects of the operation of the Fontana and Tims Ford projects have tremendous implications for our ability to recover several listed species of fish and mussels. We expect TVA to continue to cooperate in the recovery of listed species where it can and to work with us to identify measures to overcome the continued impairment of the Lower Little Tennessee River and Elk River.

Response to Comment 90: This programmatic EIS does not address site-specific water temperature issues. Recovery of listed species is addressed in Sections 4.13 and 5.13.

91. Although the scope of the DEIS does not include facilities on the Duck River, we believe significant potential for improvement exists in the Normandy tailwaters. This is due in part to the existing multi-port release mechanism and the questionable condition of the managed trout fishery below Normandy Dam.

Response to Comment 91: Comment noted.

92. Provide fishways. There are opportunities to allow for upstream and downstream passage of fishes to enhance fish populations at mainstem and tributary reservoirs. The need for fishways for species such as lake sturgeon (*Acipenser fulvescens*), black buffalo (*Ictiobus niger*), smallmouth buffalo (*Ictiobus bubalus*), freshwater drum (*Aplodinotus grunniens*), sauger (*Stizostedion canadense*), walleye (*Stizostedion vitreum*), paddlefish (*Polyodon spathula*), and river redhorse (*Moxostoma carinatum*) could be estimated from cooperative review of existing and future fish sampling from seasons when species congregate at tailwaters, as well as presence/absence data from historical spawning areas. We recommend a systematic approach to providing efficient and timely fish passage at TVA facilities.

Response to Comment 92: The ROS is a programmatic study looking at policy changes on a system-wide basis. This suggestion could require structural modifications that are not being proposed by TVA. The fish species listed do not benefit from traditional fish ladder technology because they do not jump barriers. Moving these species around a dam would require a system without any form of barrier to navigate, which is not currently economically feasible. TVA does monitor technological advances in fish passage and would be willing to revisit this issue if a suitable technology was developed.

93. Develop an advanced schedule for decommissioning and dam removal. We recommend that TVA begin to identify and prioritize its dams/reservoirs for eventual removal. It is never too early to project a schedule for removal of these facilities and to plan for restoration of the natural riverine conditions of the Tennessee Valley. Parameters to consider are relative length of reaches potentially restored by dam removal(s), value of and alternate sources of energy provided by the hydroelectric generation capacity, connectivity/fragmentation of the river system, and the benefit to species and natural communities. For TVA developments with the least storage capacity, least generation capacity, and fewest reservoir-dependent neighbors, a tentative time line and plan for removal could be developed. It is important to begin limiting future dependency on these reservoirs sooner than later, reversing trends toward more dependency on their presence, while emphasizing alternate uses of a riverine ecosystem.

Response to Comment 93: As discussed in Chapter 3, removal or modification of TVA's dams is considered beyond the scope of the ROS and this EIS, whose purpose is to consider operational changes that would increase the public value of TVA's reservoir system. Removing dams, draining reservoirs, and disaggregating the reservoir system would be inconsistent with this purpose and would not increase the overall value of the system.

94. **Maintain Ecological Staffing**. We recognize the value of TVA's professional staff in guiding and implementing the ROS. We encourage you to maintain adequate staffing and funding in these areas, with a focus on continuity, science, and professionalism.

Response to Comment 94: Comment noted.

95. Based on the above considerations, the DOI encourages TVA to maintain its existing policy and conditions within the system by selection of the Base Case alternative presented in the DEIS. TVA has made a substantial investment in improving water quality and habitat conditions within its reservoirs and tailwaters over the years, and we believe that those improvements could be substantially compromised by a majority of the other alternatives.

Response to Comment 95: TVA's Preferred Alternative was formulated to address these and other issues.

U.S. Environmental Protection Agency Comments

August 20, 2003

Mr. David Nye
ROS Project Manager
Tennessee Valley Authority
400 West Summit Hill Drive, WT11A
Knoxville, TN 37902

SUBJ: EPA Comments on the TVA DPEIS for the "Tennessee Valley Authority Reservoir Operations Study"; Greater Tennessee Valley (AL, GA, KY, MS, NC, TN & VA); CEQ No. 030303

Dear Mr. Nye:

The U.S. Environmental Protection Agency (EPA) has reviewed the referenced Tennessee Valley Authority's (TVA) Draft Programmatic Environmental Impact Statement (DPEIS) in accordance with our responsibilities under Section 102(2)(C) of the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act. The purpose of the subject document is to determine if any policy changes in TVA's reservoir operations are appropriate for greater public value. Operating objectives considered were navigation, flood control, power generation, water supply, water quality, recreation and other benefits. We appreciate TVA's presentations to EPA regarding this study, introducing it to us in March 2002, presenting water quality modeling conclusions to us and other agencies in April 2003, and presenting the DPEIS to us in July 2003. **[1]**

Seven river operations policy alternatives were considered by TVA in the DPEIS. The performances of the six action alternatives were designed to enhance certain operational aspects for public benefit and were compared against the *Base Case* (existing operating procedures) alternative. These six action policy alternatives were the Reservoir Recreation A Alternative (*Reservoir Rec A*) which would enhance flatwater (reservoir) recreation by maintaining summer pool levels longer; the Reservoir Recreation B Alternative (*Reservoir Rec B*) which would emphasize recreational benefits more than Reservoir Rec A, the Summer Hydropower Alternative (*Summer Hydro*) which would allow unrestricted drawdowns earlier to concentrate hydropower electric generation in the summer to help accommodate peak power demands; the Equalized Summer/Winter Flood Risk Alternative (*Equalized Flood Risk*) which would equalize the flood risk throughout the year, decreasing risk slightly in summer but increasing it slightly in winter; the Commercial Navigation Alternative (*Commercial Navigation*) which would enhance navigation by elevating water levels to allow greater vessel drafts for heavier cargo; the Tailwater Recreation Alternative (*Tailwater Rec*) which would increase whitewater recreational opportunities below the dam by releasing greater and more predictable volumes downstream; and the Tailwater Habitat Alternative (*Tailwater Habitat*) which would release additional flows at variable rates to simulate more natural, riverine conditions and enhance downstream aquatic habitats. TVA did not identify a preferred alternative in the DPEIS.

EPA has concentrated its review of the DPEIS on water quality and related areas such as wetlands, water supply and hydropower generation, as opposed to recreational, navigational and economic aspects. In addition to the enclosed *Detailed Comments,* we offer the following summary comments for TVA's consideration in the development of the Final PEIS (FPEIS) together with its cooperators, the U.S. Army Corps of Engineers (COE) and the U.S. Fish and Wildlife Service (FWS): **[2]**

o ENVIRONMENTAL IMPACTS

We offer the following summary comments on water quality, wetlands, water supply and hydropower. Our comments are made from a water quality perspective relative to the policy alternatives presented. Additional water quality aspects (assimilative capacity, anoxia, chlorophyll *a*, and soil erosion) are considered in the enclosed *Detailed Comments*. **[3]**

- Water Quality - Overall (Table ES-01), water quality would not be benefited by the performance of most of the policy action alternatives compared to the Base Case. Most policy alternatives would increase reservoir residence (retention) times (pg. 5.4-16). Those alternatives that propose holding water longer than the Base Case (e.g., Reservoir Rec A&B) would store water longer under lake conditions during hot summer days. This would result in longer periods of lake stratification, low DO levels, higher chlorophyll *a* levels (if sufficient nutrients are present), and possibly nuisance or invasive species such as Eurasian milfoil. Reservoir water temperatures may also be warmer on average, which would reduce the DO saturation capability of the impounded waters. Low DO waters have also been associated (pg. 5.4-20) with the mobilization of anoxic products (such as iron, manganese, sulfides and ammonia) from sediments. Once normal drawdowns are allowed for the Reservoir Rec A&B Alternatives, these reservoir releases characterized by low DOs and anoxic products would occur a greater number of days per year than currently and would inundate and adversely affect downstream aquatic habitats. By comparison, those alternatives that increase the release of downstream waters (e.g., Tailwater Rec and Tailwater Habitat) could also have negative water quality effects. That is, the increased flows could result in downstream erosion as well as the release of greater volumes of low DO waters. The performance of most other alternatives also did not favor water quality or would produce no change, although aspects of the Summer Hydro and Commercial Navigation Alternatives would be beneficial. **[4]**

- Wetlands - Based on Table ES-01, the performance of the majority of the policy alternatives would have an overall adverse effect on wetlands, or specifically on wetland type. Wetland losses would tend to occur due to their exposure (lower reservoir pool levels or reduced releases downstream) or inundation (greater pool levels or greater releases). With the implementation of a new policy alternative, it may be assumed that over time a system equilibrium would eventually be reached under the new water regime (if shallow flooded areas were to generate new wetlands to help offset wetlands losses elsewhere). However, since many shorelands are no longer natural due to shoreline development (retainer walls), wetland gains may not equal losses. In addition, the value (function, type and location) of the wetlands lost or gained may be different. For example, the loss of reservoir forested wetlands due to their dessication in low pool reservoirs would be considered a greater loss than the downstream gain of herbaceous wetlands due to greater releases. We note that only the Commercial Navigation Alternative showed no change relative to wetlands, although the Reservoir Rec A&B Alternatives and the Tailwater Rec and Habitat Alternatives would benefit wetland function and location (but not type). **[5]**

- Water Supply **-** Although water supply delivery would generally be benefited (no cost) by the alternatives (except for an adverse effect by the Summer Hydro Alternative due to intake modification costs), a general decrease in system water quality would have an adverse effect on water supply quality and treatment costs. Based on Table ES-02, only the Summer Hydro and the Commercial Navigation Alternatives would show no change in water supply quality. **[6]**

- Hydropower - Although not without downstream aquatic impacts, EPA recognizes that hydropower is a renewable form of energy useful for generating peaking and baseload power. Due to operational changes from the Base Case involving pool levels and downstream releases, some of the policy action alternatives would increase hydropower use (i.e., decrease electricity generation by non-hydropower means) and thereby decrease annual air emissions from TVA's electric generation (e.g., NOx, SOx, PM and mercury emissions). This would be particularly true for the Tailwater Habitat Alternative (Table 5.2-01). Compared to the Base Case, the Summer Hydro Alternative would annually decrease hydropower use, although it would increase its use during summer peaking and periods of ozone formation. **[7]**

o CONCLUSIONS & RECOMMENDATIONS

The concept of considering a change from the Base Case in the operation of TVA's reservoir system for public benefit is a sound one. Operational objectives considered included recreation, flood risk, summer hydropower, navigation and tailwater habitat. Upon EIS analysis, however, it appears that such enhancements would have environmental tradeoffs (slightly to substantially adverse impacts, with the exception of the Commercial Navigation Alternative). From a water quality perspective, the presented policy alternatives generally do not favor water quality overall or necessarily related areas such as wetlands. The DPEIS in fact has grouped the alternatives into three categories and concluded (pg. 3-36) that they would either produce water quality impacts, substantial environmental impacts or be somewhat neutral. Accordingly, EPA suggests that one of the following approaches be considered in the FPEIS: **[8]**

- Base Case - Given the overall impacts of the policy action alternatives compared to the Base Case, continuation of the Base Case should be considered. However, environmental and engineering improvements should be continued to further refine TVA's existing operational policy where appropriate. These actions should include elevating reservoir DO levels, increasing downstream releases, water quality monitoring, shoreline management, adaptive management and other upgrades such as the ongoing refurbishing and upgrading of TVA's hydropower turbines (pg. 2-7) to produce more power more efficiently with apparently minimal additional impacts. Similar to the Base Case, the Commercial Navigation Alternative could also be selected since it would not change (have adverse or beneficial environmental impacts) from the Base Case. **[9]**

- Tailwater Habitat Alternative - Although not without impacts, this alternative has some environmental merit. Under this scenario, more water would be released in variable volumes to downstream environments such that the current impounded system would return to a more riverine condition. Hydropower ramping rates would apparently also be changed to modify pulsing flows during periods of generation such as peaking. This change in water volume and in the timing and duration of flows would benefit downstream wetlands (function and location) and aquatic flora and fauna in general, and increase the wetted areas for fish spawning. More riverine conditions would also likely limit the conditions conducive to the eutrophication of chlorophyll *a* and nuisance species in the sense that waters would be more lotic than in the Base Case, as long as water was seasonally available. Since the DPEIS (pg. 3-21) reports that structural changes such as presumed dam removals are not options, the Tailwater Habitat Alternative could be used to nevertheless approach more riverine conditions. From a practical perspective, this alternative would also increase hydropower (reducing air emissions) and whitewater recreation, which are both economically beneficial to TVA. We also assume that basic TVA requirements for flood control and navigation would be satisfied with this alternative. **[10]**

However, as is generally the case for the policy alternatives, the Tailwater Habitat Alternative is predicted to have an overall adverse effect on water quality. Table ES-02 indicates an adverse effect on anoxic conditions (despite having a beneficial effect on assimilative capacity). The FPEIS should therefore offer methods to potentially mitigate these anoxic conditions. For example, additional bottom aeration devices may be needed in the forebays of selected dams or all dams, including aeration devices at Melton, Hill, Guntersville, Pickwick and Kentucky reservoirs which currently do not have any augmentation. Other forms of aeration (damsite aspiration, tailrace aeration, etc.) may also be tried in order to increase the DO levels in downstream releases and inhibit the mobilization of anoxic products. **[11]** Similar to water quality, the Tailwater Habitat Alternative would also generally have an overall adverse effect on wetlands – specifically on wetland type, since wetland function and location would be benefitted. The FPEIS should offer possible actions to mitigate impacts on wetland type, which may be difficult if the loss (exposure) of forested wetlands results from the implementation of the alternative. Mitigation for shoreline soil erosion downstream should also be explored in the FPEIS since this alternative was predicted to have an adverse effect on reservoir and tailwater shorelines. Mitigation might include rip-rap retainer walls in scour areas or in-stream structures that reduce erosion and dissipate wave energy. **[12]**

➢ Hybrid Alternative - Potential refinements of one or more DPEIS-presented policy alternatives to form a hybrid alternative may also be possible. Such hybrids should be designed to reduce identified environmental impacts but still have more of a public enhancement benefit than the Base Case. For example, if enhancement of reservoir recreation is targeted by TVA, the water quality lake effects of increased residence times (low DO, anoxia, anoxic products, warmer temperature, higher chlorophyll, invasive/nuisance species, etc.) should be minimized, mitigated or balanced against recreational benefits that are somewhat reduced. For example, if Reservoir Rec A or B is selected in the FPEIS, the document should discuss and recommend mitigative methods to help offset the water quality effects of longer lake storage and/or perhaps not hold reservoir water at a higher pool as long to lessen water quality impacts of the alternative. **[13]**

o SUMMARY

The enhancement of public benefits relative to the Base Case proposed by the policy alternatives would involve varying environmental tradeoffs. Accordingly, if a policy alternative is selected by TVA, the FPEIS should document how these tradeoffs will be addressed through modifying the alternative and/or mitigating the environmental impacts. In addition to consideration of the Base Case (with further refinements), we recommend consideration of the Tailwater Habitat Alternative (with mitigation) or a hybrid alternative that minimizes impacts but still provides more enhancement than the Base Case. **[14]**

o EPA DEIS RATING

EPA rates this DEIS as "EC-2" (Environmental Concerns, additional information requested). We primarily base this rating on the potential for water quality impacts of the proposed policy alternatives, and our information requests regarding the further refinement and/or mitigation of the Base Case, Tailwater Habitat Alternative, or a hybrid alternative.

Thank you for the opportunity to provide comments on the DPEIS. Should you have questions regarding our comments, the staff contact for this project is Chris Hoberg who can be reached directly at 404/562-9619.

Sincerely,

Heinz J. Mueller, Chief
Office of Environmental Assessment
Environmental Accountability Division

Enclosure - *Detailed Comments*

DETAILED COMMENTS

EPA offers the following detailed comments on water quality, wetlands, hydropower, document quality and other aspects.

o ENVIRONMENTAL IMPACTS

➢ **Water Quality** - Overall, water quality would not be benefited by the performance of most of the policy action alternatives compared to the Base Case. The following water quality aspects were reviewed:

* Water Quality Effects - Table ES-01 summarizes the overall performance of the policy alternatives by public objective. For the water quality objective (*improving water quality in reservoirs and tailwaters*), all action alternatives were rated as having the potential for adverse water quality impacts when compared to the Base Case. Using the impact descriptors in this table, the action alternatives might be ranked (overall impacts – worst to best) as follows: Tailwater Habitat (*adverse*), Reservoir Rec B (*slightly to substantially adverse*), Reservoir Rec A (*slightly adverse to adverse*), Summer Hydro (*adverse to beneficial*), Tailwater Rec (*no change to substantially adverse*), Equalized Flood Risk (*no change to adverse*), and Commercial Navigation Alternative (*no change* to *slightly beneficial*).

* Assimilative Capacity & Anoxia - The potential for the assimilative capacity and anoxic conditions was summarized in Tables ES-01 for storage, transitional and mainstem reservoirs. In general, changing the Base Case would generate greater potential for anoxia, although not for every action alternative. In this table, most action alternatives were rated as *adverse*, *substantially adverse*, *slightly adverse*, *variable*, or *no change to slightly adverse*. Only the Commercial Navigation, Equalized Flood Risk and Summer Hydro Alternatives were predicted to show a more positive *no change*, *no change to slightly beneficial*, *variable*, *slightly beneficial*, or *substantially beneficial* condition for the three types of reservoirs.

Regarding the assimilative capacity of the three types of reservoir in the TVA system, a change from the Base Case would result in either a benefit, adverse impact or no change (Table ES-02). Specifically, impact descriptors for effects on storage tributaries were *beneficial*, *slightly beneficial*, *variable* or show *no change*; for effects on transitional tributaries were *slightly adverse*, *no change to slightly adverse*, or show *no change*; and for effects on mainstem reservoirs showed *no change*. Benefited storage reservoirs were associated with the implementation of the Reservoir Rec A, Reservoir Rec B, Tailwater Rec and Tailwater Habitat Alternatives.

* Chlorophyll *a* - Chlorophyll or algal levels in aquatic environments serve as a surrogate or indicator of water quality pollution due to reservoir nutrient levels. Alternatives extending lake residence times can elevate chlorophyll *a* concentrations while those enhancing flows can reduce concentrations. Since most alternatives would increase retention times (pg. 5.4-16), chlorophyll *a* levels would tend to increase with a change from the Base Case. The DPEIS suggests these increases would be generally small "...with a maximum increase less than 10 percent." The FPEIS should discuss the ecological

significance of such increases with emphasis on any reservoirs with elevated existing levels. In any event, it can be assumed that any increase in chlorophyll *a* concentrations would not indicate water quality maintenance or improvement.

***** Soil Erosion - Since soil erosion also affects water quality through turbidity and downstream siltation, it was also considered in our review. Based on Table ES-01, the overall performance of the action alternatives were related to the soil erosion objective (*minimizing erosion of reservoir shoreline and tailwater banks*). This table predicts that the Reservoir Rec A, Reservoir Rec B, Tailwater Rec and Tailwater Habitat Alternatives would show an erosion potential (*slightly adverse* or *slightly adverse to adverse*) while the Summer Hydro and Equalized Flood Risk Alternatives were to show no change or some benefit (*no change* or *no change to slightly beneficial*). Table ES-02 dissects these data into reservoir versus tailwater shoreline effects. The Summer Hydropower and Equalized Flood Risk Alternatives were predicted to benefit (reduce) shoreline erosion for reservoirs (*slightly beneficial*) and produce *no change* in the erosion of tailwater shorelines.

***** Wetlands - Wetlands also affect water quality by providing a water treatment function. Wetland impacts are further discussed below.

***** Water Quality Modeling - EPA appreciated being invited to the TVA water quality presentation made to several agencies in Knoxville on April 15, 2003, regarding TVA's modeling conclusions on the study (*Preliminary Water Quality Results for Reservoir Operations Study*). Although an extensive amount of water quality work was performed, the DPEIS only summarizes it in general terms without presenting details. The FPEIS should provide sufficient water quality modeling detail to distinguish differences among policy alternatives. **[15]**

➢ **Wetlands** - For the public objective involving wetland protection (*protecting and improving wetlands and other ecologically sensitive areas*), Table ES-01 indicates that the potential for adverse impacts exists through implementation of most of the action alternatives, with only the Commercial Navigation Alternative showing *no change* relative to wetlands. Based on Table ES-01, the policy alternatives might be ranked (overall impacts – worst to best) as follows: Summer Hydro (*substantially adverse*), Equalized Flood Risk (*adverse to substantially adverse*), Reservoir Rec B (*adverse to slightly beneficial*), Reservoir Rec A/Tailwater Rec/Tailwater Habitat (*slightly adverse to slightly beneficial*) and Commercial Navigation Alternative (*no change*).

Table ES-02 more specifically considers impacts to the location, type and function of wetlands. In such an analysis, the two recreational enhancement alternatives (Reservoir Rec A&B) and the two Tailwater alternatives (Tailwater Rec and Tailwater Habitat) would benefit (*slightly beneficial* or *slightly beneficial to beneficial*) wetland location and function. Wetland type, however, would not be benefited by these four alternatives (*adverse (variable)* or *slightly adverse (variable)*) which would make the overall wetland impact adverse as presented in Table ES-01 and discussed above. The Commercial Navigation Alternative is the only alternative that would not impact wetland type since it is predicted to show *no change*. **[16]**

➢ **Hydropower -** The Summer Hydro Alternative maximizes summer hydropower generation for peaking purposes. On an annual basis, however, it would result in a reduction of hydropower and a consequential increase in air emissions from fossil fuel power plants. Although the emissions would increase, it should be noted that emissions (including ozone precursors such as NOx) should be less than the Base Case during the summer. This is significant since conditions are ripe for ozone formation during the summer. Although the DPEIS discusses this benefit (pg. 6-3), ozone is not specifically mentioned. The FPEIS should discuss the value of less summertime air emissions relative to ozone formation in the Tennessee Valley. **[17]**

o OTHER COMMENTS

➢ **Ramping Rates** - Page 3-20 states that "[c]hanging ramping rates was included as an element of the Tailwater Habitat Alternative" and page 3-8 states that there would be "no turbine peaking allowed." The FPEIS should further discuss how this would affect downstream aquatics versus hydropower generation during peaking. **[18]**

➢ **Structural Changes** - Page 3-21 indicates that structural changes, such as the presumed removal or modification of dams and levees, was not carried forward in the DPEIS as a component to any of the policy alternatives. However, all such structures have a finite project life. Are any TVA owned or operated dams nearing the end of their project life? Would TVA refurbish or remove such facilities? The FPEIS should discuss the TVA policy and any candidate sites. **[19]**

➢ **Document Quality** - Although the DPEIS was well organized, the nature of the subject matter is complex since enhancement of one benefit for a given alternative often resulted in a tradeoff of other benefits. In order to facilitate public readability and review of the FPEIS, we recommend the following modifications: **[20]**

* Designed Enhancements - Page 1-9 and 1-10 indicate that based on the scoping process, the top three public priorities were recreational benefits, environmental protection and flood control, while the public priorities at the workshops were environmental protection, power production and water supply. Given that environmental protection was the first or second priority for the public, it is somewhat surprising that essentially only one alternative (Tailwater Habitat) was analyzed that would enhance the environment (by comparison, three alternatives would enhance recreation). **[21]**

* Study Objectives - The study objectives provided by the public during the scoping process are listed on page 1-12. Although most are self explanatory, the FPEIS would be improved if some definitions were provided. For example, the objective for *improving aquatic habitat in reservoirs and tailwaters* might suggest increasing submerged aquatic vegetation in both the downstream tailwater area and in the littoral zone of the reservoir. However, an adverse impact to this objective might not only imply a *reduction* in submerged aquatic vegetation but also an *increase* in invasive species such as Eurasian milfoil or a pollution indicator species such as chlorophyll *a*. Where appropriate, the FPEIS should clarify the objectives through textual discussion or tabular footnotes to better describe the objectives being considered. **[22]**

* Impact Descriptors - Tables ES-01 and ES-02 present impact descriptors for various identified public study objectives or impact categories by alternative. In general, Table ES-02 is more specific than Table ES-01 since it dissects data (e.g., wetland impacts are divided into wetland location type and

function), so that the impact descriptors in Table ES-01 seem to be a composite of various components in Table ES-02 (we note that this resulted in some wide-ranging conclusions such as a *slightly adverse to slightly beneficial* effect that appear confusing). However, in the case of the public study objective for water quality (*improving water quality in reservoirs and tailwaters*), the impact descriptors for the various water quality aspects considered in Table ES-02 (assimilative capacity and anoxia in tributary and mainstem reservoirs) do not relate to those descriptors used in Table ES-01 (i.e., are not a composite of the descriptors used in Table ES-01). The FPEIS should discuss this and the basis for the descriptors used in Table ES-01 for water quality.

We also note from Table ES-02 that even though the Tailwater Habitat Alternative (for storage tributaries) was predicted to be *beneficial* for assimilative capacity, its performance was considered *adverse* for anoxia. The FPEIS should discuss why this was predicted. Can the same system be beneficial for one and adverse for the other? **[23]**

* <u>Significance</u> - In addition to clarifying impact descriptors, the basis of these conclusions should be further discussed. Although Tables ES-01 and ES-02 are intended to be summary tables, the text (Chapter 5) should further explain how these conclusions were reached and summarized in the tables. For example, page 5.4-13 states that "...mainstem reservoirs would experience an increase in volumes of water with low DO concentrations under Reservoir Rec Alternative B relative to the Base Case..." We suggest that such conclusory statements be substantiated, such as "...mainstem reservoirs would experience an increase in volumes of water with low DO concentrations under Reservoir Rec B Alternative relative to the Base Case <u>since reservoir residence times would be longer</u>." Without such discussion, some of the conclusions in tables are not always intuitive and may even seem counterintuitive. **[24]**

* <u>Typographical</u> - We note that Table 5.2-01 may contain an error. The first column of this table presents an increase (+) of 298,810 MW hours of non-hydro generation for the Tailwater Habitat Alternative. However, given that the emissions are predicted to be decreased (-) for this alternative, the 298,810 MW hour figure should presumably also be negative to indicate a decrease in MW hours of non-hydro generation and to account for the decreased emissions. This should be modified or discussed in the FPEIS. EPA has assumed this value to be a negative 298,810 (-298,810) in our hydropower review. **[25]**

RESPONSE TO COMMENTS

1. We appreciate TVA's presentations to EPA regarding this study, introducing it to us in March 2002, presenting water quality modeling conclusions to us and other agencies in April 2003, and presenting the DPEIS to us in July 2003.

Response to Comment 1: Comment noted.

2. Seven river operations policy alternatives were considered by TVA in the DPEIS. The performances of the six action alternatives were designed to enhance certain operational aspects for public benefit and were compared against the Base Case (existing operating procedures) alternative. These six action policy alternatives were the Reservoir Recreation A Alternative (Reservoir Rec A) which would enhance flatwater (reservoir) recreation by maintaining summer pool levels longer; the Reservoir Recreation B Alternative (Reservoir Rec B) which would emphasize recreational benefits more than Reservoir Rec A, the Summer Hydropower Alternative (Summer Hydro) which would allow unrestricted drawdowns earlier to concentrate hydropower electric generation in the summer to help accommodate peak power demands; the Equalized Summer/Winter Flood Risk Alternative (Equalized Flood Risk) which would equalize the flood risk throughout the year, decreasing risk slightly in summer but increasing it slightly in winter; the Commercial Navigation Alternative (Commercial Navigation) which would enhance navigation by elevating water levels to allow greater vessel drafts for heavier cargo; the Tailwater Recreation Alternative (Tailwater Rec) which would increase whitewater recreational opportunities below the dam by releasing greater and more predictable volumes downstream; and the Tailwater Habitat Alternative (Tailwater Habitat) which would release additional flows at variable rates to simulate more natural, riverine conditions and enhance downstream aquatic habitats. TVA did not identify a preferred alternative in the DPEIS.

EPA has concentrated its review of the DPEIS on water quality and related areas such as wetlands, water supply and hydropower generation, as opposed to recreational, navigational and economic aspects. In addition to the enclosed Detailed Comments, we offer the following summary comments for TVA's consideration in the development of the Final PEIS (FPEIS) together with its cooperators, the U.S. Army Corps of Engineers (COE) and the U.S. Fish and Wildlife Service (FWS):

Response to Comment 2: Comment noted.

3. We offer the following summary comments on water quality, wetlands, water supply and hydropower. Our comments are made from a water quality perspective relative to the policy alternatives presented. Additional water quality aspects (assimilative capacity, anoxia, chlorophyll a, and soil erosion) are considered in the enclosed Detailed Comments.

Response to Comment 3: Comment noted.

4. ➢ Water Quality - Overall (Table ES-01), water quality would not be benefited by the performance of most of the policy action alternatives compared to the Base Case. Most policy alternatives would increase reservoir residence (retention) times (pg. 5.4-16). Those alternatives that propose holding water longer than the Base Case (e.g., Reservoir Rec A&B) would store water longer under lake conditions during hot summer days. This would result in longer periods of lake stratification, low DO levels, higher chlorophyll a levels (if sufficient nutrients are present), and possibly nuisance or invasive species such as Eurasian milfoil. Reservoir water temperatures may also be warmer on average, which would reduce the DO saturation capability of the impounded waters. Low DO waters have also been associated (pg. 5.4-20) with the mobilization of anoxic products (such as iron, manganese, sulfides and ammonia) from sediments. Once normal drawdowns are allowed for the Reservoir Rec A&B Alternatives, these reservoir releases characterized by low DOs and anoxic products would occur a greater number of days per year than currently and would inundate and adversely affect downstream aquatic habitats. By comparison, those alternatives that increase the release of downstream waters (e.g., Tailwater Rec and Tailwater Habitat) could also have negative water quality effects. That is, the increased flows could result in downstream erosion as well as the release of greater volumes of low DO waters. The performance of most other alternatives also did not favor water quality or would produce no change, although aspects of the Summer Hydro and Commercial Navigation Alternatives would be beneficial.

Response to Comment 4: TVA considered the potential impacts on water quality while formulating its Preferred Alternative to reduce the risk of adverse impacts associated with the alternatives identified in the DEIS.

5. ➢ Wetlands - Based on Table ES-01, the performance of the majority of the policy alternatives would have an overall adverse effect on wetlands, or specifically on wetland type. Wetland losses would tend to occur due to their exposure (lower reservoir pool levels or reduced releases downstream) or inundation (greater pool levels or greater releases). With the implementation of a new policy alternative, it may be assumed that over time a system equilibrium would eventually be reached under the new water regime (if shallow flooded areas were to generate new wetlands to help offset wetlands losses elsewhere). However, since many shorelands are no longer natural due to shoreline development (retainer walls), wetland gains may not equal losses. In addition, the value (function, type and location) of the wetlands lost or gained may be different. For example, the loss of reservoir forested wetlands due to their desiccation in low pool reservoirs would be considered a greater loss than the downstream gain of herbaceous wetlands due to greater releases. We note that only the Commercial Navigation Alternative showed no change relative to wetlands, although the Reservoir Rec A&B Alternatives and the Tailwater Rec and Habitat Alternatives would benefit wetland function and location (but not type).

Response to Comment 5: TVA's Preferred Alternative would reduce the potential impacts on wetlands relative to the impacts associated with the action alternatives described in the DEIS. See Section 3.3.9.

6. ➢ Water Supply - Although water supply delivery would generally be benefited (no cost) by the alternatives (except for an adverse effect by the Summer Hydro Alternative due to intake modification costs), a general decrease in system water quality would have an adverse effect on water supply quality and treatment costs. Based on Table ES-02, only the Summer Hydro and the Commercial Navigation Alternatives would show no change in water supply quality.

Response to Comment 6: See Response to Comment 4.

7. ➢ Hydropower - Although not without downstream aquatic impacts, EPA recognizes that hydropower is a renewable form of energy useful for generating peaking and baseload power. Due to operational changes from the Base Case involving pool levels and downstream releases, some of the policy action alternatives would increase hydropower use (i.e., decrease electricity generation by non-hydropower means) and thereby decrease annual air emissions from TVA's electric generation (e.g., NOx, SOx, PM and mercury emissions). This would be particularly true for the Tailwater Habitat Alternative (Table 5.2-01). Compared to the Base Case, the Summer Hydro Alternative would annually decrease hydropower use, although it would increase its use during summer peaking and periods of ozone formation.

Response to Comment 7: TVA formulated its Preferred Alternative to reduce the potential impact on hydropower generation values, relative to the action alternatives in the DEIS. See Section 3.3.9.

8. The concept of considering a change from the Base Case in the operation of TVA's reservoir system for public benefit is a sound one. Operational objectives considered included recreation, flood risk, summer hydropower, navigation and tailwater habitat. Upon EIS analysis, however, it appears that such enhancements would have environmental tradeoffs (slightly to substantially adverse impacts, with the exception of the Commercial Navigation Alternative). From a water quality perspective, the presented policy alternatives generally do not favor water quality overall or necessarily related areas such as wetlands. The DPEIS in fact has grouped the alternatives into three categories and concluded (pg. 3-36) that they would either produce water quality impacts, substantial environmental impacts or be somewhat neutral. Accordingly, EPA suggests that one of the following approaches be considered in the FPEIS:

Response to Comment 8: Comment noted.

9. ➢ Base Case - Given the overall impacts of the policy action alternatives compared to the Base Case, continuation of the Base Case should be considered. However, environmental and engineering improvements should be continued to further refine TVA's existing operational policy where appropriate. These actions should include elevating reservoir DO levels, increasing downstream releases, water quality monitoring, shoreline management, adaptive management and other upgrades such as the ongoing refurbishing and upgrading of TVA's hydropower turbines (pg. 2-7) to produce more power more efficiently with apparently minimal additional impacts. Similar to the Base Case, the Commercial Navigation Alternative could also be selected since it would not change (have adverse or beneficial environmental impacts) from the Base Case.

Response to Comment 9: TVA developed the Preferred Alternative in response to these and other issues, and also investigated the kind of adjustments described in the comment that could be made to the Base Case. Unfortunately, TVA was unable to effectively address the general public desire for enhanced recreational opportunities with this approach. TVA believes that the Preferred Alternative identified in the FEIS does appropriately address the concerns expressed in the comment.

10. ➢ Tailwater Habitat Alternative - Although not without impacts, this alternative has some environmental merit. Under this scenario, more water would be released in variable volumes to downstream environments such that the current impounded system would return to a more riverine condition. Hydropower ramping rates would apparently also be changed to modify pulsing flows during periods of generation such as peaking. This change in water volume and in the timing and duration of flows would benefit downstream wetlands (function and location) and aquatic flora and fauna in general, and increase the wetted areas for fish spawning. More riverine conditions would also likely limit the conditions conducive to the eutrophication of chlorophyll a and nuisance species in the sense that waters would be more lotic than in the Base Case, as long as water was seasonally available. Since the DPEIS (pg. 3-21) reports that structural changes such as presumed dam removals are not options, the Tailwater Habitat Alternative could be used to nevertheless approach more riverine conditions. From a practical perspective, this alternative would also increase hydropower (reducing air emissions) and whitewater recreation, which are both economically beneficial to TVA. We also assume that basic TVA requirements for flood control and navigation would be satisfied with this alternative.

Response to Comment 10: See Response to Comment 9.

11. However, as is generally the case for the policy alternatives, the Tailwater Habitat Alternative is predicted to have an overall adverse effect on water quality. Table ES-02 indicates an adverse effect on anoxic conditions (despite having a beneficial effect on assimilative capacity). The FPEIS should therefore offer methods to potentially mitigate these anoxic conditions. For example, additional bottom aeration devices may be needed in the forebays of selected dams or all dams, including aeration devices at Melton, Hill, Guntersville, Pickwick and Kentucky reservoirs which currently do not have any augmentation. Other forms of aeration (damsite aspiration, tailrace aeration, etc.) may also be tried in order to increase the DO levels in downstream releases and inhibit the mobilization of anoxic products.

Response to Comment 11: The particular situation mentioned—adverse effect on anoxic conditions despite a beneficial effect on assimilative capacity under the Tailwater Habitat Alternative (Table ES-02)—would occur only on storage tributary reservoirs. The two representative reservoirs for this category included in the EIS are Douglas and South Holston Reservoirs—both of which already have aeration equipment and target DO concentrations. TVA has committed to maintaining these targets, regardless of which operations alternative is eventually selected.

12. Similar to water quality, the Tailwater Habitat Alternative would also generally have an overall adverse effect on wetlands – specifically on wetland type, since wetland function and location would be benefited. The FPEIS should offer possible actions to mitigate impacts on wetland type, which may be difficult if the loss (exposure) of forested wetlands results from the implementation of the alternative. Mitigation for shoreline soil erosion downstream should also be explored in the FPEIS since this alternative was predicted to have an adverse effect on reservoir and tailwater shorelines. Mitigation might include rip-rap retainer walls in scour areas or in-stream structures that reduce erosion and dissipate wave energy.

Response to Comment 12: TVA's Preferred Alternative was designed, in part, to reduce impacts on wetlands relative to the impacts associated with the action alternatives in the DEIS. An ongoing TVA program assesses, prioritizes, and repairs eroding TVA-owned shoreline. In addition, TVA Watershed Teams work with local communities and property owners to address problem areas on tailwater banks. Watershed Teams provide technical support and assist with obtaining funding.

In addition to traditional riprap, TVA supports the use of bioengineering and natural channel design techniques in order to enhance habitat and aesthetics, while stabilizing the shoreline and channels. These efforts will be ongoing and may be expanded if the chosen alternative is shown to increase erosion rates.

13. ➢ Hybrid Alternative - Potential refinements of one or more DPEIS-presented policy alternatives to form a hybrid alternative may also be possible. Such hybrids should be designed to reduce identified environmental impacts but still have more of a public enhancement benefit than the Base Case. For example, if enhancement of reservoir recreation is targeted by TVA, the water quality lake effects of increased residence times (low DO, anoxia, anoxic products, warmer temperature, higher chlorophyll, invasive/nuisance species, etc.) should be minimized, mitigated or balanced against recreational benefits that are somewhat reduced. For example, if Reservoir Rec A or B is selected in the FPEIS, the document should discuss and recommend mitigative methods to help offset the water quality effects of longer lake storage and/or perhaps not hold reservoir water at a higher pool as long to lessen water quality impacts of the alternative.

Response to Comment 13: The alternative identified in the FEIS as TVA's Preferred Alternative is a hybrid or blended alternative. It was formulated to accomplish what is suggested by this comment.

14. The enhancement of public benefits relative to the Base Case proposed by the policy alternatives would involve varying environmental tradeoffs. Accordingly, if a policy alternative is selected by TVA, the FPEIS should document how these tradeoffs will be addressed through modifying the alternative and/or mitigating the environmental impacts. In addition to consideration of the Base Case (with further refinements), we recommend consideration of the Tailwater Habitat Alternative (with mitigation) or a hybrid alternative that minimizes impacts but still provides more enhancement than the Base Case.

Response to Comment 14: As suggested, TVA created a hybrid or blended alternative and identified it as TVA's Preferred Alternative. Chapter 3 discusses what the Preferred Alternative would accomplish and how it addresses the comments received on the DEIS.

15. ➢ Water Quality - Overall, water quality would not be benefited by the performance of most of the policy action alternatives compared to the Base Case. The following water quality aspects were reviewed:

* Water Quality Effects - Table ES-01 summarizes the overall performance of the policy alternatives by public objective. For the water quality objective (improving water quality in reservoirs and tailwaters), all action alternatives were rated as having the potential for adverse water quality impacts when compared to the Base Case. Using the impact descriptors in this table, the action alternatives might be ranked (overall impacts – worst to best) as follows: Tailwater Habitat (adverse), Reservoir Rec B (slightly to substantially adverse), Reservoir Rec A (slightly adverse to adverse), Summer Hydro (adverse to beneficial), Tailwater Rec (no change to substantially adverse), Equalized Flood Risk (no change to adverse), and Commercial Navigation Alternative (no change to slightly beneficial).

* Assimilative Capacity & Anoxia - The potential for the assimilative capacity and anoxic conditions was summarized in Tables ES-01 for storage, transitional and mainstem reservoirs. In general, changing the Base Case would generate greater potential for anoxia, although not for every action alternative. In this table, most action alternatives were rated as adverse, substantially adverse, slightly adverse, variable, or no change to slightly adverse. Only the Commercial Navigation, Equalized Flood Risk and Summer Hydro Alternatives were predicted to show a more positive no change, no change to slightly beneficial, variable, slightly beneficial, or substantially beneficial condition for the three types of reservoirs.

Regarding the assimilative capacity of the three types of reservoir in the TVA system, a change from the Base Case would result in either a benefit, adverse impact or no change (Table ES-02). Specifically, impact descriptors for effects on storage tributaries were beneficial, slightly beneficial, variable or show no change; for effects on transitional tributaries were slightly adverse, no change to slightly adverse, or show no change; and for effects on mainstem reservoirs showed no change. Benefited storage reservoirs were associated with the implementation of the Reservoir Rec A, Reservoir Rec B, Tailwater Rec and Tailwater Habitat Alternatives.

Chlorophyll a - Chlorophyll or algal levels in aquatic environments serve as a surrogate or indicator of water quality pollution due to reservoir nutrient levels. Alternatives extending lake residence times can elevate chlorophyll a concentrations while those enhancing flows can reduce concentrations. Since most alternatives would increase retention times (pg. 5.4-16), chlorophyll a levels would tend to increase with a change from the Base Case. The DPEIS suggests these increases would be generally small "...with a maximum increase less than 10 percent." The FPEIS should discuss the ecological significance of such increases with emphasis on any reservoirs with elevated existing levels. In any event, it can be assumed that any increase in chlorophyll a concentrations would not indicate water quality maintenance or improvement.

* Soil Erosion - Since soil erosion also affects water quality through turbidity and downstream siltation, it was also considered in our review. Based on Table ES-01, the overall performance of the action alternatives were related to the soil erosion objective (minimizing erosion of reservoir shoreline and tailwater banks). This table predicts that the Reservoir Rec A, Reservoir Rec B, Tailwater Rec and Tailwater Habitat Alternatives would show an erosion potential (slightly adverse or slightly adverse to adverse) while the Summer Hydro and Equalized Flood Risk Alternatives were to show no change or some benefit (no change or no change to slightly beneficial). Table ES-02 dissects these data into reservoir versus tailwater shoreline effects. The Summer Hydropower and Equalized Flood Risk Alternatives were predicted to benefit (reduce) shoreline erosion for reservoirs (slightly beneficial) and produce no change in the erosion of tailwater shorelines.

* Wetlands - Wetlands also affect water quality by providing a water treatment function. Wetland impacts are further discussed below.

* Water Quality Modeling - EPA appreciated being invited to the TVA water quality presentation made to several agencies in Knoxville on April 15, 2003, regarding TVA's modeling conclusions on the study (Preliminary Water Quality Results for Reservoir Operations Study). Although an extensive amount of water quality work was performed, the DPEIS only summarizes it in general terms without presenting details. The FPEIS should provide sufficient water quality modeling detail to distinguish differences among policy alternatives.

Response to Comment 15: As the U.S. Environmental Protection Agency (USEPA) notes, an extensive amount of water quality modeling was conducted. From the analyses, TVA concluded that increases in chlorophyll-a—even on reservoirs where levels are already elevated—would not result in substantially adverse impacts. Much of the water quality modeling information was contained in the Water Quality Technical Report prepared to support the EIS, but was not included as a core component because of size limitations. It is always difficult to judge how much technical detail to provide in a document that is supposed to be understandable and usable by the average, non-technical reader. TVA thinks that the balance struck in the EIS is appropriate. If a reviewer would like more detail, the Water Quality Technical Report is available on request.

16. ➢ Wetlands - For the public objective involving wetland protection (protecting and improving wetlands and other ecologically sensitive areas), Table ES-01 indicates that the potential for adverse impacts exists through implementation of most of the action alternatives, with only the Commercial Navigation Alternative showing no change relative to wetlands. Based on Table ES-01, the policy alternatives might be ranked (overall impacts – worst to best) as follows: Summer Hydro (substantially adverse), Equalized Flood Risk (adverse to substantially adverse), Reservoir Rec B (adverse to slightly beneficial), Reservoir Rec A/Tailwater Rec/Tailwater Habitat (slightly adverse to slightly beneficial) and Commercial Navigation Alternative (no change).

Table ES-02 more specifically considers impacts to the location, type and function of wetlands. In such an analysis, the two recreational enhancement alternatives (Reservoir Rec A&B) and the two Tailwater alternatives (Tailwater Rec and Tailwater Habitat) would benefit (slightly beneficial or slightly beneficial to beneficial) wetland location and function. Wetland type, however, would not be benefited by these four alternatives (adverse (variable) or slightly adverse (variable)) which would make the overall wetland impact adverse as presented in Table ES-01 and discussed above. The Commercial Navigation Alternative is the only alternative that would not impact wetland type since it is predicted to show no change.

Response to Comment 16: See Response to Comment 5.

17. ➢ Hydropower - The Summer Hydro Alternative maximizes summer hydropower generation for peaking purposes. On an annual basis, however, it would result in a reduction of hydropower and a consequential increase in air emissions from fossil fuel power plants. Although the emissions would increase, it should be noted that emissions (including ozone precursors such as NOx) should be less than the Base Case during the summer. This is significant since conditions are ripe for ozone formation during the summer. Although the DPEIS discusses this benefit (pg. 6-3), ozone is not specifically mentioned. The FPEIS should discuss the value of less summertime air emissions relative to ozone formation in the Tennessee Valley.

Response to Comment 17: While some alternatives would result in slightly more fossil generation and others less, TVA does not believe that these slight potential emission changes would result in a substantial change in air quality (see Section 5.2). TVA's ongoing emissions control programs for nitrogen oxides and sulfur dioxide would continue to reduce TVA's impact on regional air quality.

18. ➢ Ramping Rates - Page 3-20 states that "[c]hanging ramping rates was included as an element of the Tailwater Habitat Alternative" and page 3-8 states that there would be "no turbine peaking allowed." The FPEIS should further discuss how this would affect downstream aquatics versus hydropower generation during peaking.

Response to Comment 18: Ramping rates would not be increased under any of the alternatives, which would provide more stable flows that would contribute to a more diverse aquatic community. The issue is addressed in Section 5.7.2.

19. ➢ Structural Changes - Page 3-21 indicates that structural changes, such as the presumed removal or modification of dams and levees, were not carried forward in the DPEIS as a component to any of the policy alternatives. However, all such structures have a finite project life. Are any TVA owned or operated dams nearing the end of their project life? Would TVA refurbish or remove such facilities? The FPEIS should discuss the TVA policy and any candidate sites.

Response to Comment 19: As discussed in Chapter 3, removal or modification of TVA's dams is considered beyond the scope of ROS and this EIS, whose purpose is to consider operational changes that would increase the public value of TVA's reservoir system. Removing dams, draining reservoirs, and disaggregating the reservoir system would be inconsistent with this purpose and would not increase the overall value of the system. TVA has an ongoing effort to modernize its hydropower generation facilities.

20. ➢ Document Quality - Although the DPEIS was well organized, the nature of the subject matter is complex since enhancement of one benefit for a given alternative often resulted in a tradeoff of other benefits. In order to facilitate public readability and review of the FPEIS, we recommend the following modifications:

Response to Comment 20: Comment noted.

21. * Designed Enhancements - Page 1-9 and 1-10 indicate that based on the scoping process, the top three public priorities were recreational benefits, environmental protection and flood control, while the public priorities at the workshops were environmental protection, power production and water supply. Given that environmental protection was the first or second priority for the public, it is somewhat surprising that essentially only one alternative (Tailwater Habitat) was analyzed that would enhance the environment (by comparison, three alternatives would enhance recreation).

Response to Comment 21: The Tailwater Habitat Alternative was structured to enhance certain environmental features, but all of the alternatives were formulated with environmental protection in mind. As discussed in Chapter 3 of the EIS, one of the first things TVA did in formulating alternatives was to eliminate possible alternatives that would result in substantially adverse environmental impacts. The TVA reservoir system is so large and has such a wide range of different habitats and resource conditions that it is difficult to make any changes to operations that would not result in some adverse impacts somewhere. While formulating the Preferred Alternative, TVA made every effort to reduce adverse impacts to the greatest extent possible, while still achieving or enhancing those aspects of the reservoir system most valued by the public.

22. * Study Objectives - The study objectives provided by the public during the scoping process are listed on page 1-12. Although most are self explanatory, the FPEIS would be improved if some definitions were provided. For example, the objective for improving aquatic habitat in reservoirs and tailwaters might suggest increasing submerged aquatic vegetation in both the downstream tailwater area and in the littoral zone of the reservoir. However, an adverse impact to this objective might not only imply a reduction in submerged aquatic vegetation but also an increase in invasive species such as Eurasian milfoil or a pollution indicator species such as chlorophyll a. Where appropriate, the FPEIS should clarify the objectives through textual discussion or tabular footnotes to better describe the objectives being considered.

Response to Comment 22: As suggested, TVA modified discussions in the FEIS to better define the identified objectives.

23. * Impact Descriptors - Tables ES-01 and ES-02 present impact descriptors for various identified public study objectives or impact categories by alternative. In general, Table ES-02 is more specific than Table ES-01 since it dissects data (e.g., wetland impacts are divided into wetland location type and function), so that the impact descriptors in Table ES-01 seem to be a composite of various components in Table ES-02 (we note that this resulted in some wide-ranging conclusions such as a slightly adverse to slightly beneficial effect that appear confusing). However, in the case of the public study objective for water quality (improving water quality in reservoirs and tailwaters), the impact descriptors for the various water quality aspects considered in Table ES-02 (assimilative capacity and anoxia in tributary and mainstem reservoirs) do not relate to those descriptors used in Table ES-01 (i.e., are not a composite of the descriptors used in Table ES-01). The FPEIS should discuss this and the basis for the descriptors used in Table ES-01 for water quality.

We also note from Table ES-02 that even though the Tailwater Habitat Alternative (for storage tributaries) was predicted to be beneficial for assimilative capacity, its performance was considered adverse for anoxia. The FPEIS should discuss why this was predicted. Can the same system be beneficial for one and adverse for the other?

Response to Comment 23: The FEIS addresses this issue. Tables ES-01 and ES-02 have been extensively revised.

24. * Significance - In addition to clarifying impact descriptors, the basis of these conclusions should be further discussed. Although Tables ES-01 and ES-02 are intended to be summary tables, the text (Chapter 5) should further explain how these conclusions were reached and summarized in the tables. For example, page 5.4-13 states that "...mainstem reservoirs would experience an increase in volumes of water with low DO concentrations under Reservoir Rec Alternative B relative to the Base Case..." We suggest that such conclusory statements be substantiated, such as "...mainstem reservoirs would experience an increase in volumes of water with low DO concentrations under Reservoir Rec B Alternative relative to the Base Case since reservoir residence times would be longer." Without such discussion, some of the conclusions in tables are not always intuitive and may even seem counterintuitive.

Response to Comment 24: A balance must be struck between concisely summarizing results of analyses and including too much information. TVA believes that the conclusions presented in the EIS are supported and explained by information in the document, either in the text itself or in the appendices. Nevertheless, we have reviewed the document and, as suggested, have provided further explanation of conclusions where appropriate.

The water quality components of Tables ES-01 and ES-02 are summaries of information in Table 5.4-02. Table D1-02 provides the actual model-generated data on which the summaries in Table 5.4-02 were based. The text in Section 5.4 under "Model Results" explains how data in Table D1-02 were evaluated and transformed into the information in Table 5.4-02. A more detailed discussion of results is provided in the Water Quality Technical Report, which was prepared to support the EIS and is available on request.

25. * Typographical - We note that Table 5.2-01 may contain an error. The first column of this table presents an increase (+) of 298,810 MW hours of non-hydro generation for the Tailwater Habitat Alternative. However, given that the emissions are predicted to be decreased (-) for this alternative, the 298,810 MW hour figure should presumably also be negative to indicate a decrease in MW hours of non-hydro generation and to account for the decreased emissions. This should be modified or discussed in the FPEIS. EPA has assumed this value to be a negative 298,810 (-298,810) in our hydropower review.

Response to Comment 25: The number is correct as reported, and the reason for the drop in emissions is discussed in Section 5.2.10.

U.S. Geological Survey

United States Geological Survey
3039 Amwiler Road, Suite 130
Atlanta, Georgia 30360

Memo

To: David Nye
ROS Project Manager, Tennessee Valley Authority
400 West Summit Hill Drive, WT11A
Knoxville, TN 37902

From: Edward M Martin
United States Geological Survey, District Chief
3039 Amwiler Road, Suite 130
Atlanta, Georgia 30360

Date: 10/19/2003

Re: **Review of Draft Programmatic Environmental Impact Statement: Tennessee Valley Authority Reservoir Operations Study June 2003**

Thank you for the opportunity to review the subject draft Environmental Impact Statement. This office has limited its review of this broad-based study to those report components focused on the hydrology and hydraulics of the watersheds and streams in Georgia in the affected basins. **[1]** The discussions of water-quality effects in Georgia were also reviewed. The largely qualitative discussions are technically sound and well written. Because they are largely qualitative, we have limited ability to evaluate or comment upon them in any detail. **[2]** Under the Peak Flows and Frequency section (4.22.3), it does not seem reasonable to conclude that "Because the flow frequency analyses were not performed using a methodology consistent with those performed for this EIS as described above, a comparison of the estimated frequencies from this analysis with the flow frequencies used for the Flood Insurance Studies is not meaningful." The FEMA FIS studies typically require a FEMA approved method, and are a valuable base of comparison. It is good engineering practice to compare the results of frequency estimates from different methods; especially when one method is regarded as standard practice (such as the FEMA FIS methods) and the other is less well known. The single paragraph in the appendix on Flood Flow Modeling is somewhat brief. **[3]**

Again, thank you for the opportunity to review the subject report.

RESPONSE TO COMMENTS

1. Thank you for the opportunity to review the subject draft Environmental Impact Statement. This office has limited its review of this broad-based study to those report components focused on the hydrology and hydraulics of the watersheds and streams in Georgia in the affected basins.

Response to Comment 1: We appreciate your review and comments on the DEIS.

2. The discussions of water-quality effects in Georgia were also reviewed. The largely qualitative discussions are technically sound and well written. Because they are largely qualitative, we have limited ability to evaluate or comment upon them in any detail.

Response to Comment 2: As stated in Chapter 1, the analysis presented in the EIS was conducted at a programmatic level. With respect to water quality effects, a more detailed information is contained in the Water Quality Technical Report, which is available on request.

3. Under the Peak Flows and Frequency section (4.22.3), it does not seem reasonable to conclude that "Because the flow frequency analyses were not performed using a methodology consistent with those performed for this EIS as described above, a comparison of the estimated frequencies from this analysis with the flow frequencies used for the Flood Insurance Studies is not meaningful." The FEMA FIS studies typically require a FEMA approved method, and are a valuable base of comparison. It is good engineering practice to compare the results of frequency estimates from different methods; especially when one method is regarded as standard practice (such as the FEMA FIS methods) and the other is less well known. The single paragraph in the appendix on Flood Flow Modeling is somewhat brief.

Response to Comment 3: TVA made changes in Section 4.22.3 in the FEIS to address this issue. Previously published Federal Emergency Management Agency flood insurance studies include regulated flow-frequency curves that were developed using the best information available at the time. At many locations, this meant having 20 to 40 years of observed annual peak flow data, collected over a period during which floodplain development led to fairly large modifications to upstream reservoir operations policy. In TVA's judgment, comparing these data was not meaningful.

U.S. Department of Agriculture Natural Resources Conservation Service

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
4405 Bland Road, Suite 205
Raleigh. NC 27609

Mary K. Combs, State Conservationist
Phone: (919) 873-2101
Fax No.: (919) 873-2156
Email: mary.combs@nc.usda.gov

July 11, 2003

Mr. David Nye
ROS Project Manager
Tennessee Valley Authority
400 West Summit hill Dr, WT11A
Knoxville, IN 37902

Dear Mr. Nye:

Thank you for the opportunity to provide comments on Draft Programmatic Environmental Impact Statement as part of TVA Reservoir Operations Study, which covers almost all of the state of Tennessee and parts of Alabama, Kentucky, Georgia, Mississippi, North Carolina and Virginia.

The Natural Resources Conservation Service in the state of North Carolina does not have any comments at this time. **[1]**

If you need additional information, please feel free to contact Mike Hinton at (919) 873-2134,

Sincerely,

Mary K. Combs
State Conservationist

Response to Comments

1. The Natural Resources Conservation Service in the state of North Carolina does not have any comments at this time.

Response to Comment 1: Comment noted.

F4.2 State Agencies

Alabama Department of Environmental Management Water Division

August 29, 2003

Mr. David Nye
ROS Project Manager
Tennessee Valley Authority
400 West Summit Hill Drive, WT11A
Knoxville, TN 37902

Dear Mr. Nye:

The Alabama Department of Environmental Management (ADEM) has reviewed the draft programmatic Environmental Impact Statement prepared as a part of the Tennessee Valley Authority's (TVA) Reservoir Operations Study. We appreciate the opportunity to provide the following comments regarding impacts that the various alternatives may have on water quality in the Tennessee River in Alabama.

The study considers seven alternatives to the current operating plan and provides a clear discussion of how changes in reservoir operations could impact various objectives, including hydropower, navigation, recreation, habitat, and flood risk. As a part of the study, TVA considered how the proposed changes could affect, among other things, water quality and water supply. Since ADEM has regulatory authority regarding these uses, any changes that would have a negative impact on either use is a concern to the Department. **[1]**

Specifically, alternatives which would result in decreased flows and/or increased retention times in the mainstem reservoirs will likely contribute to eutrophication in these systems. The Department recently (2002) established chlorophyll-*a* criteria for all of the Tennessee River mainstem reservoirs in Alabama. These criteria were established using historic chlorophyll-*a* levels associated with the current operating plan, and an increase in chlorophyll-*a* levels could result in non-attainment of these criteria. In addition, increased reservoir retention times and subsequent elevated chlorophyll-*a* levels may increase water supply treatment costs necessary to meet drinking water standards.

An additional concern related to increased retention time in the reservoirs is the increase in the volume of the anoxic zone and the likely decrease in tailwater dissolved oxygen concentrations downstream of each reservoir. Alabama's water quality standards require a minimum dissolved oxygen concentration of 4.0 mg/l downstream of existing hydroelectric generating turbines. **[2]**

In light of these concerns, ADEM recommends that TVA not make changes to its current operating plan which may result in unfavorable impacts to water quality. The current plan (basecase alternative), in place since 1990, has provided water quality conditions which support the many varied uses throughout the Tennessee River in Alabama. **[3]**

Page 2

David Nye

August 29, 2003

Again, we appreciate the opportunity to provide comments as a part of TVA's thorough review of its Reservoir Operations Plan. If you have questions about any of the comments or need additional information, please call Lynn Sisk at (334) 271-7826. **[4]**

Sincerely,

James E. McIndoe, Chief
Water Division

RESPONSE TO COMMENTS

1. The study considers seven alternatives to the current operating plan and provides a clear discussion of how changes in reservoir operations could impact various objectives, including hydropower, navigation, recreation, habitat, and flood risk. As a part of the study, TVA considered how the proposed changes could affect, among other things, water quality and water supply. Since ADEM has regulatory authority regarding these uses, any changes that would have a negative impact on either use is a concern to the Department.

Response to Comment 1: Comment noted.

2. Specifically, alternatives which would result in decreased flows and/or increased retention times in the mainstem reservoirs will likely contribute to eutrophication in these systems. The Department recently (2002) established chlorophyll-a criteria for all of the Tennessee River mainstem reservoirs in Alabama. These criteria were established using historic chlorophyll-a levels associated with the current operating plan, and an increase in chlorophyll-a levels could result in non-attainment of these criteria. In addition, increased reservoir retention times and subsequent elevated chlorophyll-a levels may increase water supply treatment costs necessary to meet drinking water standards.

An additional concern related to increased retention time in the reservoirs is the increase in the volume of the anoxic zone and the likely decrease in tailwater DO concentrations downstream of each reservoir. Alabama's water quality standards require a minimum DO concentration of 4.0 mg/l downstream of existing hydroelectric generating turbines.

Response to Comment 2: TVA shares your concern about increased eutrophication and anoxia in TVA reservoirs, which arise primarily from nutrient over-enrichment. Alabama Department of Environmental Management (ADEM) recognizes this and has been modifying its existing embayment-watershed approach to monitoring and pollution abatement in the Tennessee Valley region. TVA also recognizes the relationship between algal productivity and reservoir residence time. Reservoir flows should not be viewed as the sole control mechanism for algal productivity. However, TVA concentrated on reservoir flows in its Preferred Alternative rather than reservoir elevations, as it does under its existing operations policy. Minimum system flows in summer that are included in the Preferred Alternative would help alleviate some of the concerns over low flows that would result from several of the action alternatives in the DEIS.

3. In light of these concerns, ADEM recommends that TVA not make changes to its current operating plan which may result in unfavorable impacts to water quality. The current plan (basecase alternative), in place since 1990, has provided water quality conditions which support the many varied uses throughout the Tennessee River in Alabama.

Response to Comment 3: TVA formulated the Preferred Alternative to address these and other concerns, and to enhance other system benefits.

4. Again, we appreciate the opportunity to provide comments as a part of TVA's thorough review of its Reservoir Operations Plan. If you have questions about any of the comments or need additional information, please call Lynn Sisk at (334) 271-7826.

Response to Comment 4: We appreciate ADEM's review of the DEIS.

Alabama Department of Economic and Community Affairs Office of Water Resources

September 2, 2003

Mr. David Nye
TVA ROS Project Manager
Tennessee Valley Authority
400 West Summit Hill Drive, WT11A
Knoxville, TN 37902

RE: TVA ROS Programmatic EIS Comments

Dear Mr. Nye:

The ADECA Office of Water Resources (OWR) has reviewed the draft programmatic Environmental Impact Statement (EIS) prepared as part of TV A's Reservoir Operations Study (ROS). It certainly represents a significant amount of work on the part of the TVA staff and we applaud your efforts to solicit public input and involvement.

We also appreciate your efforts to provide Alabama agencies with a special briefing on August 13, 2003. As a result, staff members from ADEM, ADCNR, and OWR were able to develop a better understanding of the ROS, the technical analysis and tools used in the ROS, and the development of alternatives under evaluation. **[1]**

The focus of our comments on the ROS concerns the use and management of these water resources. As we discussed while you were here, a key aspect of the successful implementation of any operational changes to the system will be heavily depended upon how water is used and managed in the TVA region. **[2]**

As a result, we strongly recommend the creation of a committee of state representatives to provide advice and recommendations to TVA on the use and management of these water resources. The convergence of overlapping authorities and responsibilities as well as the wide ranging differences in state laws and regulations require that the states work together with TVA to preserve and share the water resources of the region. Foremost in the effort should be a commitment to address drought planning and management and to understand how the states and TV A will work together in the event of a significant drought. We, along with many other states in the region, are actively working on drought planning and water conservation measures. It will only improve our results if we can work with surrounding states on these issues. **[3]**

Other issues such as the assessment of groundwater withdrawals, interbasin transfers, shared opportunities for public education and outreach, and the need for more comprehensive gauging and monitoring would also be appropriate issues for discussion. **[4]**

We appreciate the opportunity to participate in this ROS process and look forward to helping in any way we can as this process moves forward. **[5]**

Please let us know if we can provide any assistance.

Sincerely,

Onis "Trey" Glenn III, Division Director
Office of Water Resources

cc: Mr. Lynn Sisk, ADEM
Mr. Stan Cook, ADCNR

RESPONSE TO COMMENTS

1. The ADECA Office of Water Resources (OWR) has reviewed the draft programmatic Environmental Impact Statement (EIS) prepared as part of TVA's Reservoir Operations Study (ROS). It certainly represents a significant amount of work on the part of the TVA staff and we applaud your efforts to solicit public input and involvement.

   We also appreciate your efforts to provide Alabama agencies with a special briefing on August 13, 2003. As a result, staff members from ADEM, ADCNR, and OWR were able to develop a better understanding of the ROS, the technical analysis and tools used in the ROS, and the development of alternatives under evaluation.

   Response to Comment 1: Thank you for your comment.

2. The focus of our comments on the ROS concerns the use and management of these water resources. As we discussed while you were here, a key aspect of the successful implementation of any operational changes to the system will be heavily depended upon how water is used and managed in the TVA region. As a result, we strongly recommend the creation of a committee of state representatives to provide advice and recommendations to TVA on the use and management of these water resources. The convergence of overlapping authorities and responsibilities as well as the wide ranging differences in state laws and regulations require that the states work together with TVA to preserve and share the water resources of the region

   Response to Comment 2: At the recommendation of TVA's chartered federal advisory committee, the Regional Resource Stewardship Council, TVA is considering formation of such a committee.

3. Foremost in the effort should be a commitment to address drought planning and management and to understand how the states and TVA will work together in the event of a significant drought. We, along with many other states in the region, are actively working on drought planning and water conservation measures. It will only improve our results if we can work with surrounding states on these issues.

   Response to Comment 3: As stated in Section 3.4.1 and Chapter 7, TVA is considering development of a formal drought management plan that would include other agencies. TVA fully agrees that drought management requires regional planning and is willing to participate in the commenter's state efforts for that.

4. Other issues such as the assessment of groundwater withdrawals, interbasin transfers, shared opportunities for public education and outreach, and the need for more comprehensive gauging and monitoring would also be appropriate issues for discussion.

   Response to Comment 4: Comment noted.

5. We appreciate the opportunity to participate in this ROS process and look forward to helping in any way we can as this process moves forward

   Response to Comment 5: We appreciate your review of the DEIS.

Alabama Department of Conservation and Natural Resources Wildlife and Freshwater Fisheries Division

August 27, 2003

Mr. David Ney
ROS Project Manager
TVA, WT 11A
400 West Summit Hill Drive
Knoxville, TN 37902

Re: TVA Reservoir Operations Study: Draft Environmental Impact Statement Comments

Dear Mr. Ney:

The Alabama Wildlife and Freshwater Fisheries Division (AWFF) has reviewed the Draft Environmental Impact Statement (DEIS) of the TVA Reservoir Operations Study. We support DEIS alternatives which provide the least impact on the aquatic resources of the Tennessee River Watershed in Alabama and significantly improve recreational opportunities available to the public. We submit the following comments concerning our review of the DEIS:

1. Research on Alabama reservoirs has revealed the relationship between reservoir hydrology and variability of year-class strength of fishes. AWFF supports the concept of water level manipulation to enhance crappie and bass sport fisheries and to benefit the overall fish community. A rising or higher than average lake level in the winter months (January-March) before the spawning period may increase crappie year-class strength. Stable or long retention times during the post-winter period will enhance both crappie and largemouth bass recruitment success (stable water levels in April are particularly important for bass recruitment). Operation of the Tennessee River reservoirs to maintain higher winter lake levels should be fully evaluated to determine impacts on fish population dynamics. Priority should be given to storage reservoirs where the lake level may be easier to manipulate; for example, Wheeler and Pickwick Reservoirs in Alabama. **[1]**

2. AWFF supports mitigation measures that will enhance boating access facilities and increase areas for angler bank access. Boating facility enhancements could include adding floating courtesy boat docks at many of the access areas that now have only fixed docks or none. Adding lighting at many of the facilities would enhance security and increase the opportunities for night angling. Some access areas need the addition of restrooms and increased parking spaces. AWFF would consider partnering with TVA to investigate and upgrade facilities in those areas where feasible. **[2]**

3. We recommend that a minimum continuous flow from Wilson Dam be considered. One of the most important freshwater mussel beds in the world, with regard to federally endangered species, as well as commercial harvest, lies in the tailwaters of Wilson Dam. A cumulative total of 40 species has been reported from that reach of river since 1990, including five federally endangered species and two species recently elevated to candidates for protection. Wilson tailwaters appear to be home to the only remaining population of White Wartybacks (*Plethobasus cicatricosus*). The riverine habitat and frequent releases from Wilson Dam during hydropower generation provide excellent habitat for these large-river species. However, the discharge of sewage from the Florence wastewater treatment facility has the potential to cause problems. Discharge from the plant is continuous (according to the

Alabama Department of Environmental Management), but release of water from Wilson Dam is negligible when power is not being generated or water spilled through floodgates. Our malacologist has observed that on most days, current is not perceptible until late morning, at least during summer and fall months. Thus, treated sewage accumulates in the vicinity of the treatment plant diffuser for at least several hours on most days. Continual release, in quantities adequate to flush the treated sewage, would probably be of great benefit to this globally important mussel community. **[3]**

4. We recommend that consideration be given to how the reservoir water levels are manipulated in the four reservoirs of the Bear Creek system, particularly in the fall to early winter period. Bear Creek is home to a diverse assemblage of freshwater mussels. However, poor water release practices from the four Bear Creek system dams have caused a drastic reduction in the fauna. A total of 25 species remains in the Bear Creek system, including two federally endangered species. However, most species are limited to a reach of stream less than two miles long, located just upstream of the portion of creek impounded as part of Pickwick Reservoir. In discussions with TVA personnel, our malacologist has found that water is held as long as possible in the fall to satisfy landowners. Then water is quickly released in order to increase holding capacity for winter rains. This quick release of water causes incredible amounts of bank and stream bed erosion, which has resulted in elimination of mussels, and probably some fish, from most of the system. With much of the historic fauna maintaining a foothold in the lower reaches (tenuous though it may be), alteration of flow regime and mitigation of affected habitat would almost certainly allow repopulation of the system. What should be questioned is the need to have these reservoirs empty by mid-December. Is their capacity (compared to that of Pickwick Reservoir) enough to make a significant difference in the ability of TVA to control floods? **[4]**

5. Other important issues which need to be addressed in TVA's reservoir operation plan include:

   (a) Water temperature fluctuations and dissolved oxygen levels below generating plants. **[5]**
   (b) Lack of fish passage facilities for riverine species. **[6]**
   (c) Entrainment and impingement of fishes in generating facilities. **[7]**
   (d) Loss of increasing amounts of littoral zone habitat due to bulkheads. **[8]**
   (e) Greenway development along riparian habitat and the setting aside of undeveloped properties for future wild, scenic, and natural use. **[9]**
   (f) The minimization of risks from aquatic nuisance species. **[10]**
   (g) The discharge of heated effluents which exceed Alabama's water quality standard for thermal discharges at fossil fuel or nuclear plants. **[11]**

These are the primary concerns of AWFF regarding the TVA Reservoir Operations Study and the policy alternatives that have been presented. AWFF urges TVA to consider alternatives which have the least impact on the aquatic resources of the Tennessee Valley system and which significantly increase recreational opportunities. Thank you for the opportunity to provide comments. **[12]** Please contact us if you have questions.

Sincerely,

M. N. Pugh
Director

RESPONSE TO COMMENTS

1. Research on Alabama reservoirs has revealed the relationship between reservoir hydrology and variability of year-class strength of fishes. AWFF supports the concept of water level manipulation to enhance crappie and bass sport fisheries and to benefit the overall fish community. A rising or higher than average lake level in the winter months (January-March) before the spawning period may increase crappie year-class strength. Stable or long retention times during the post-winter period will enhance both crappie and largemouth bass recruitment success (stable water levels in April are particularly important for bass recruitment). Operation of the Tennessee River reservoirs to maintain higher winter lake levels should be fully evaluated to determine impacts on fish population dynamics. Priority should be given to storage reservoirs where the lake level may be easier to manipulate; for example, Wheeler and Pickwick Reservoirs in Alabama.

Response to Comment 1: As discussed in Section 4.7.2, TVA attempts to stabilize tributary reservoir water levels as the water temperature at a depth of 5 feet reaches 65 ºF, by minimizing for a 2-week period water level fluctuations (maintaining level within 1 foot per week, either higher or lower). Beginning as early as spring 2004, TVA proposes to adjust this program so that it stabilizes levels at 60 ºF in order to better help crappie, smallmouth bass, and early largemouth and spotted bass spawning. Minimizing water level fluctuations is only one part of the fish spawning issue. Other environmental characteristics are also important in determining larvae and juvenile fish production. For example, the amount of food and cover available for much of the initial growing season are critical to determining the number of catchable fish. Higher winter levels would positively affect aquatic species (see Section 5.7.2). Daily fluctuations on Wheeler Reservoir are not conducive to stabilization during spring spawning. TVA has discussed this issue with the Alabama Department of Conservation and Natural Resources (ADCNR) in the past.

2. AWFF supports mitigation measures that will enhance boating access facilities and increase areas for angler bank access. Boating facility enhancements could include adding floating courtesy boat docks at many of the access areas that now have only fixed docks or none. Adding lighting at many of the facilities would enhance security and increase the opportunities for night angling. Some access areas need the addition of restrooms and increased parking spaces. AWFF would consider partnering with TVA to investigate and upgrade facilities in those areas where feasible.

Response to Comment 2: TVA would welcome partnering with the Alabama Wildlife and Freshwater Fisheries Division (AWFF) to investigate and, subject to the availability of resources, upgrade recreational access facilities.

3. We recommend that a minimum continuous flow from Wilson Dam be considered. One of the most important freshwater mussel beds in the world, with regard to federally endangered species, as well as commercial harvest, lies in the tailwaters of Wilson Dam. A cumulative total of 40 species has been reported from that reach of river since 1990, including five federally endangered species and two species recently elevated to candidates for protection. Wilson tailwaters appear to be home to the only remaining population of White Wartybacks (Plethobasus cicatricosus).

The riverine habitat and frequent releases from Wilson Dam during hydropower generation provide excellent habitat for these large-river species. However, the discharge of sewage from the Florence wastewater treatment facility has the potential to cause problems. Discharge from the plant is continuous (according to the Alabama Department of Environmental Management), but release of water from Wilson Dam is negligible when power is not being generated or water spilled through floodgates. Our malacologist has observed that on most days, current is not perceptible until late morning, at least during summer and fall months. Thus, treated sewage accumulates in the vicinity of the treatment plant diffuser for at least several hours on most days. Continual release, in quantities adequate to flush the treated sewage, would probably be of great benefit to this globally important mussel community.

Response to Comment 3: It is our understanding that the sewage treatment plant is in compliance with its permit. TVA realizes that the permit is based on minimum flows from Wilson Dam that would not be decreased under the Preferred Alternative. Under the Preferred Alternative, TVA would begin operating its reservoir system with the goal of achieving certain flows from its dams rather than certain elevations on its reservoirs. This approach should be more environmentally advantageous from a water quality standpoint and would address the concern identified in this comment.

4. We recommend that consideration be given to how the reservoir water levels are manipulated in the four reservoirs of the Bear Creek system, particularly in the fall to early winter period. Bear Creek is home to a diverse assemblage of freshwater mussels. However, poor water release practices from the four Bear Creek system dams have caused a drastic reduction in the fauna. A total of 25 species remains in the Bear Creek system, including two federally endangered species. However, most species are limited to a reach of stream less than two miles long, located just upstream of the portion of creek impounded as part of Pickwick Reservoir. In discussions with TVA personnel, our malacologist has found that water is held as long as possible in the fall to satisfy landowners. Then water is quickly released in order to increase holding capacity for winter rains. This quick release of water causes incredible amounts of bank and stream bed erosion, which has resulted in elimination of mussels, and probably some fish, from most of the system. With much of the historic fauna maintaining a foothold in the lower reaches (tenuous though it may be), alteration of flow regime and mitigation of affected habitat would almost certainly allow repopulation of the system. What should be questioned is the need to have these reservoirs empty by mid-December. Is their capacity (compared to that of Pickwick Reservoir) enough to make a significant difference in the ability of TVA to control floods?

Response to Comment 4: As discussed in Section 3.4.1, none of the alternatives evaluated for the ROS would affect operation of the Bear Creek Projects. Changes at the Bear Creek Projects could be analyzed on a case-by-case basis, as the opportunity for habitat improvement is identified.

5. Other important issues which need to be addressed in TVA's reservoir operation plan include:

(a) Water temperature fluctuations and dissolved oxygen levels below generating plants.

Response to Comment 5: Water temperature fluctuations and DO concentrations below hydropower generating facilities were evaluated in the ROS. TVA evaluated each alternative by comparing temperature and oxygen concentrations predicted by water quality models. Numerous metrics were calculated for this comparison, such as the water temperature variation at critical locations during spawning periods and the total number of hours that DO concentrations met a target at a critical location. These metrics were used to evaluate impacts on aquatic resources and on threatened and endangered species.

6. Other important issues which need to be addressed in TVA's reservoir operation plan include:

(b) Lack of fish passage facilities for riverine species.

Response to Comment 6: The ROS is a programmatic study looking at policy changes on a system-wide basis. This suggestion could require structural modifications that are not being proposed by TVA. However, the fish species listed do not benefit from traditional fish ladder technology because they do not jump barriers. Moving these species around a dam would require a system without any form of barrier to navigate, which is not currently economically feasible. TVA does monitor technological advances in fish passage and would be willing to revisit this issue if a suitable technology was developed.

7. Other important issues which need to be addressed in TVA's reservoir operation plan include:

(c) Entrainment and impingement of fishes in generating facilities.

Response to Comment 7: These activities are normally conducted under Section 316(b) evaluations for TVA facilities. TVA has installed screens on its plant intakes and taken other measures to reduce entrainment and impingement impacts. Previous analyses indicate that such measures are effective, and that entrainment and impingement of fish would be reduced to acceptable levels.

8. Other important issues which need to be addressed in TVA's reservoir operation plan include:

(d) Loss of increasing amounts of littoral zone habitat due to bulkheads.

Response to Comment 8: This issue was addressed as part of TVA's Shoreline Management Initiative EIS in 1998, and TVA adopted a policy to manage shoreline development.

9. Other important issues which need to be addressed in TVA's reservoir operation plan include:

(e) Greenway development along riparian habitat and the setting aside of undeveloped properties for future wild, scenic, and natural use.

Response to Comment 9: The focus of the ROS EIS is the operations policy of the TVA reservoir system, not land use. TVA does address land use in its comprehensive reservoir land use plans and associated NEPA reviews. For example, TVA examined residential access and shoreline uses in its reservoir land management plans for Pickwick, Guntersville, and Bear Creek Reservoirs.

10. Other important issues which need to be addressed in TVA's reservoir operation plan include:

(f) The minimization of risks from aquatic nuisance species.

Response to Comment 10: Impacts related to invasive aquatic species are addressed for each policy alternative in Sections 5.9 and 5.11. Minimization of the risks from such species is a high priority for TVA.

11. Other important issues which need to be addressed in TVA's reservoir operation plan include:

(g) The discharge of heated effluents which exceed Alabama's water quality standard for thermal discharges at fossil fuel or nuclear plants.

Response to Comment 11: Thermal plant discharges are regulated under Section 316(a) of the Clean Water Act. National Pollutant Discharge Elimination System permits have been issued for TVA facilities. TVA would comply with these permits, regardless of which alternative is chosen. Some alternatives would require more generation reduction and cooling tower use than others. This potential effect was evaluated in Section 5.23.2, Step 3.

12. AWFF urges TVA to consider alternatives which have the least impact on the aquatic resources of the Tennessee Valley system and which significantly increase recreational opportunities.

Response to Comment 12: TVA's Preferred Alternative was formulated to enhance recreational opportunities, while reducing potential environmental impacts associated with the alternatives identified in the DEIS that would enhance recreation.

Georgia State Clearinghouse (Georgia Department of Natural Resources Historic Preservation Division, Soil & Water Conservation, EPD/Floodplain Management)

EPD/Floodplain Management

TO: Barbara Jackson
Georgia State Clearinghouse
270 Washington Street, SW, Eighth Floor
Atlanta, Georgia 30334

FROM: MR. COLLIS BROWN
EPD/FLOOD PLAIN MANAGEMENT

SUBJECT: Executive Order 12372 Review

PROJECT: Draft Programmatic EIS: Reservoir Operations Study (ROS) – Tennessee Valley Authority

STATE ID: GA030703003

DATE: *7—09-2003*

[✓] This notice is considered to be consistent with those state or regional goals, policies, plans, fiscal resources, criteria for developments of regional impact, environmental impacts, federal executive orders, acts and/or rules and regulations with which this organization is concerned.

See attached comments.

This notice is not consistent with:

[ ] The goals, plans, policies, or fiscal resources with which this organization is concerned. (Line through inappropriate word or words and prepare a statement that explains the rationale for the inconsistency. Additional pages may be used for outlining the inconsistencies).

[ ] The criteria for developments of regional impact, federal executive orders, acts and/or rules and regulations administered by your agency. Negative environmental impacts or provision for protection of the environment should be pointed out. (Additional pages may be used for outlining the inconsistencies).

[ ] This notice does not impact upon the activities of the organization.

PROJECT: Draft Programmatic EIS: Reservoir Operations Study (ROS) - Tennessee Valley Authority

STATE IDENTIFICATION: GA030703003

For floodplain management purposes, any alternative that increases peak discharge and results in adverse damages including slight or substantially adverse damages. appears to be a deviation from Executive Order 11988. Sound floodplain management does not support the alternative reservoir operation policies called Reservoir Recreation A, Reservoir Recreation B, Summer Hydropower. Equalized Summer/Winter Flood Risk, Commercial] Navigation, Tai]water Recreation. and Tai1water Habitat. **[1]**

Additionally, the proposed project referenced above may alter federally designated Special Flood Hazard Areas (SFHA) and federally designated floodways. It is necessary to notify adjacent communities and the Georgia Department of Natural Resources prior to any alteration or relocation of a watercourse and submit evidence of such notification to the Federal Emergency Management Agency (FEMA), Region IV Office in Atlanta, Georgia. For any altered or relocated watercourse, submit engineering data/analysis within six (6) months to the FEMA, Region IV Office, in Atlanta, Georgia to ensure accuracy of community flood maps through the **Letter or Map Revision** process. Assure flood carrying capacity of any altered or relocated watercourse is maintained. You may obtain federal application forms for map revisions by contacting the Georgia Floodplain Management Office at (404) 656-6382.

Pursuant to Executive Order 11988, (Floodplain Management), direct or indirect federal support of floodplain development should be avoided unless there are no practicable alternatives. If there are no practicable alternatives and development in the floodplain is to be undertaken, the federal agency should document the reasons supporting this finding through the notification procedures outlined in the Executive Order. **[2]**

RESPONSE TO COMMENTS

1. For floodplain management purposes, any alternative that increases peak discharge and results in adverse damages including slight or substantially adverse damages, appears to be a deviation from Executive Order 11988. Sound floodplain management does not support the alternative reservoir operation policies called Reservoir Recreation A, Reservoir Recreation B, Summer Hydropower, Equalized Summer/Winter Flood Risk, Commercial Navigation, Tailwater Recreation, and Tailwater Habitat.

Response to Comment 1: Eliminating unacceptable flood risk effects associated with the alternatives identified in the DEIS was one of the primary drivers in the formulation of TVA's Preferred Alternative.

2. Additionally, the proposed project referenced above may alter federally designated Special Flood Hazard Areas (SFHA) and federally designated floodways. It is necessary to notify adjacent communities and the Georgia Department of Natural Resources prior to any alteration or relocation of a watercourse and submit evidence of such notification to the Federal Emergency Management Agency (FEMA), Region IV Office in Atlanta, Georgia. For any altered or relocated watercourse, submit engineering data/analysis within six (6) months to the FEMA, Region IV Office, in Atlanta, Georgia to ensure accuracy of community flood maps through the Letter of Map Revision process. Assure food carrying capacity of any altered or relocated watercourse is maintained. You may obtain federal application forms for map revisions by contacting the Georgia Floodplain Management Office at (404) 656-6382.

Pursuant to Executive Order 11988, (Floodplain Management), direct or indirect federal support of floodplain development should be avoided unless there are no practicable alternatives. If there are no practicable alternatives and development in the floodplain is to be undertaken, the federal agency should document the reasons supporting this finding through the notification procedures outlined in the Executive Order.

Response to Comment 2: See Response to Comment 1. TVA does not propose to alter or relocate any water courses.

Office of Planning and Budget

SONNY PERDUE
GOVERNOR

TIMOTHY A. CONNELL
DIRECTOR

GEORGIA STATE CLEARINGHOUSE MEMORANDUM
EXECUTIVE ORDER 12372 REVIEW PROCESS

TO: David Nye
Tennessee Valley Authority
400 W. Summit Hill Dr., WT11A
Knoxville, TN 37902-

FROM: Barbara Jackson
Georgia State Clearinghouse

DATE: 8/29/2003

SUBJECT: Executive Order 12372 Review

PROJECT: Draft Programmatic EIS: Reservoir Operations Study (ROS) – Tennessee Valley Authority

STATE ID: GA030703003

CFDA NO:

THE APPLICANT IS ADVISED TO NOTE ADDITIONAL COMMENTS FROM DNR'S HISTORIC PRESERVATION DIVISION.

THE APPLICANT IS ADVISED TO NOTE ADDITIONAL COMMENTS FROM THE SOIL & WATER CONSERVATION COMMISSION.

THE APPLICANT IS ADVISED TO NOTE ADDITIONAL COMMENTS FROM DNR'S EPD/FLOOD PLAIN MANAGEMENT.

THESE REVIEWERS WERE ALSO INCLUDED: DEPARTMENT OF NATURAL RESOURCES' DRINKING WATER PROTECTION, SAFE DAMS PROGRAM, AND WILDLIFE RESOURCES DIVISION. HOWEVER, THEY DID NOT COMMENT WITHIN THE REVIEW PERIOD. SHOULD THEY HAVE COMMENTS, THEY WILL CONTACT YOU DIRECTLY.

/BJ
ENC.: HPD, JULY 25, 2003
GA GEOLOGIC SURVEY, JULY 8, 2003
SWCC, JULY 22, 2003
DNR WATER PROTEC BRANCH, JULY 16, 2003
DNR WATER RESOURCES, JULY 28, 2003
EPD/FLOOD PLAIN MGT, JULY 14, 2003

GEORGIA STATE CLEARINGHOUSE MEMORANDUM
EXECUTIVE ORDER 12372 REVIEW PROCESS

TO: Barbara Jackson
Georgia State Clearinghouse
270 Washington Street, SW, Eighth Floor
Atlanta, Georgia 30334

FROM: MR. BILL MCLEMORE
GEORGIA GEOLOGIC SURVEY

SUBJECT: Executive Order 12372 Review

PROJECT: Draft Programmatic EIS: Reservoir Operations Study (ROS) – Tennessee Valley Authority

STATE ID: GA030703003

DATE: 7/7/03

[✓] This notice is considered to be consistent with those state or regional goals, policies, plans, fiscal resources, criteria for developments of regional impact, environmental impacts, federal executive orders, acts and/or rules and regulations with which this organization is concerned.

See attached comments.

This notice is not consistent with:

[ ] The goals, plans, policies, or fiscal resources with which this organization is concerned. (Line through inappropriate word or words and prepare a statement that explains the rationale for the inconsistency. Additional pages may be used for outlining the inconsistencies).

[ ] The criteria for developments of regional impact, federal executive orders, acts and/or rules and regulations administered by your agency. Negative environmental impacts or provision for protection of the environment should be pointed out. (Additional pages may be used for outlining the inconsistencies).

[ ] This notice does not impact upon the activities of the organization.

GEORGIA STATE CLEARINGHOUSE MEMORANDUM
EXECUTIVE ORDER 12372 REVIEW PROCESS

TO: Barbara Jackson
Georgia State Clearinghouse
270 Washington Street, SW, Eighth Floor
Atlanta, Georgia 30334

FROM: MR. WILLIAM D. BENNETT, ACTING EXECUTIVE DIRECTOR
SOIL & WATER CONSERVATION COMMISSION

SUBJECT: Executive Order 12372 Review

PROJECT: Draft Programmatic EIS: Reservoir Operations Study (ROS) – Tennessee Valley Authority

STATE ID: GA030703003

DATE: 7/21/03

[✓] This notice is considered to be consistent with those state or regional goals, policies, plans, fiscal resources, criteria for developments of regional impact, environmental impacts, federal executive orders, acts and/or rules and regulations with which this organization is concerned.

See attached comments.

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[ ] This notice does not impact upon the activities of the organization.

GEORGIA STATE CLEARINGHOUSE MEMORANDUM
EXECUTIVE ORDER 12372 REVIEW PROCESS

TO: Barbara Jackson
Georgia State Clearinghouse
270 Washington Street, SW, Eighth Floor
Atlanta, Georgia 30334

FROM: MR. ALAN W. HALLUM, CHIEF
DNR WATER PROTECTION BRANCH

SUBJECT: Executive Order 12372 Review

PROJECT: Draft Programmatic EIS: Reservoir Operations Study (ROS) – Tennessee Valley Authority

STATE ID: GA030703003

DATE: 7-10-03

[ ] This notice is considered to be consistent with those state or regional goals, policies, plans, fiscal resources, criteria for developments of regional impact, environmental impacts, federal executive orders, acts and/or rules and regulations with which this organization is concerned.

See attached comments.

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[✓] This notice does not impact upon the activities of the organization.

GEORGIA STATE CLEARINGHOUSE MEMORANDUM
EXECUTIVE ORDER 12372 REVIEW PROCESS

TO: Barbara Jackson
Georgia State Clearinghouse
270 Washington Street, SW, Eighth Floor
Atlanta, Georgia 30334

FROM: MR. NOLTON JOHNSON
DNR WATER RESOURCES

SUBJECT: Executive Order 12372 Review

PROJECT: Draft Programmatic EIS: Reservoir Operations Study (ROS) – Tennessee Valley Authority

STATE ID: GA030703003

DATE: 7/24/03

[✓] This notice is considered to be consistent with those state or regional goals, policies, plans, fiscal resources, criteria for developments of regional impact, environmental impacts, federal executive orders, acts and/or rules and regulations with which this organization is concerned.

See attached comments.

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[ ] This notice does not impact upon the activities of the organization.

July 23, 2003

Mr. David Nye
ROS Project Manager
TVA c/o WT 11A
400 West Summit Drive
Knoxville, TN 37902

RE: TVA Reservoir Operations Study (ROS): Draft Programmatic EIS
Fannin County, et al., Georgia
GA-030703-003

Dear Mr. Nye:

The Historic Preservation Division (HPD) has received the Draft Environmental Impact Statement (EIS) for the Tennessee Valley Authority Reservoir Operations Study. Our comments are offered the assist the Tennessee Valley Authority (TVA) and its applicants in complying with the provisions of Section 106 of the National Historic Preservation Act.

According to the Draft EIS, the effects to cultural resources of the proposed alternatives range from "adverse" to "slightly beneficial," with "adverse" and "slightly adverse" listed for half of the alternatives. HPD would, of course, prefer that the TVA choose an alternative with no adverse effects to historic resources, but, as the draft EIS points out, no decision has been made concerning preferred alternatives. We look forward to receiving a copy of the revised EIS after you have selected a preferred alternative. At that point, we will be able to offer our comments on the proposed undertaking. **[1]**

We look forward to working with you on this project. Please refer to the project number referenced above in any future correspondence. **[2]** If we may be of any further assistance, please do not hesitate to contact me at (404) 651-6777 or Serena Bellew, Environmental Review Coordinator at (404) 651-6624.

Sincerely,

Denise P. Messick

Environmental Review Historian

Enclosure: "Documentation Required for Review of Projects Under Section 106 of the NHPA of 1966"

CC: Barbara Jackson, Georgia State Clearinghouse
Kevin McAuliff, North Georgia ROC
Dan Latham, Jr., Coosa Valley RDC
Bryan Flower, Georgia Mountains ROC

DOCUMENTATION REQUIRED FOR REVIEW OF PROJECTS UNDER
SECTION 106 OF THE NATIONAL HISTORIC PRESERVATION ACT OF 1966

At a minimum, the Historic Preservation Division (HPD) requires the following information in order to conduct a review of any proposed undertaking in accordance with Section 106 of the National Historic Preservation Act:

1. A letter describing the proposed undertaking, the federal agency involved (i.e. HUD funding, FDIC insurance, etc.) and language requesting HPD's review of the undertaking in accordance with the appropriate legis1ation.

2. A USGS topographic map indicating the location and area of potential effect (APE) of the proposed undertaking. Please indicate the "footprint' of the proposed project (i.e. the ground disturbing area). The name of that specific topographic map and its scale should also be included.

3. Original 35mm or high quality digital color photographs of all buildings that appear to be fifty years old or older, which are located on, immediately adjacent to and/or within view of the project area, as well as photographs of the surrounding area to document the "setting" of the proposed undertaking. All photographs must be keyed to a site map indicating their location and direction of view.

    - For projects involving the rehabilitation, alteration, or demolition of buildings, please provide interior and exterior photographs whenever possible (including all facades and significant details). Photographs must be keyed to a floor plan indicating the location and direction of view of each photograph.

4. For projects involving alteration or rehabilitation, include a detailed work write-up, existing floor plans and proposed floor plans.

5. For projects involving the demolition of buildings that appear to be fifty years old or older, include alternatives to demolition that were considered and a discussion of why such alternatives were determined not to be feasible.

6. For projects involving archaeological resources, include any cultural resource surveys or reports conducted on the site.

All submittals should be addressed to W. Ray Luce, Division Director, at the above address. Please note that there is a thirty (30) day review and comment period for project submittals.

Prepared by: Historic Preservation Division,
Georgia Department of Natural Resources
SGB/April, 2002

RESPONSE TO COMMENTS

1. According to the Draft EIS, the effects to cultural resources of the proposed alternatives range from "adverse" to "slightly beneficial," with "adverse" and "slightly adverse" listed for half of the alternatives. HPD would, of course, prefer that the TVA choose an alternative with no adverse effects to historic resources, but, as the draft EIS points out, no decision has been made concerning preferred alternatives. We look forward to receiving a copy of the revised EIS after you have selected a preferred alternative. At that point, we will be able to offer our comments on the proposed undertaking.

Response to Comment 1: TVA is executing an agreement with the seven Tennessee Valley region State Historic Preservation Officers, including Georgia and other consulting parties. The agreement outlines the actions that TVA will take to address potential adverse effects on historic properties associated with the Preferred Alternative.

2. We look forward to working with you on this project. Please refer to the project number referenced above in any future correspondence.

Response to Comment 2: Thank you for your comment.

Georgia Department of Natural Resources Wildlife Resources Division

August 25, 2003

Mr. David Nye
ROS Project Manager
Tennessee Valley Authority
400 West Summit Drive, WT11A
Knoxville, TN 37902

Dear Mr. Nye:

Thank you for the opportunity to comment on the draft programmatic environmental impact statement (EIS) for your agency's Reservoir Operations Study (ROS). Fish and wildlife resources in north Georgia have benefited from prior TVA initiatives, such as the Reservoir Release Improvement Program, to improve habitat conditions, and we believe that additional improvements can be achieved as a result of this study. We have also appreciated the opportunity to provide input into the ROS process via Regional Fisheries Supervisor Jeff Duniak's participation on your Public Review Group. We commend your agency on an open and objective process that, most importantly, has maintained its efficiency and is on schedule to meet an ambitious two-year deadline for study completion. The inclusion of north Georgia destinations in your public meeting tour was also appreciated. **[1]**

There are three TVA tributary reservoir projects (Blue Ridge, Chatuge, Nottely) and two associated tailwaters (Blue Ridge, Nottely) located in north Georgia. My agency is keenly interested in the aquatic and terrestrial communities and the associated public uses that are supported by these three TVA projects. **[2]** Staffs from our Fisheries Management. Game Management, and Nongame Wildlife/Natural Heritage sections have reviewed your document. The following comments are provided to help your agency strengthen your final EIS and to decide which operational changes may provide the greatest benefit to the natural resources and citizens of the Tennessee Valley, including north Georgia.

We certainly understand the programmatic nature of the ROS and the intense balancing act among competing water uses in the Tennessee Valley. In simple terms, we have two primary interests in the three Georgia TVA projects as they relate to this study. The first is a desire to maintain and hopefully enhance the aquatic habitat conditions for fish species of concern in the Blue Ridge tailwater. The second is a goal to maintain higher water levels in these tributary reservoirs, which currently suffer from extreme water level fluctuations, to benefit resident fish communities and their associated recreational uses. Any operational changes that can improve these two conditions over those currently existing under the Base Case Alternative would be highly desirable. To that end, we support, in declining order of preference, the Tailwater Habitat, Reservoir Recreation A, and Reservoir Recreation B operating alternatives. Conversely, we do not support the Summer Hydropower and Equalized Flood Risk alternatives due to predicted adverse impacts to our stated interests. **[3]**

Although our three reservoirs comprise a very small segment of TVA's overall system, they are very representative of your basinwide issue of the management of tributary reservoirs. There seems to be some opportunity to closely examine your needs for flood storage and possibly increase tributary reservoir water levels where appropriate. **[4]** We commend you on the proposal in the draft EIS to extend the duration of spring water level stabilization, when climatic conditions permit, to enhance fish spawning and recruitment. That is a significant step toward the improvement of our reservoir fish communities. **[5]** Attached are more specific comments on your draft EIS that should help your staff to finalize that document. A boldfaced page marker indicates significant issues.

The Georgia Wildlife Resources Division has enjoyed our longstanding partnership with TVA in the management of fish and Wildlife resources at the Blue Ridge, Chatuge, and Nottely projects. We look forward to continuing this relationship and taking it to a new level as a result of the Reservoir Operations Study. **[6]** If you have any questions regarding these comments, feel free to contact Regional Fisheries Supervisor Jeff Durniak at 770-535-5498.

Sincerely,

David Waller

DW/jd

Attachment

cc: Section Chiefs

Georgia Wildlife Resources Division (GAWRD)
Specific Comments on TVA Reservoir Operations Study-
Proposed draft Programmatic Environmental Impact Statement
August 2003

* Page 2-25; Section 2.3.6: The last sentence in the second paragraph should read: "This lower level of DO stresses aquatic life in tailwaters and *coolwater species in reservoirs*, and limits the water's capacity for assimilating waste." **[7]**

*** Page 3-9; Table 3.3-01:** Water level stabilization during fish spawning is mentioned several times (Table 3.3-01 and Page 3.20) and is being considered under all alternatives. The temperature criterion for initiation of the stabilization period (60°F) and the duration (4-6 weeks) should be explicitly stated together in the text. **[8]**

* Page 3-20; Fish Spawning: Need to insert in the text the new temperature criterion of 60°F. Both the water temperature (60°F) when stabilization will begin and the duration of the period should appear together in the "Fish Spawning" text. **[9]**

* Page 4.7-21; Table 4.7-08: Omit the SFI score for striped bass in Lake Chatuge because they have not been stocked in Lake Chatuge. **[10]**

* Page 4.7-23; 1st paragraph, lines 7-8: Need to include "stocking success" as a major factor influencing striped bass populations. **[11]**

* Page 4.7-23; Line 13: states, "present walleye populations in tributary reservoirs have been maintained by stocking." The Blue Ridge walleye population is self-sustaining and is not maintained by stocking. It was last stocked by GAWRD in 1961. **[12]**

* Page 4.7-24; Future Trends, Line 6: Replace "while recruitment of young fish is expected to be poor in dry years" with "while lower recruitment rates of a number of littoral spawners are expected in dry years." **[13]**

*** Page 4.7-24; Future Trends,** Lines 9-12: The text, "However, dry years would decrease reservoir conditions for cool-water species due to increased stratification causing summer/fall water quality problems" is not true, based on our data. The DEIS used 1990, 1993, and 1994 to represent normal, dry, and wet climatic years, respectively in modeling the effects of TVA alternatives on water quality (DO and temperature). Our September oxygen profiles documented higher DO levels (2-6 ppm) in 1993 (dry year) compared to anoxic to low concentrations (0-0.5 ppm) in 1994 (wet year) at Lake Nottely. The case is similar in Lake Lanier, where we have documented generally higher DO levels and lower water temperatures in coolwater habitat during summers of dry years in the Lanier watershed. **[14]**

* Page 4.8-3; Table 4.8-01: Total acreage (4,551) for wetland types appears to be in error. Total lake acreage is 4,180 at normal full pool. **[15]**

* Page 4.11-3; Section 4.11.4: The blueback herring, an invasive aquatic species illegally introduced to the TVA system during the early 1990s, should be included in this section. Negative impacts of

bluebacks on largemouth bass populations have been documented in these two TVA Tributary impoundments (*Lake Nottely Annual Report 2002 GAWRD, unpublished*). **[16]**

* Page 4.24-4 Section 4.24.3: Hunting should be listed as a non-water activity (waterfowl hunting would be water-based) on this page. Hunting is included on the list of activities on Page 4.24-7. **[17]**

* **Page 5.4.3:** Douglas and South Holston reservoirs were selected as the "representatives" for modeling the different alternatives in tributary reservoirs. Model results were occasionally contrasting and varied in magnitude between the two impoundments. There was insufficient information (i.e. fisheries, existing water quality) describing both "representative" reservoirs so it was difficult to determine which impoundment would best represent the impact potential for reservoirs not specifically modeled. The same argument could be made for the "representative" tailwaters modeled and extrapolating their applicability to the Blue Ridge tailwater. **[18]**

* Page 5.4-5; Line 14: Error in Table 4.4-02. Should read Table 5.4-02. **[19]**

* Page 5.4-5; Lines 16-21: We do not agree with the statement that impacts related to DO and high water temperatures would be less during cool, wet years and greater during hot, dry years. See previous comments for Page 4.7-24. **[20]**

* Page 5.4-13; Section 5.4.5 (3rd paragraph): The word "cold" should replace the word "cool" on line 23, using your defined coldwater temperature criteria (≤10°C) in Tables 5.4-02 and 5.4-01. **[21]**

* Page 5.7-3; Table 5.7-01: Word error for Condition Indicator under Tributary Type for "mean volume of suitable cool-water habitat (temperature <20°C and DO >5 mg/L)". It should read "mean volume of suitable cold-water habitat…" **[22]**

* **Page 5.7-18; Table 5.7-07:** The DEIS does not effectively address the effects of the alternatives on coolwater and coldwater habitats in reservoirs. For example, there is no analysis on volume of critical and preferable coolwater habitat for representative reservoirs and the effects on coolwater species. Table 5.7-07 does not give enough detail for our interpretation of effects. **[23]**

* Pages 5.7-22 and 5.7-23; Sport Fisheries-Reservoirs: We suggest adding the word "may" before "adversely influencing cool-water species…" (Line 15, Page 5.7-22) and insert in parenthesis "(DO levels)" between "coolwater habitat" and "would be more important…" (Line 25, Page 5.7-23). Increasing the volume of low DO water in the thermocline/hypolimnion layers would not necessarily be more stressful for coolwater species. **[24]**

* Pages 5.7-22–5.7-28; Sport Fisheries-Reservoirs: Even though this is a programmatic EIS, localized reservoir effects (water quality problems) by reservoir alternatives should be mentioned and considered in the overall metrics rating. For example, four localized September fish kills of coolwater species (trophy striped bass and walleye) have occurred on Lake Nottely between 1980 and 1996. These apparently resulted from low dissolved oxygen conditions deep (22-28 m) in the reservoir in the vicinity of the dam. Temperature/oxygen data collected by GAWRD fishery biologists before and following the 1996 kill document a rapid loss of a deep-water layer with sufficient oxygen to support fish. The kill probably resulted from oxygen depletion in the deep layer and fish stress when the fish were forced to undergo a rapid pressure change as they tried to get to the epilimnion. The available evidence suggests that this kill and previous kills of this nature at Lake Nottely may be related to power generation and water withdrawals in late summer. The DEIS did not address this problem. **[25]**

Pages 5.11-2—5.11-4; Invasive Plants and Animals: Include blueback herring as invasive aquatic pests where appropriate. **[26]** End

RESPONSE TO COMMENTS

1. Fish and wildlife resources in north Georgia have benefited from prior TVA initiatives, such as the Reservoir Release Improvement Program, to improve habitat conditions, and we believe that additional improvements can be achieved as a result of this study. We have also appreciated the opportunity to provide input into the ROS process via Regional Fisheries Supervisor Jeff Durniak's participation on your Public Review Group. We commend your agency on all open and objective process that, most importantly, has maintained its efficiency and is on schedule to meet an ambitious two-year deadline for study completion. The inclusion of north Georgia destinations in your public meeting tour was also appreciated.

Response to Comment 1: Thank you for your comment regarding TVA undertaking the ROS. TVA appreciates Georgia Wildlife Resources Division's input—especially the contributions the Regional Fisheries Supervisor, Jeff Durniak, has made as a member of the Public Review Group.

2. There are three TVA tributary reservoir projects (Blue Ridge, Chatuge, Nottely) and two associated tailwaters (Blue Ridge, Nottely) located in north Georgia. My agency is keenly interested in the aquatic and terrestrial communities and the associated public uses that are supported by these three TVA projects.

Response to Comment 2: Comment noted.

3. In simple terms, we have two primary interests in the three Georgia TVA projects as they relate to this study. The first is a desire to maintain and hopefully enhance the aquatic habitat conditions for fish species of concern in the Blue Ridge tailwater. The second is a goal to maintain higher water levels in these tributary reservoirs, which currently suffer from extreme water level fluctuations, to benefit resident fish communities and their associated recreational uses.

Any operational changes that can improve these two conditions over those currently existing under the Base Case Alternative would be highly desirable. To that end, we support, in declining order of preference, the Tailwater Habitat, Reservoir Recreation A, and Reservoir Recreation B operating alternatives. Conversely we do not support the Summer Hydropower and Equalized flood risk alternatives due to predicted adverse impacts to our stated interests.

Response to Comment 3: TVA's Preferred Alternative was formulated to enhance recreational opportunities, while reducing potential environmental impacts associated with the alternatives identified in the DEIS that would enhance recreation.

4. Although our three reservoirs comprise a very small segment of TVA's overall system, they are very representative of your basinwide issue of the management of tributary reservoirs. There seems to be some opportunity to closely examine your needs for flood storage and possibly increase tributary reservoir water levels where appropriate.

Response to Comment 4: TVA's Preferred Alternative does this.

5. We commend you on the proposal in the draft EIS to extend the duration of spring water level stabilization, when climatic conditions permit, to enhance fish spawning and recruitment. That is a significant step toward the improvement of our reservoir fish communities.

Response to Comment 5: Unfortunately, TVA's analysis of flood risks indicates that risks would become unacceptable if the length of the stabilization was longer than 2 weeks.

6. The Georgia Wildlife Resources Division has enjoyed our longstanding partnership with TVA in the management of fish and wildlife resources at the Blue Ridge, Chatuge, and Nottely projects. We look forward to continuing this relationship and taking it to a new level as a result of the Reservoir Operations Study.

Response to Comment 6: Comment noted.

7. * Page 2-25; Section 2.3.6: The last sentence in the second paragraph should read: "This lower level of DO stresses aquatic life in tailwaters and coolwater species in reservoirs, and limits the water's capacity for assimilating waste."

Response to Comment 7: This change has been made in the FEIS.

8. *** Page 3-9; Table 3.3-01:** Water level stabilization during fish spawning is mentioned several times (Table 3.3-01 and Page 3.20) and is being considered under all alternatives. The temperature criterion for initiation of the stabilization period (60°F) and the duration (4-6 weeks) should be explicitly stated together in the text.

Response to Comment 8: The water temperature used as the trigger point for the 2-week fish spawning stabilization in individual tributary reservoirs will be reduced to 60 ºF beginning in spring 2004. See Response to Comment 5.

9. * Page 3-20; Fish Spawning: Need to insert in the text the new temperature criterion of 60°F. Both the water temperature (60°F) when stabilization will begin and the duration of the period should appear together in the "Fish Spawning" text.

Response to Comment 9: The suggested changes were made in the FEIS.

10. * Page 4.7-21; Table 4.7-08: Omit the SFI score for striped bass in Lake Chatuge because they have not been stocked in Lake Chatuge.

Response to Comment 10: The table was adjusted in the FEIS.

11. * Page 4.7-23; 1st paragraph, lines 7-8: Need to include "stocking success" as a major factor influencing striped bass populations.

Response to Comment 11: The text was changed in the FEIS.

12. * Page 4.7-23; Line 13: states, "present walleye populations in tributary reservoirs have been maintained by stocking." The Blue Ridge walleye population is self-sustaining and is not maintained by stocking. It was last stocked by GAWRD in 1961.

Response to Comment 12: Additional text was added in the FEIS to clarify that walleye populations are naturally sustained in many tributary reservoirs.

13. * Page 4.7-24; Future Trends, Line 6: Replace "while recruitment of young fish is expected to be poor in dry years" with "while lower recruitment rates of a number of littoral spawners are expected in dry years."

Response to Comment 13: The text was changed in the FEIS.

14. *** Page 4.7-24; Future Trends**, Lines 9-12: The text, “However, dry years would decrease reservoir conditions for cool-water species due to increased stratification causing summer/fall water quality problems" is not true, based on our data. The DEIS used 1990, 1993, and 1994 to represent normal, dry, and wet climatic years, respectively in modeling the effects of TVA alternatives on water quality (DO and temperature). Our September oxygen profiles documented higher DO levels (2-6 ppm) in 1993 (dry year) compared to anoxic to low concentrations (0-0.5 ppm) in 1994 (wet year) at Lake Nottely. The case is similar in Lake Lanier, where we have documented generally higher DO levels and lower water temperatures in coolwater habitat during summers of dry years in the Lanier watershed.

Response to Comment 14: The statement was intended to be applied to mainstem reservoirs and some, but not all, tributary reservoirs. The statement has been rewritten in the FEIS.

15. * Page 4.8-3; Table 4.8-01: Total acreage (4,551) for wetland types appears to be in error. Total lake acreage is 4,180 at normal full pool.

Response to Comment 15: All wetland acreage was derived from National Wetland Inventory (NWI) data that was prepared by USFWS. NWI maps are based on aerial photographs taken in the mid-1980s. The numbers that were used included data not only for the reservoir but also for any NWI wetlands within the shoreline fringe and isolated wetlands within the groundwater influence zone. On Nottely Reservoir, this zone was estimated to extend 1,250 feet beyond the maximum pool elevation.

16. * Page 4.11-3; Section 4.11.4: The blueback herring, an invasive aquatic species illegally introduced to the TVA system during the early 1990s, should be included in this section. Negative impacts of bluebacks on largemouth bass populations have been documented in these two TVA Tributary impoundments (Lake Nottely Annual Re port 2002 GAWRD, unpublished).

Response to Comment 16: TVA agrees that, if not already an actual problem, blueback herring is a potential problem for sport fish, and added the species to the FEIS as an invasive species in some of the Hiwassee River reservoirs in North Carolina, Georgia, and Tennessee. TVA believes that expansion of blueback herring, as well as alewives, in TVA reservoirs would be limited by low DO concentrations and warm temperatures.

17. * Page 4.24-4 Section 4.24.3: Hunting should be listed as a non-water activity (waterfowl hunting would be water-based) on this page. Hunting is included on the list of activities on Page 4.24-7.

Response to Comment 17: The change was made in the FEIS.

18. *** Page 5.4.3:** Douglas and South Holston reservoirs were selected as the "representatives" for modeling the different alternatives in tributary reservoirs. Model results were occasionally contrasting and varied in magnitude between the two impoundments. There was insufficient information (i.e. fisheries, existing water quality) describing both "representative" reservoirs so it was difficult to determine which impoundment would best represent the impact potential for reservoirs not specifically modeled. The same argument could be made for the "representative" tailwaters modeled and extrapolating their applicability to the Blue Ridge tailwater.

Response to Comment 18: Representative storage tributary reservoirs responded differently for certain water quality metrics. However, detailed information was provided in Appendix D of the FEIS under "Base Case" in order to allow reviewers to become familiar with the water quality characteristics of all representative reservoirs.

An additional representative storage tributary reservoir (Hiwassee Reservoir) was included in the FEIS. This reservoir was added in response to a comment that the initial evaluation did not include a reservoir representative of the upper-elevation, oligotrophic reservoirs in the Blue Ridge ecoregion.

19. * Page 5.4-5; Line 14: Error in Table 4.4-02. Should read Table 5.4-02.

Response to Comment 19: This was corrected in the FEIS.

20. * Page 5.4-5; Lines 16-21: We do not agree with the statement that impacts related to DO and high water temperatures would be less during cool, wet years and greater during hot, dry years. See previous comments for Page 4.7-24.

Response to Comment 20: The statement was intended to be applied to mainstem reservoirs and some, but not all tributary reservoirs. The statement was rewritten in the FEIS.

21. * Page 5.4-13; Section 5.4.5 (3rd paragraph): The word "cold" should replace the word "cool" on line 23, using your defined coldwater temperature criteria ($\leq$10°C) in Tables 5.4-02 and 5.4-01.

Response to Comment 21: This was revised in the FEIS.

22. * Page 5.7-3; Table 5.7-01: Word error for Condition Indicator under Tributary Type for "mean volume of suitable cool-water habitat (temperature <20°C and DO >5 mg/L)". It should read "mean volume of suitable cold-water habitat…"

Response to Comment 22: This change was made in the FEIS.

23. * **Page 5.7-18; Table 5.7-07:** The DEIS does not effectively address the effects of the alternatives on coolwater and coldwater habitats in reservoirs. For example, there is no analysis on volume of critical and preferable coolwater habitat for representative reservoirs and the effects on coolwater species. Table 5.7-07 does not give enough detail for our interpretation of effects.

Response to Comment 23: Section 5.7.2 describes the methods used to assess the impacts of the alternatives. The FEIS has been revised to include additional information on this subject. The volume of preferred or critical cool-water fish habitat is not expected to change under the Preferred Alternative.

24. * Pages 5.7-22 and 5.7-23; Sport Fisheries-Reservoirs: We suggest adding the word "may" before "adversely influencing cool-water species…" (Line 15, Page 5.7-22) and insert in parenthesis "(DO levels)" between "coolwater habitat" and "would be more important…"

(Line 25, Page 5.7-23). Increasing the volume of low DO water in the thermocline/hypolimnion layers would not necessarily be more stressful for coolwater species.

Response to Comment 24: The changes were made in the FEIS.

25. * Pages 5.7-22–5.7-28; Sport Fisheries-Reservoirs: Even though this is a programmatic EIS, localized reservoir effects (water quality problems) by reservoir alternatives should be mentioned and considered in the overall metrics rating. For example, four localized September fish kills of coolwater species (trophy striped bass and walleye) have occurred on Lake Nottely between 1980 and 1996. These apparently resulted from low dissolved oxygen conditions deep (22-28 m) in the reservoir in the vicinity of the dam. Temperature/oxygen data collected by GAWRD fishery biologists before and following the 1996 kill document a rapid loss of a deep-water layer with sufficient oxygen to support fish. The kill probably resulted from oxygen depletion in the deep layer and fish stress when the fish were forced to undergo a rapid pressure change as they tried to get to the epilimnion. The available evidence suggests that this kill and previous kills of this nature at Lake Nottely may be related to power generation and water withdrawals in late summer. The DEIS did not address this problem.

Response to Comment 25: This issue was considered in the analysis of the volume of water with low DO concentrations.

26.. * Pages 5.11-2—5.11-4; Invasive Plants and Animals: Include blueback herring as invasive aquatic pests where appropriate.

Response to Comment 26: See Response to Comment 16.

Kentucky Department of Fish and Wildlife Resources

September 23, 2004

Mr. David Nye, ROS Project Manager
Tennessee Valley Authority
400 West Summit Hill Drive, WTIIA
Knoxville, TN 37902

Dear Mr. Nye:

The Kentucky Department of Fish and Wildlife Resources (KDFWR) has reviewed the Draft Programmatic Environmental Impact Statement (EIS) for the Reservoir Operations Study. KDFWR staff has also participated in the meetings that have been held by the Tennessee Valley Authority (TVA) on this study. Accordingly, we offer the following comments and recommendations. **[1]**

The purpose of the study was to identify and evaluate the environmental and socioeconomic impacts of TVA's existing reservoir operations policy and develop options that might produce greater public value. As a result of this study, 8 options were identified (including the Base Case) for further evaluation and study. All of these options, excluding the Base Case, looked at changes in the timing of filling and emptying the reservoirs in the TVA system and how those changes might impact the environment and socioeconomics around each reservoir.

After reviewing the document, KDFWR recommends the Base Case option should become the Preferred Alternative for the Final EIS. We believe the other options could have impacts on fish spawning activity, reduce water quality, result in lost shoreline and shoreline habitat, and negatively impact adjacent wetlands. By delaying reservoir filling later, this could result in crappie and bass spawns being very low which would impact sport-fishing opportunities. By keeping water levels higher through the summer, there could be a loss of shoreline through increased erosion and a loss of habitat since mudflats won't have time to become vegetated. **[2]**

Additionally, since Kentucky Lake is connected to Lake Barkley by a canal, any change in the operation of Kentucky Lake will have a similar change on Lake Barkley. Therefore, any EIS should not only consider impacts to Kentucky Lake but should evaluate impacts on Lake Barkley. **[3]**

If you or any of your staff should have any questions regarding our comments, please contact Mr. Wayne L. Davis, Environmental Section Chief, at 502/564-7109, ext. 365.

We appreciate the opportunity to comment.

Sincerely,

C. Tom Bennett
Commissioner

cc: Benjamin T. Kinman, Director, Division of Fisheries
Edwin F. Crowell, Asst. Director, Division of Fisheries
Paul W. Rister, Western Fishery District Biologist
Pat Brandon, Purchase Wildlife Region Supervisor
Boyce Wells, KY Dept. for Environmental Protection
Lee Andrews, USFWS, Frankfort, KY
Environmental Section Files

RESPONSE TO COMMENTS

1. The Kentucky Department of Fish and Wildlife Resources (KDFWR) has reviewed the Draft Programmatic Environmental Impact Statement (EIS) for the Reservoir Operations Study. KDFWR staff has also participated in the meetings that have been held by the Tennessee Valley Authority (TVA) on this study. Accordingly, we offer the following comments and recommendations.

Response to Comment 1: Thank you for your comments and continued participation in the ROS as a member of the Interagency Team.

2. After reviewing the document, KDFWR recommends the Base Case option should become the Preferred Alternative for the Final EIS. We believe the other options could have impacts on fish spawning activity, reduce water quality, result in lost shoreline and shoreline habitat, and negatively impact adjacent wetlands. By delaying reservoir filling later, this could result in crappie and bass spawns being very low which would impact sport-fishing opportunities. By keeping water levels higher through the summer, there could be a loss of shoreline through increased erosion and a loss of habitat since mudflats won't have time to become vegetated.

Response to Comment 2: Thank you for supporting the Base Case Alternative. Many of the concerns addressed in your comments were considered during the development of TVA's Preferred Alternative that is now identified in the FEIS.

3. Additionally, since Kentucky Lake is connected to Lake Barkley by a canal, any change in the operation of Kentucky Lake will have a similar change on Lake Barkley. Therefore, any EIS should not only consider impacts to Kentucky Lake but should evaluate impacts on Lake Barkley.

Response to Comment 3: Under the Preferred Alternative, Kentucky and Barkley Reservoirs would be operated similar to the Base Case.

North Carolina Wildlife Resources Commission

September 3, 2003

Mr. David T. Nye
Project Manager
Reservoir Operations Study
Tennessee Valley Authority
400 West Summit Hill Drive, WT11A
Knoxville, TN 37902

Subject: Draft Programmatic Environmental Impact Statement, Reservoir Operations Study

Dear Mr. Nye:

Biologists with the North Carolina Wildlife Resources Commission (NCWRC) have reviewed the Draft Programmatic Environmental Impact Statement (DPEIS). The DPEIS has been prepared by Tennessee Valley Authority (TVA) staff and consultants to report on the outcome of a basin-wide Reservoir Operations Study (ROS). Our comments are provided in accordance with provisions of the National Environmental Policy Act (42 U.S.C. 4332 (2) (C)) and the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

We commend TVA for initiating a study of this magnitude to re-evaluate the potential of the greater Tennessee Valley's hydropower projects to serve multiple resource interests. We are optimistic that the ROS development process will identify important issues regarding the reservoirs, tailraces and other resources associated with these projects, and lead to better management of these resources. **[1]** Pursuant to that goal, the following comments are offered:

In our scoping comments on the ROS (C. Goudreau, April 26, 2002), NCWRC staff outlined specific concerns regarding current TVA operating policies, including: conservation and management of shoreline habitat; magnitude of winter drawdown on large reservoirs; duration/timing of reservoir elevation changes; reservoir habitat development opportunities and a variety of reservoir-specific issues. A copy of our scoping letter is attached for your reference. In reviewing the DPEIS, we found no record of agency scoping comments, nor any specific responses to the concerns expressed in our letter or by any other resource agency. We recommend that the final Environmental Impact Statement (EIS) document include a section devoted to TVA responses to resource agency comments, providing detailed information on how each comment was incorporated into the ROS or why it was not incorporated.

Because the DPEIS has not addressed many of the concerns detailed in our scoping letter of April 26, 2002, and because neither our recommended operational alternatives nor any alternatives that would target benefits to natural resources associated with reservoirs have been developed in the document, we cannot support any of the alternatives presented. While strengths and weaknesses of several alternatives are discussed herein, we caution the document preparers that such discussions should not be used to categorize the NCWRC as favoring those alternatives in any simplification or summarization of public or agency comment. Our specific concerns are discussed below. **[2]**

In general, the scope of the ROS document is too geographically broad or operationally narrow to address many long-standing project-specific issues. In our scoping comments, we listed a variety of such issues, including: houseboat permitting on Fontana and other reservoirs; the shortage of low-water access on Chatuge Reservoir; the five-year "maintenance" drawdown of Fontana Reservoir; opportunities for creating small subimpoundments to improve fish habitat and recreational access, particularly at Siles Branch on Fontana Reservoir; improved boating access on Appalachia reservoir; impact of peaking flows from Nottely Reservoir on the Nottely River, and from Chatuge Reservoir on the Hiwassee River; and improved flows in the bypass reach below Appalachia Dam. As part of the agency response section recommended above, TVA should identify those agency comments and requests that are outside the intended scope of the ROS, and propose alternative processes by which those concerns might be addressed. In some cases, particularly regarding reservoir levels and tailrace flows, opportunity still exists to address these issues through a more detailed alternatives analysis within the ROS development process. Where applicable, we recommend that discussion of operational alternatives include references to specific agency concerns expressed during the scoping process. For example, would an operational shift toward more stable lake levels eliminate the current five-year drawdown practice on Fontana, or would alternatives intended to improve tailrace conditions affect the frequency or amplitude of peaking flows in the Nottely River? While we recognize that it would be impractical to consider all possible scenarios for all projects in the TVA system, the final EIS should address those reservoirs or river reaches identified by resource agencies as areas of particular concern. **[3]**

The broad scope of the ROS document also confounds any meaningful interpretation of the alternatives summaries presented in public hearings, handouts and newsletters by TVA. Concepts such as recreation and water quality are too diverse and variable across the project area to be depicted as having unilaterally good or bad responses to any of the operational alternatives. Such simplistic depiction of study results precludes any opportunity to address these issues by project, region or type of water body (reservoir versus tailrace), and may mislead the public into choosing an operational alternative that is not the most beneficial to their local resources and associated economies. **[4]**

The analysis of operational alternatives in the ROS is based mainly on basin-wide predictive models. Based on our review of the DPEIS document and materials presented at the public meetings, the sources of data used for model input appear in some cases to be vague, arbitrary, inappropriate or incomplete. Where applicable, we have outlined our concerns about questionable model input in our comments on specific alternatives and document sections below. We encourage TVA to carefully review input data for all models used for alternatives analysis, and expand or balance these data sets as needed. This will ensure that the potential of available water resources, not the limits of predictive models, determines the amount of public benefit that is derived from the costly and difficult ROS development process.

In addition to concerns regarding input data, the calibration of the models appears to be biased. Benefits of operational changes are presented in document and handout graphics on the same four-point scale as adverse results, but benefits are rarely measured above one-half of the available scale, while adverse results employ the entire scale. While this is intended to show the relative importance, from TVA's perspective, of the beneficial and adverse effects of each alternative, the resulting graphs are of little use in comparing benefits of similar alternatives to a particular resource category. For example, the estimated benefit to recreation is shown as "slightly beneficial" for all three alternatives for which recreational benefits are projected. Because most of the benefit scale is unused, it is difficult or impossible to compare relative degrees of benefit among alternatives. Also, the unused portion of the benefit scale presumably represents outcomes that are impossible under any operational scenario. Because arbitrary values or composite index scores are used for all scaling of impacts, it would be more useful and informative to rate the maximum possible benefits at the top of the four-point scale, just as maximum adverse impacts are calibrated. This would allow a more insightful review of alternatives by members of the public who are unlikely to read the text of the document. **[5]**

The DPEIS describes a process by which TVA staff condensed 65 preliminary alternatives into a refined list of 25, of which eight were developed in the document. While details on the 25 refined alternatives are provided in Appendix B, information on the initial screening is limited to a single page of text in Chapter 3 of the DPEIS, describing a process of consolidating and scoring preliminary alternatives by TVA staff to eliminate those that directly conflicted with operational capabilities. Although an overview of the public input process is provided in Section 1.6, operating options considered are described only in general terms. The final EIS document should describe the initial screening process in detail, including information on scoring criteria used to screen alternatives and a complete list of alternatives with justification for their selection or elimination. Without this information, it is impossible to determine whether our recommended alternative involving filling of reservoirs by April 1, which did not appear in the DPEIS, was eliminated in the preliminary screening, inappropriately consolidated with other operating options or omitted entirely from the alternatives review process. **[6]**

Although two alternatives involving longer retention of summer reservoir levels are presented in the DPEIS, neither alternative considers reaching summer lake levels earlier in the season. In our scoping comments, we specifically requested consideration of operational alternatives that produce higher and more stable reservoir water levels during the period from April through June, with a target date of April 1 for full pool. We reiterate that such an alternative should be considered, and request that it be included in the final EIS. While we recognize that flood control potential of reservoirs would be compromised during this period, water quality impacts attributed to the two existing full pool alternatives should be alleviated, because water level management during the late summer would be similar to existing conditions. By achieving full pool in April, the fisheries resources of tributary reservoirs would be enhanced though improved fish spawning success and reservoir primary productivity, with resulting benefits to recreation and associated local economies. **[7]**

We also requested that extent of winter drawdown be reduced in at least one alternative, particularly on Fontana and Hiwassee reservoirs, where significant portions of the reservoirs are completely dewatered annually. While the “Equalized Winter/Summer Flood Risk” alternative would partially achieve this objective, the alternative as considered in the DPEIS produces significant impacts to other resource categories, largely due to its basin-wide scope. We recommend that a similar alternative be evaluated that equalizes winter and summer water levels in the tributary reservoirs only, similar to the full pool models used in the recreational alternatives. It is likely that substantial improvements in winter and early spring water levels of tributary reservoirs could be compensated by slight modifications in water levels of larger downstream impoundments. This is particularly true of Fontana Reservoir, where extensive dewatering continues in spite of the more recent development of Tellico Reservoir downstream. **[8]**

Comparisons of reservoir elevations projected under the different operational alternatives are presented in the document using numeric data and box plots that show predicted elevations at one point during each season. Of greater concern to us is the rate and timing of reservoir filling during the critical spawning period from April through June. At the public meeting, TVA computer specialists were able to model continuous curves depicting daily water levels for specific reservoirs. For all alternatives developed in the final EIS, such curves should be included in the document for representative reservoirs, showing mean, minimum and maximum predicted water levels projected by each operational model. **[9]**

The following comments apply to specific document sections, primarily those in Chapters 4 through 7 that relate to natural resources and associated recreation and economics:

<u>Section 4.7.8</u>: In the discussion of existing sport fisheries, the document should clarify that in contrast to striped bass and striped bass hybrid fisheries, walleye populations in many tributary reservoirs have become naturalized and are now sustained by natural reproduction, not by stocking. We would also

contend that in reservoir environments, the stability of water levels may be more important than the amount of annual rainfall for many centrarchid species. While these two phenomena may be difficult to distinguish under current operational conditions in tributary reservoirs, future conditions will likely depend on the operational regime selected through the ROS process. **[10]**

Section 5.4: Water quality modeling is based on levels of dissolved oxygen, temperature and algal activity in two "representative" tributary storage reservoirs. While the development of this water quality model is useful for predicting overall conditions in the entire volume of water in a reservoir, it is a poor predictor of water quality aspects that directly affect fish populations, especially when used to evaluate different levels of reservoir filling. While we concede that a reservoir at full pond may potentially have a higher volume of anoxic water at certain times of the year, it also has a substantially greater amount of oxygenated littoral habitat, due to the inundation of coves. It is also unfortunate that the only full pool alternatives developed in the document involve late summer filling, when anoxic conditions would be most widespread. The extrapolation of water quality parameters from lower-elevation Tennessee reservoirs to North Carolina's mountain reservoirs is probably tenuous as well. Algal activity in Fontana or Hiwassee would likely be low compared to other tributary storage reservoirs, and in any case would represent much-needed primary productivity rather than any kind of harmful eutrophication. Because water quality is one of the resource categories presented to the public in the alternatives analysis process, it is unfortunate that the indices used for model input have so little relevance to quality of sport fisheries in mountain reservoirs. **[11]**

Section 5.7: Again as in section 5.4, availability of habitat, including modeled oxygen levels, is related to total reservoir volume, limiting the model's ability to predict fishery resource benefits of higher lake levels, which inundate greater amounts of littoral habitat but also increase the relative volume of anoxic water in the reservoir. Biodiversity is also applied to both tailrace and reservoir habitats as an indicator of quality. As with dissolved oxygen, this is more relevant to tailrace habitats than reservoir systems. Species diversity in reservoirs is determined as much by species introductions as by habitat quality; in oligotrophic systems like our mountain reservoirs, the addition of species over time has not necessarily benefited the quality of fishery resources. White bass and other temperate basses overlap and compete with walleye for prey resources, spotted bass compete for reproductive habitat and readily hybridize with other black basses, and river herring adversely impact walleye recruitment. While Fontana Reservoir may have a less diverse fish community than downstream reservoirs, we view the absence of alewife and yellow bass as a benefit, rather than an impairment, to fishery resources. The difficulties of incorporating biodiversity indices into reservoir quality assessment are acknowledged in the text, but it is not clear how much these indices affected relative scoring of operational alternatives. As indicated in our opening comments, we requested that TVA develop a full summer pool alternative incorporating stable water levels from April through June. While the document text discusses the adverse impacts of rapid spring water level changes on fish spawning, and describes existing TVA measures to briefly limit fluctuations during times of critical bass spawning temperatures, no operational alternative is proposed in the document that would both inundate cove areas and stabilize water levels in the April-June period. None of the alternatives presented in the DPEIS has a substantial projected benefit to sport fisheries. At least one such alternative should be developed and evaluated in the final EIS. **[12]**

Section 5.8: The wetlands section of the document deals primarily with wetland losses associated with various alternatives. It is likely that wetland areas will be created or enhanced under some alternatives, particularly those associated with water margins. The wetlands analysis used in the document is admitted by the preparers to be limited in predicting changes in wetland extents; as a result, any alternatives analysis based on wetlands impacts is likely to be tenuous at best. The information in this section would be clarified by including tables similar to the table in Section 4.8, comparing projected wetlands for each alternative. In the wetlands section as in other places in the DPEIS document, sweeping predictions about impacts of alternatives on large geographic scales, such as "tributary reservoirs" or "mainstem tailwaters", seem not to be supported by data, and reflect the difficulty of modeling localized natural resource impacts on such scales. The associated appendix (D4b) provides details on wetlands analysis, but does not explain the theoretical basis or literature sources for reservoir-specific coefficients used to predict wetland impacts. Differences in impacts of alternatives listed in the appended analyses do not appear to be reflected in the document, where alternatives with dissimilar coefficient scores have similar statements evaluating wetland impacts. **[13]**

Section 5.11: Blueback herring is an invasive non-native aquatic species that potentially affects sport fisheries. While some species or life stages of species of game fish appear to benefit from blueback herring as a forage resource, other species or life stages may be adversely affected. Blueback herring should be included in the list and discussion of invasive animals. **[14]**

Section 5.13: The document attempts to predict threatened and endangered species impacts at the scope of the ROS. However, project-specific evaluations would be required for any change in operations that would adversely impact threatened or endangered species or their habitats. Because these species are typically limited in range or habitat requirements, it is likely that under any alternative chosen, projects with significant threatened and endangered species concerns would have to be treated differently than other projects of that type. Therefore, threatened and endangered species impacts may not be the best tool for evaluating alternatives on a basin-wide scale. We appreciate that flow improvements in the Appalachia bypass reach, mentioned in our scoping letter as a concern, are discussed in the DPEIS document and will be implemented under all operational alternatives. **[15]**

Section 5.24: Models used to predict recreational use of reservoirs under different operational alternatives assume reservoir level to be the only variable that would change. However, access area use information used for model input (Section 4.24) does not appear to distinguish between angling and non-angling boating use. Because quality of recreational fisheries may be affected by operational alternatives, the recreational model should include a modifier to reflect improved or impaired recreational boat fishing. Breakdowns of recreational users in the model should include separate seasonal estimates of angling and non-angling boaters based on or extrapolated from creel survey information on reservoirs in the region. Our recent surveys from reservoirs in the upper Little Tennessee Basin indicate that 70 to 95 percent of annual boating use and nearly all cool-season boating is associated with recreational fishing. Failure to incorporate impacts of alternatives on fishery resource quality therefore limits the utility of the existing recreational model on mountain reservoirs, and it should be revised accordingly. **[16]**

Section 5.25: Based on discussions between our staff and TVA representatives at the recent informational meeting, economic models include only recreation-associated jobs that occurred entirely within the Tennessee Valley, omitting those jobs associated with outfitters or fishing/hunting guide services based in adjacent areas. It is likely that the economic benefits of alternatives enhancing reservoir or tailrace recreation are therefore underestimated, particularly when compared to economic benefits of navigation, which are presumably confined to the mainstem region. All known economic impacts of each alternative should be included in comparative analysis for the final EIS. **[17]**

Chapter 6: Discussion of cumulative impacts of the ROS alternatives is brief, typically in the form of a summary paragraph for each of the affected resources. No comprehensive, multi-resource assessment of cumulative impacts is attempted. As the list of alternatives should be narrowed in the final document, the EIS should include a more detailed projection of overall cumulative impacts associated with the recommended operational changes. The DPEIS does not provide enough information on the methods used to evaluate cumulative impacts to allow us to comment on their validity; these should also be described in detail in the EIS. **[18]**

Chapter 7: As with the cumulative impacts chapter, the discussion of mitigation is generic in nature and does not outline specific areas where mitigation opportunities might be reduced or enhanced under different operational alternatives. Again we refer to our scoping comments, and suggest that our project-specific issues, and those of other resource agencies, form the basis of a list of mitigation opportunities for any resource impacts associated with the operational alternative recommended in the final EIS. **[19]**

As always, our field staff will be available to clarify any of the comments provided, or to cooperate as needed with development of the final EIS document. If you have questions regarding the information in this letter, please contact me at (919) 733-3633. **[20]**

Sincerely,

Fred A. Harris, Chief
Division of Inland Fisheries

Attachment

RESPONSE TO COMMENTS

1. We commend TVA for initiating a study of this magnitude to re-evaluate the potential of the greater Tennessee Valley's hydropower projects to serve multiple resource interests. We are optimistic that the ROS development process will identify important issues regarding the reservoirs, tailraces and other resources associated with these projects, and lead to better management of these resources.

Response to Comment 1: Comment noted.

2. In our scoping comments on the ROS (C. Goudreau, April 26, 2002), NCWRC staff outlined specific concerns regarding current TVA operating policies, including: conservation and management of shoreline habitat; magnitude of winter drawdown on large reservoirs; duration/timing of reservoir elevation changes; reservoir habitat development opportunities and a variety of reservoir-specific issues. A copy of our scoping letter is attached for your reference. In reviewing the DPEIS, we found no record of agency scoping comments, nor any specific responses to the concerns expressed in our letter or by any other resource agency. We recommend that the final Environmental Impact Statement (EIS) document include a section devoted to TVA responses to resource agency comments, providing detailed information on how each comment was incorporated into the ROS or why it was not incorporated.

Because the DPEIS has not addressed many of the concerns detailed in our scoping letter of April 26, 2002, and because neither our recommended operational alternatives nor any alternatives that would target benefits to natural resources associated with reservoirs have been developed in the document, we cannot support any of the alternatives presented. While strengths and weaknesses of several alternatives are discussed herein, we caution the document preparers that such discussions should not be used to categorize the NCWRC as favoring those alternatives in any simplification or summarization of public or agency comment. Our specific concerns are discussed below.

Response to Comment 2: As suggested, TVA is responding separately to federal and state agencies that submitted comments on the DEIS. TVA issued a 15-page document that summarized its evaluation of all of the comments received during the scoping period. This document also described how TVA intended to use those comments to establish the contents of the FEIS and better define the analyses that would be conducted to support this effort. The Scoping Document was widely distributed and made available on TVA's public web site. The reservoir system issues identified in this comment and in the earlier referenced scoping comments have been analyzed in this EIS to the extent that they relate to a system-wide operations policy. Although potential impacts on shoreline resources were analyzed as part of the ROS, possible changes to TVA's shoreline management policies and practices were not included. Those policies and practices were the subject of TVA's 1998 Shoreline Management Initiative EIS.

The focus of this programmatic EIS was to conduct detailed analysis on system-wide issues, not the kind of reservoir-specific issues that are the dominant focus of this and other comments from the North Carolina Wildlife Resources Commission. However, reservoir-specific recommendations that were received from scoping through the DEIS were considered in constructing all of the policy alternatives evaluated in this EIS, including the Preferred Alternative. Due to the infinite number of policy alternatives that could be developed from combinations of these recommendations, not all of the suggestions could be specifically included in the detailed analysis, but the nature of the suggestions was addressed within the context of broader programmatic issues. For example, under TVA's Preferred Alternative, winter flood guides would be raised on Boone, Chatuge, Cherokee, Douglas, Norris, Nottely, South Holston, and Watauga Reservoirs. Also, the duration of the restricted summer drawdown would be extended on Blue Ridge, Chatuge, Cherokee, Douglas, Great Falls, Norris, Nottely, South Holston, Watauga, and Wheeler Reservoirs under the Preferred Alternative. During the implementation of any ROS decision, or in the context of other actions that may be proposed on reservoirs of specific interest to the Commission, reservoir-specific issues and concerns would be addressed, as appropriate. TVA encourages the Commission to raise any such concerns in that context.

3. In general, the scope of the ROS document is too geographically broad or operationally narrow to address many long-standing project-specific issues. In our scoping comments, we listed a variety of such issues, including: houseboat permitting on Fontana and other reservoirs; the shortage of low-water access on Chatuge Reservoir; the five-year "maintenance" drawdown of Fontana Reservoir; opportunities for creating small subimpoundments to improve fish habitat and recreational access, particularly at Siles Branch on Fontana Reservoir; improved boating access on Appalachia reservoir; impact of peaking flows from Nottely Reservoir on the Nottely River, and from Chatuge Reservoir on the Hiwassee River; and improved flows in the bypass reach below Appalachia Dam. As part of the agency response section recommended above, TVA should identify those agency comments and requests that are outside the intended scope of the ROS, and propose alternative processes by which those concerns might be addressed. In some cases, particularly regarding reservoir levels and tailrace flows, opportunity still exists to address these issues through a more detailed alternatives analysis within the ROS development process. Where applicable, we recommend that discussion of operational alternatives include references to specific agency concerns expressed during the scoping process. For example, would an operational shift toward more stable lake levels eliminate the current five-year drawdown practice on Fontana, or would alternatives intended to improve tailrace conditions affect the frequency or amplitude of peaking flows in the Nottely River? While we recognize that it would be impractical to consider all possible scenarios for all projects in the TVA system, the final EIS should address those reservoirs or river reaches identified by resource agencies as areas of particular concern.

Response to Comment 3: See Response to Comment 2. TVA agrees that the ROS EIS is too broad to appropriately address the kind of reservoir-specific concerns identified in this comment. As a programmatic level of review, the ROS EIS is purposefully structured for a broader level of analyses. However, the impact analyses, as well as Appendix C, do provide a great deal of information about individual reservoirs and tailwaters. TVA explained in some detail how alternative operations policies could affect the operation of specific reservoirs, including the reservoirs identified in this comment. Under the Preferred Alternative, a number of reservoirs would be maintained at higher levels for longer durations, including Fontana, Chatuge, Nottely, and Hiwassee. However, deep drawdowns on the reservoirs would still be periodically required for mandated dam safety inspections and maintenance.

4. The broad scope of the ROS document also confounds any meaningful interpretation of the alternatives summaries presented in public hearings, handouts and newsletters by TVA. Concepts such as recreation and water quality are too diverse and variable across the project area to be depicted as having unilaterally good or bad responses to any of the operational alternatives. Such simplistic depiction of study results precludes any opportunity to address these issues by project, region or type of water body (reservoir versus tailrace), and may mislead the public into choosing an operational alternative that is not the most beneficial to their local resources and associated economies.

Response to Comment 4: By their nature, programmatic reviews have broad scopes and purposefully analyze issues and alternatives in broad ways. Indeed, if we allowed this programmatic review to be dominated by reservoir-specific concerns, decision makers' and the public's ability to understand the system-wide ramifications of proposed actions could easily be impaired. We do agree that generalizing the results of impact analyses could obscure unique effects on specific reservoirs. Based on our knowledge of TVA's reservoirs, the kinds of analyses and analytical methods used for the ROS, and TVA's extensive monitoring of various reservoir parameters, we do not think this has occurred to any material extent. We have provided detailed information about the potential ramifications of alternative operations policies on each of the reservoirs studied for the ROS. Additional details have now been provided about TVA's Preferred Alternative. We hope and anticipate that this will enable the public (and commenting agencies with reservoir-specific interests) to discern how their interests could be affected.

5. The analysis of operational alternatives in the ROS is based mainly on basin-wide predictive models. Based on our review of the DPEIS document and materials presented at the public meetings, the sources of data used for model input appear in some cases to be vague, arbitrary, inappropriate or incomplete. Where applicable, we have outlined our concerns about questionable model input in our comments on specific alternatives and document sections below. We encourage TVA to carefully review input data for all models used for alternatives analysis, and expand or balance these data sets as needed. This will ensure that the potential of available water resources, not the limits of predictive models, determines the amount of public benefit that is derived from the costly and difficult ROS development process.

In addition to concerns regarding input data, the calibration of the models appears to be biased. Benefits of operational changes are presented in document and handout graphics on the same four-point scale as adverse results, but benefits are rarely measured above one-half of the available scale, while adverse results employ the entire scale. While this is intended to show the relative importance, from TVA's perspective, of the beneficial and adverse effects of each alternative, the resulting graphs are of little use in comparing benefits of similar alternatives to a particular resource category. For example, the estimated benefit to recreation is shown as "slightly beneficial" for all three alternatives for which recreational benefits are projected. Because most of the benefit scale is unused, it is difficult or impossible to compare relative degrees of benefit among alternatives. Also, the unused portion of the benefit scale presumably represents outcomes that are impossible under any operational scenario. Because arbitrary values or composite index scores are used for all scaling of impacts, it would be more useful and informative to rate the maximum possible benefits at the top of the four-point scale, just as maximum adverse impacts are calibrated. This would allow a more insightful review of alternatives by members of the public who are unlikely to read the text of the document.

Response to Comment 5: As the comment suggested, TVA has carefully reviewed its modeling efforts associated with the ROS and has determined they were comprehensive, driven by valid data, tested extensively, and adequate to demonstrate real changes between the Base Case and any simulated alternative operations policy. Additional information regarding the models is provided in Appendix C, and detailed results are contained in technical reports and other information that is part of the ROS administrative record. Some of the details about the models are as follows:

The flood risk analysis was driven primarily by continuous simulations of the Tennessee River basin over the 99-year period between 1903 and 2001. The watershed was conceptually subdivided into 55 sub-basins, and a continuous hydrologic inflow time series was developed for each sub-basin. This effort was supported by comprehensive hydrologic data records, including U.S. Geological Survey (USGS) stream gage records and TVA reservoir operations data. Where necessary, gaps in the hydrologic data record were filled using standard hydrologic techniques in such a way that mass balance was preserved throughout the basin, and—to the extent practical for a study of this nature—that the dynamic response of each sub-basin was quantified for a wide range of spatially and temporally varying flood events.

The reservoir simulation model used in the flood risk analysis was RiverWare. This software has been routinely used by TVA for several years. The model captures all of the physical processes that are important to effective flood analysis. Operational rules were developed to reflect existing and alternative operations policies, and significant effort was made to test them.

Given the scope of the project, it was not possible to perform typical model calibration. The model was never intended to reproduce every water release decision made over a period during which the extent of flood-regulating capability, operations policy and staffing levels, forecasting technology, and basin development were continuously evolving. The intent of the simulation effort was to be able to demonstrate any real, defensible changes between existing and proposed operations policies.

Model verification was performed by comparing simulated elevation and discharge hydrographs at key points throughout the system with observed data for 1991 to 2001. This period encompasses the time frame that most closely reflects TVA's existing operations policy (that is, the time since the implementation of the policy modifications associated with the Lake Improvement Plan in 1991).

Water quality model input varied between bodies of water. Any available data from the extensive TVA monitoring program and USGS gages were used. Geometry was obtained from the most recent sediment surveys. Meteorology was obtained from the nearest National Weather Service airport stations. Where available, inflow water quality was obtained from monitoring data on tributary streams. Where inflow water quality data were not available, values were used that represented similar streams.

Each waterbody (reservoir or tailwater) was calibrated individually by comparing at least 1 year of water temperature and DO data with model results. The calibration year was chosen for each waterbody based on the year for which the most data were available. The models were then linked together to create the system-wide model. After linkage, the system-wide model was calibrated by comparing model results with 8 years of measured data for water temperatures and DO concentrations. In most cases, computed water temperature matched measured data within 1 ºF, and DO concentrations matched measured data within 1 milligram per liter.

Using water quality model results, numerous metrics were computed for Water Quality, Aquatic Resources, Water Supply, Threatened and Endangered Species, and other resource areas. These metrics included, for example, the seasonal volume of suitable habitat, the volume of water with suitable assimilative capacity, and the hours per year that a DO target was met at a critical location.

These numerous metrics were then summarized by the resource specialists to form the four-point scale mentioned in the comment. The alternatives were judged based on the weight of evidence in the various metrics.

Additional information has been added to the FEIS to better define the four-point performance scale that was used to document the impacts of each alternative.

6. The DPEIS describes a process by which TVA staff condensed 65 preliminary alternatives into a refined list of 25, of which eight were developed in the document. While details on the 25 refined alternatives are provided in Appendix B, information on the initial screening is limited to a single page of text in Chapter 3 of the DPEIS, describing a process of consolidating and scoring preliminary alternatives by TVA staff to eliminate those that directly conflicted with operational capabilities. Although an overview of the public input process is provided in Section 1.6, operating options considered are described only in general terms. The final EIS document should describe the initial screening process in detail, including information on scoring criteria used to screen alternatives and a complete list of alternatives with justification for their selection or elimination. Without this information, it is impossible to determine whether our recommended alternative involving filling of reservoirs by April 1, which did not appear in the DPEIS, was eliminated in the preliminary screening, inappropriately consolidated with other operating options or omitted entirely from the alternatives review process.

Response to Comment 6: Additional information about the alternative screening process has been provided in Section 3.2 of the FEIS. Results of the flood risk analysis showed that changing reservoir operations to achieve full pool on April 1 would result in unacceptable increases in flood risk.

7. Although two alternatives involving longer retention of summer reservoir levels are presented in the DPEIS, neither alternative considers reaching summer lake levels earlier in the season. In our scoping comments, we specifically requested consideration of operational alternatives that produce higher and more stable reservoir water levels during the period from April through June, with a target date of April 1 for full pool. We reiterate that such an alternative should be considered, and request that it be included in the final EIS. While we recognize that flood control potential of reservoirs would be compromised during this period, water quality impacts attributed to the two existing full pool alternatives should be alleviated, because water level management during the late summer would be similar to existing conditions. By achieving full pool in April, the fisheries resources of tributary reservoirs would be enhanced though improved fish spawning success and reservoir primary productivity, with resulting benefits to recreation and associated local economies.

Response to Comment 7: See Response to Comment 6.

8. We also requested that extent of winter drawdown be reduced in at least one alternative, particularly on Fontana and Hiwassee reservoirs, where significant portions of the reservoirs are completely dewatered annually. While the “Equalized Winter/Summer Flood

Risk" alternative would partially achieve this objective, the alternative as considered in the DPEIS produces significant impacts to other resource categories, largely due to its basin-wide scope. We recommend that a similar alternative be evaluated that equalizes winter and summer water levels in the tributary reservoirs only, similar to the full pool models used in the recreational alternatives. It is likely that substantial improvements in winter and early spring water levels of tributary reservoirs could be compensated by slight modifications in water levels of larger downstream impoundments. This is particularly true of Fontana Reservoir, where extensive dewatering continues in spite of the more recent development of Tellico Reservoir downstream.

Response to Comment 8: TVA's Preferred Alternative was formulated partially in response to this comment. One of its features is reduced winter drawdowns at several reservoirs, including Chatuge, Fontana, Nottely, and Hiwassee.

9. Comparisons of reservoir elevations projected under the different operational alternatives are presented in the document using numeric data and box plots that show predicted elevations at one point during each season. Of greater concern to us is the rate and timing of reservoir filling during the critical spawning period from April through June. At the public meeting, TVA computer specialists were able to model continuous curves depicting daily water levels for specific reservoirs. For all alternatives developed in the final EIS, such curves should be included in the document for representative reservoirs, showing mean, minimum and maximum predicted water levels projected by each operational model.

Response to Comment 9: Appropriate plots for the Base Case and Preferred Alternative are provided in the FEIS (see Appendix C).

10. Section 4.7.8: In the discussion of existing sport fisheries, the document should clarify that in contrast to striped bass and striped bass hybrid fisheries, walleye populations in many tributary reservoirs have become naturalized and are now sustained by natural reproduction, not by stocking. We would also contend that in reservoir environments, the stability of water levels may be more important than the amount of annual rainfall for many centrarchid species. While these two phenomena may be difficult to distinguish under current operational conditions in tributary reservoirs, future conditions will likely depend on the operational regime selected through the ROS process.

Response to Comment 10: The FEIS was changed to clarify that walleye populations are naturally sustained in many tributary reservoirs. Stable water for centrarchid species are considered, along with other concerns, in Section 4.7.2 of the FEIS.

11. Section 5.4: Water quality modeling is based on levels of dissolved oxygen, temperature and algal activity in two "representative" tributary storage reservoirs. While the development of this water quality model is useful for predicting overall conditions in the entire volume of water in a reservoir, it is a poor predictor of water quality aspects that directly affect fish populations, especially when used to evaluate different levels of reservoir filling. While we concede that a reservoir at full pond may potentially have a higher volume of anoxic water at certain times of the year, it also has a substantially greater amount of oxygenated littoral habitat, due to the inundation of coves. It is also unfortunate that the only full pool alternatives developed in the document involve late summer filling, when anoxic conditions would be most widespread. The extrapolation of water quality parameters from lower-elevation Tennessee reservoirs to North Carolina's mountain reservoirs is probably tenuous as well. Algal activity in Fontana or Hiwassee would likely be low compared to other tributary storage reservoirs, and in any case would represent much-needed primary productivity rather than any kind of harmful eutrophication. Because water quality is one of the resource categories presented to the public in the alternatives analysis process, it is unfortunate that the indices used for model input have so little relevance to quality of sport fisheries in mountain reservoirs.

Response to Comment 11: Indices that were used focused on the availability of suitable cool-water species habitat. This habitat was considered the most vulnerable habitat in reservoirs, even in oligotrophic mountain reservoirs. To respond to this comment, Hiwassee Reservoir was added to the representative reservoirs used for analysis in the FEIS.

12. Section 5.7: Again as in section 5.4, availability of habitat, including modeled oxygen levels, is related to total reservoir volume, limiting the model's ability to predict fishery resource benefits of higher lake levels, which inundate greater amounts of littoral habitat but also increase the relative volume of anoxic water in the reservoir. Biodiversity is also applied to both tailrace and reservoir habitats as an indicator of quality. As with dissolved oxygen, this is more relevant to tailrace habitats than reservoir systems. Species diversity in reservoirs is determined as much by species introductions as by habitat quality; in oligotrophic systems like our mountain reservoirs, the addition of species over time has not necessarily benefited the quality of fishery resources. White bass and other temperate basses overlap and compete with walleye for prey resources, spotted bass compete for reproductive habitat and readily hybridize with other black basses, and river herring adversely impact walleye recruitment. While Fontana Reservoir may have a less diverse fish community than downstream reservoirs, we view the absence of alewife and yellow bass as a benefit, rather than an impairment, to fishery resources. The difficulties of incorporating biodiversity indices into reservoir quality assessment are acknowledged in the text, but it is not clear how much these indices affected relative scoring of operational alternatives. As indicated in our opening comments, we requested that TVA develop a full summer pool alternative incorporating stable water levels from April through June. While the document text discusses the adverse impacts of rapid spring water level changes on fish spawning, and describes existing TVA measures to briefly limit fluctuations during times of critical bass spawning temperatures, no operational alternative is proposed in the document that would both inundate cove areas and stabilize water levels in the April-June period. None of the alternatives presented in the DPEIS has a substantial projected benefit to sport fisheries. At least one such alternative should be developed and evaluated in the final EIS.

Response to Comment 12: While it is true that reservoirs and some tailwaters are heavily managed for sport fisheries and that management actions can affect biodiversity, biodiversity is still an important measure of environmental quality. Non-native species stocked are not counted in biodiversity metrics for reservoirs. TVA's assessment of preliminary alternatives did include earlier and more stable fills of the reservoir system. Unfortunately, the increase in flood risks made an alternative with early fill or extended stabilization periods beyond the current 2-week period unreasonable at most tributary reservoirs.

As discussed in Section 4.7.2, TVA attempts to stabilize tributary reservoir water levels as the water temperature at a depth of 5 feet reaches 65 ºF, by minimizing for a 2-week period water level fluctuations (maintaining level within 1 foot per week, either higher or lower). Beginning as early as spring 2004, TVA proposes to adjust this program so that it stabilizes levels at 60 ºF in order to better help crappie, smallmouth bass, and early largemouth and spotted bass spawning. Minimizing water level fluctuations is only one part of the fish spawning issue. Other environmental characteristics are important in determining larvae and juvenile fish production. For example, the amount of food and cover available for much of the initial growing season are critical to determining the number of catchable fish. Different aspects of the alternatives benefit different sport fisheries.

13. Section 5.8: The wetlands section of the document deals primarily with wetland losses associated with various alternatives. It is likely that wetland areas will be created or enhanced under some alternatives, particularly those associated with water margins. The wetlands analysis used in the document is admitted by the preparers to be limited in predicting changes in wetland extents; as a result, any alternatives analysis based on wetlands impacts is likely to be tenuous at best. The information in this section would be clarified by including tables similar to the table in Section 4.8, comparing projected wetlands for each alternative. In the wetlands section as in other places in the DPEIS document, sweeping predictions about impacts of alternatives on large geographic scales, such as “tributary reservoirs” or “mainstem tailwaters”, seem not to be supported by data, and reflect the difficulty of modeling localized natural resource impacts on such scales. The associated appendix (D4b) provides details on wetlands analysis, but does not explain the theoretical basis or literature sources for reservoir-specific coefficients used to predict wetland impacts. Differences in impacts of alternatives listed in the appended analyses do not appear to be reflected in the document, where alternatives with dissimilar coefficient scores have similar statements evaluating wetland impacts.

Response to Comment 13: As stated in Section 5.8, five policy alternatives would increase the duration of summer pool (Reservoir Recreation Alternatives A and B, the Tailwater Recreation Alternative, the Tailwater Habitat Alternative, and the Preferred Alternative). These five alternatives could result in some conversion of wetland habitat on affected reservoirs. Forested and scrub/shrub wetlands could be affected most by lengthened summer pools. Therefore, the primary effect of these five alternatives could be loss of forested wetlands and specific types of scrub/shrub wetlands (i.e., buttonbush swamps).

The metrics chosen to evaluate changes in wetland habitat were the best available, considering the programmatic nature of the analysis. The rationale for their selection is described in Sections 5.8.1 and 5.8.2, and in Appendix D4b.2. Coefficient scores vary widely because the proposed changes in summer and winter pool conditions associated with each alternative would affect each reservoir differently, particularly tributary reservoirs.

14. Section 5.11: Blueback herring is an invasive non-native aquatic species that potentially affects sport fisheries. While some species or life stages of species of game fish appear to benefit from blueback herring as a forage resource, other species or life stages may be adversely affected. Blueback herring should be included in the list and discussion of invasive animals.

Response to Comment 14: Discussions of blueback herring were added to Sections 4.11 and 5.11 of the FEIS.

15. Section 5.13: The document attempts to predict threatened and endangered species impacts at the scope of the ROS. However, project-specific evaluations would be required for any change in operations that would adversely impact threatened or endangered species or their habitats. Because these species are typically limited in range or habitat requirements, it is likely that under any alternative chosen, projects with significant threatened and endangered species concerns would have to be treated differently than other projects of that type. Therefore, threatened and endangered species impacts may not be the best tool for evaluating alternatives on a basin-wide scale. We appreciate that flow improvements in the Appalachia bypass reach, mentioned in our scoping letter as a concern, are discussed in the DPEIS document and will be implemented under all operational alternatives.

Response to Comment 15: Threatened and endangered species have been addressed in the Biological Assessment. The Biological Opinion is included in Appendix G of the FEIS.

16. Section 5.24: Models used to predict recreational use of reservoirs under different operational alternatives assume reservoir level to be the only variable that would change. However, access area use information used for model input (Section 4.24) does not appear to distinguish between angling and non-angling boating use. Because quality of recreational fisheries may be affected by operational alternatives, the recreational model should include a modifier to reflect improved or impaired recreational boat fishing. Breakdowns of recreational users in the model should include separate seasonal estimates of angling and non-angling boaters based on or extrapolated from creel survey information on reservoirs in the region. Our recent surveys from reservoirs in the upper Little Tennessee Basin indicate that 70 to 95 percent of annual boating use and nearly all cool-season boating is associated with recreational fishing. Failure to incorporate impacts of alternatives on fishery resource quality therefore limits the utility of the existing recreational model on mountain reservoirs, and it should be revised accordingly.

Response to Comment 16: Two separate response models were developed: a "Trip Response Model" and a "Property Owners Model." The Trip Response Model was based on survey data collected at access points (public and commercial) on TVA lakes and tailwaters. The Property Owners Model was based on survey data collected from shoreline homeowners. The models were used to predict recreational use of reservoirs under different operations alternatives. For public and commercial access site users, the trip response model included variables to indicate primary activity (e.g., pleasure boating or fishing). The model used to predict recreational use by shoreline property owners was developed differently to address residency and does not include activity as a variable.

Trip Response Model: The recreational use estimates provided in Section 4.24 for public access sites were developed through on-site monitoring efforts at various TVA access points. On-site monitoring efforts did not distinguish between angling and non-angling boaters (boaters were counted as they exited the water but were not approached to determine the primary purpose of the activity). Recreationists were, however, surveyed as they exited each access point; the survey asked individuals to indicate the primary purpose of their trip. The Trip Response Model that was used to predict recreational use of reservoirs was developed with survey data, which is presented in Section 5.24.

For the Trip Response Model, a two-stage modeling approach was used. During the first stage, site and region characteristics were used to model the probability that any given lake would be visited on any one occasion. Site characteristics included distance from the respondent's home, the number of boat ramps and campgrounds at any given site, and measures of pool elevation on particular dates. Regional characteristics included measures of precipitation and temperature, and the percentage of the region covered by water. The information from this model was accumulated into an index of the "utility" associated with reservoir and tailwater recreation. The index was then used during the second stage of the model, which related the utility index and individual characteristics to describe the total number of trips taken to all lakes and tailwaters during the 3-month period of interest.

The second-stage model included two binary variables, one for boating (BOATER) and one for angling (ANGLER), whose values were based on the respondent's self-reported primary activity. The data were structured in the following way:

	BOATER	ANGLER
Pleasure boater:	1	0
Fish from boat:	1	1
Fish from shore:	0	1

The statistical model estimated parameters α, β, γ, and η for the following specification,

$TRIPS = \exp(\alpha + \beta \text{ OTHER VARIABLES} + \gamma \text{ BOATER} + \eta \text{ ANGLER})$

Trips will differ between the three kinds of users, depending on the values for BOATER and ANGLER (reservoir-level information is contained in other variables).

The variable for boating was statistically significant; the variable for angling was not. Following standard econometric practice, however, all variables included in the statistical model were used to estimate the change in total trips. Thus, changes in total trips for each management scenario do differentiate between pleasure boaters, anglers who fish from boats, and anglers who fish from shore.

The potential differences between anglers and boaters suggested by the reviewer are incorporated into the Trip Response Model for public and commercial reservoir and tailwater access sites.

Property Owners Model: Primary recreation activity was not included as an explanatory variable in the Property Owners Model. Property owners typically access water from their properties and use the water for multiple activities. As a result, we could not relate a single primary purpose to the volume of activity. Estimated changes in use for property owners under various operations alternatives were based on the total change in recreation use, in trips by activity.

Summary: A distinction was made between angling and non-angling boating use for people accessing reservoirs and tailwaters at public and commercial access sites. This distinction was not made for shoreline property owners. Attention to anglers and their individual characteristics and needs are appropriately accounted for in the models. See Section 5.7 for a discussion of impacts on recreation fishery resources.

17. Section 5.25: Based on discussions between our staff and TVA representatives at the recent informational meeting, economic models include only recreation-associated jobs that occurred entirely within the Tennessee Valley, omitting those jobs associated with outfitters or fishing/hunting guide services based in adjacent areas. It is likely that the economic benefits of alternatives enhancing reservoir or tailrace recreation are therefore underestimated, particularly when compared to economic benefits of navigation, which are presumably confined to the mainstem region. All known economic impacts of each alternative should be included in comparative analysis for the final EIS.

Response to Comment 17: The regional economic model that was used, REMI, was custom-designed for the Tennessee Valley region, including the TVA Power Service Area and the watershed counties in North Carolina and Virginia. The model contains Bureau of Economic Analysis data for those counties, including jobs, demographics, and industries.

The economic analysis for recreation was based on surveys of recreationists and shoreline property owners that focused on net effects of changes in alternative reservoir operations policies. The surveys from customers outside the region were included in the economic analysis because they represented a net gain to the Tennessee Valley region.

TVA's random surveys of reservoir users should have captured some number of these out-of-region outfitters and guides, particularly since these surveys were conducted throughout the primary recreation season. Therefore, while it is possible that some of these outfitters and guides were left out using this analytical approach, the effect of this omission on the conclusions reached is likely to be minor.

18. Chapter 6: Discussion of cumulative impacts of the ROS alternatives is brief, typically in the form of a summary paragraph for each of the affected resources. No comprehensive, multi-resource assessment of cumulative impacts is attempted. As the list of alternatives should be narrowed in the final document, the EIS should include a more detailed projection of overall cumulative impacts associated with the recommended operational changes. The DPEIS does not provide enough information on the methods used to evaluate cumulative impacts to allow us to comment on their validity; these should also be described in detail in the EIS.

Response to Comment 18: The discussion of cumulative impacts was expanded in the FEIS.

19. Chapter 7: As with the cumulative impacts chapter, the discussion of mitigation is generic in nature and does not outline specific areas where mitigation opportunities might be reduced or enhanced under different operational alternatives. Again we refer to our scoping comments, and suggest that our project-specific issues, and those of other resource agencies, form the basis of a list of mitigation opportunities for any resource impacts associated with the operational alternative recommended in the final EIS.

Response to Comment 19: The discussion of possible mitigation measures in Chapter 7 was expanded in the FEIS, in light of the identification of a Preferred Alternative by TVA. Because this is a programmatic level of review, the identified mitigation measures are generally programmatic in nature.

20. As always, our field staff will be available to clarify any of the comments provided, or to cooperate as needed with development of the final EIS document. If you have questions regarding the information in this letter, please contact me at (919) 733-3633.

Response to Comment 20: Comment noted.

Tennessee Department of Environment and Conservation (TDEC) Division of Water Pollution Control

Mr. David Nye
ROS Project Manager
Tennessee Valley Authority
400 West Summit Hill Drive
Knoxville, TN 37902

Dear Mr. Nye:

This will transmit the comments of the Tennessee Department of Environment and Conservation on the Draft Programmatic Environmental Impact Statement for the TVA Reservoir Operations Study.
TDEC very much appreciates TVA's commitment to a full and thorough review of all aspects of reservoir operations and to implementation of the alternative that will yield the greatest overall public benefit to citizens in the TVA area. We recognize that this has been a tremendous effort, and we believe that both the process and the product will be of lasting value in guiding TVA's resource management decisions for years to come. **[1]**

We agree with TVA that the preferred alternative should be that which yields the greatest overall public benefit while carefully valuing the importance of environmental quality. Among the options evaluated, we believe the base case best serves that objective. The commercial navigation alternative is close to the base case in most regards and also has merit. By comparison, the other alternatives present less overall benefit and involve unwarranted compromise in environmental objectives. **[2]**

We agree that where the study does identify minor or site-specific operational changes that will benefit some users without offsetting harm to others, those changes should be adopted. For example, TVA proposes under all alternatives to hold reservoir levels steady for a longer period to improve fish spawning. We certainly support that. **[3]**

Wherever possible, water quality standards should be attained and impairments resolved. We agree that ongoing programs and planned efforts to improve tailwater quality and control shoreline erosion should go forward. And we agree that TVA should work with appropriate agencies to develop a formal drought plan. **[4]**

Thank you for your work on this study and your consideration of these comments. **[5]**

Paul E. Davis, P.E. Director
Division of Water Pollution Control
Tennessee Department of Environment and Conservation

Paul Davis
Paul.Estill.Davis@state.tn.us
615/532-0632

RESPONSE TO COMMENTS

1. TDEC very much appreciates TVA's commitment to a full and thorough review of all aspects of reservoir operations and to implementation of the alternative that will yield the greatest overall public benefit to citizens in the TVA area. We recognize that this has been a tremendous effort, and we believe that both the process and the product will be of lasting value in guiding TVA's resource management decisions for years to come.

   Response to Comment 1: We appreciate the Tennessee Department of Environment and Conservation's (TDEC's) participation on the Interagency Team that provided oversight for this effort.

2. We agree with TVA that the preferred alternative should be that which yields the greatest overall public benefit while carefully valuing the importance of environmental quality. Among the options evaluated, we believe the base case best serves that objective. The commercial navigation alternative is close to the base case in most regards and also has merit. By comparison, the other alternatives present less overall benefit and involve unwarranted compromise in environmental objectives.

   Response to Comment 2: After extensive public review of the DEIS and additional analyses, TVA has formulated the Preferred Alternative, which would enhance recreation opportunities while lessening impacts on the environment and other operating objectives. The Preferred Alternative combines and adjusts desirable features of the alternatives identified in the DEIS to create a more feasible, publicly responsive alternative.

3. We agree that where the study does identify minor or site-specific operational changes that will benefit some users without offsetting harm to others, those changes should be adopted. For example, TVA proposes under all alternatives to hold reservoir levels steady for a longer period to improve fish spawning. We certainly support that.

   Response to Comment 3: Unfortunately, TVA's analysis of flood risks indicates that risks become unacceptable if the length of the stabilization is longer than 2 weeks.

4. Wherever possible, water quality standards should be attained and impairments resolved. We agree that ongoing programs and planned efforts to improve tailwater quality and control shoreline erosion should go forward. And we agree that TVA should work with appropriate agencies to develop a formal drought plan.

   Response to Comment 4: TVA plans to meet DO concentration and minimum flow targets established in the 1990 Lake Improvement Plan. Furthermore, TVA is available to work with the Tennessee Valley region states to develop a formal drought plan.

5. Thank you for your work on this study and your consideration of these comments.

   Response to Comment 5: We appreciate TDEC's continued involvement in the study as part of the Interagency Team.

Tennessee Historical Commission

July 8, 2003

Mr. David Nye
Tennessee Valley Authority
400 West Summit Hill Drive/WT11A
Knoxville, Tennessee, 37902

RE: TVA, RESERVOIR OPERATIONS STUDY, UNINCORPOREATED, MULTI COUNTY

Dear Mr. Nye:

In response to your request, received on Thursday, July 3, 2003, we have reviewed the documents you submitted regarding your proposed undertaking. Our review of and comment on your proposed undertaking are among the requirements of Section 106 of the National Historic Preservation Act. This Act requires federal agencies or applicant for federal assistance to consult with the appropriate State Historic Preservation Office before they carry out their proposed undertakings. The Advisory Council on Historic Preservation has codified procedures for carrying out Section 106 review in 36 CFR 800. You may wish to familiarize yourself with these procedures (Federal Register, December 12, 2000, pages 77698-77739) if you are unsure about the Section 106 process. **[1]**

Considering available information, we find that the project as currently proposed MAY ADVERSELY AFFECT PROPERTIES THAT ARE ELIGIBLE FOR LISTIGN IN THE NATIONAL REGISTER OF HISTORIC PLACES. You should now begin immediate consultation with our office. **[2]** Please direct question and comments to Joe Garrison (615) 532-1550-103. We appreciate your cooperation.

Sincerely,

Herbert L. Harper
Executive Directory and
Deputy State Historic
Preservation Officer

HLH/jyg

RESPONSE TO COMMENTS

1. Our review of and comment on your proposed undertaking are among the requirements of Section 106 of the National Historic Preservation Act. This Act requires federal agencies or applicant for federal assistance to consult with the appropriate State Historic Preservation Office before they carry out their proposed undertakings. The Advisory Council on Historic Preservation has codified procedures for carrying out Section 106 review in 36 CFR 800. You may wish to familiarize yourself with these procedures (Federal Register, December 12, 2000, pages 77698-77739) if you are unsure about the Section 106 process.

   Response to Comment 1: Comment noted.

2. Project as currently proposed MAY ADVERSELY AFFECT PROPERTIES THAT ARE ELIGIBLE FOR LISTING IN THE NATIONAL REGISTER OF HISTORIC PLACES. You should now begin immediate consultation with our office.

   Response to Comment 2: TVA is executing an agreement with the seven Tennessee Valley region State Historic Preservation Officers, including Tennessee and other consulting parties, which outlines the actions TVA would take to avoid or mitigate adverse effects on historic properties associated with TVA's Preferred Alternative.

Tennessee Wildlife Resources Agency

September 2, 2003

Mr. David Nye
ROS Project Manager
Tennessee Valley Authority
400 West Summit Hill Drive, WT11A
Knoxville, TN 37902

Re: Reservoir Operations Draft EIS

Dear Mr. Nye:

The Tennessee Wildlife Resources Agency (TWRA) appreciates the opportunity to provide comments and recommendations on the Draft Reservoir Operations Study (ROS). Please find attached the Agency's recommendations for inclusion in a final EIS. We appreciate TVA's effort to consider the impact of changes in the reservoir operations on reservoir users and TVA ratepayers. Likewise, we appreciate TVA's effort to assess impacts on natural resources including wildlife, fish and aquatic life, and habitat. **[1]** In general, we find the least damaging alternative to be the "base case" and elements of the "navigation" operation. We are concerned that the recreation options will result in unacceptable adverse impact to wildlife resources, water quality, and habitat. **[2]**

We look forward to continued discussions with TVA technical staff regarding preparation of the final EIS and identification of preferred alternatives. If you have any questions or need additional information related to the attached TWRA comments and recommendations, please contact David McKinney, Division of Environmental Services, at (615) 781-6643. **[3]**

Sincerely

Gary T. Myers

Executive Director

DM:bg
attachment

Recreational Benefit Projects:

We find the economic analysis upon which the recreational option benefit projections are based to be suspect. Tennessee has approximately 270,000 registered boats; this number of watercraft does not include canoes, kayaks, or various inflatables. Unregistered boats and boats registered in other states routinely utilize Tennessee reservoirs. Assuming full, year-round occupancy of all available commercial boat slips, fewer than thirteen percent of Tennessee's registered watercraft are associated contractually with commercial marinas. The economic data utilized here are unverified. The in-state economic value of boat sales, fuel purchases, boat maintenance, lodging, fishing gear, and travel cost associated with public access boating should be fully and fairly assessed. The majority of boat owners, including those who trailer their boats in pursuit of seasonal sport fishing opportunity, have been given limited consideration. TVA's assumption that the majority of all economic benefit from boating is from or through commercial operations should be verified by an independent economic analysis conducted by an unbiased expert, such as the University of Tennessee. An independent economic evaluation would give TVA a much-needed credible basis for decision-making. **[4]**

Adverse Impacts:

Consideration of the adverse impacts of higher, longer duration reservoir levels on near shore and riparian habitat is inadequate. The adverse impacts on habitat and water quality from higher, longer duration reservoir levels adopted in the 1990's should be addressed as separate components of the current base case. Vegetation required for successful spawning and recruitment of sport fish and as essential riparian habitat has retreated to incrementally higher elevation contours and is unavailable as aquatic habitat for spawning, nursery areas, or as suitable habitat for riparian species such as migratory shore birds. Higher, longer duration reservoir levels above the base case will cause incrementally greater destruction of shoreline habitat. The Draft EIS appears to significantly underestimate the adverse impact of higher, longer summer pool levels, especially on main-stem reservoirs. TWRA is engaged in an innovative agency-citizen project to restore near-shore and shoreline habitat on Kentucky Lake. It is likely this effort will be negated if TVA initiates higher, longer duration summer pools. **[5]**

TVA should, as part of the Draft EIS, contract with independent habitat analysis expertise, such as the Oak Ridge National Laboratory (ORNL), to develop a comprehensive habitat behavior model relative to reservoir pool elevation and duration. This model should include analysis of the natural resource and economic impact of lost near-shore and shoreline habitat on fish and aquatic life, migratory shorebirds, and waterfowl. This analysis should also consider the impact of extended higher pool levels on shoreline erosion. Exposed mud-flats are essential habitat for wildlife resources. **[6]**

Stable Spring Spawning Levels:

Fish and aquatic life resources in Tennessee would benefit from stable reservoir surface elevations for spring spawning. Given the variability of spring reservoir inflow and power demands, TVA's commitment to providing stable spring spawning conditions is no stronger than the base case. TWRA request that TVA prepare an option which provides that each tributary and each main-stem reservoir be provided a minimum of one year of stable spring conditions in each four-year cycle. Such a rotation in non-average spring inflow years would greatly assist to prevent the loss of or greatly diminished sport fish opportunity on a given reservoir. **[7]**

Tailwater Restoration:

TVA's agreement with the State of Tennessee as found in the Phased Approach to Tailwater Restoration, later advanced and expanded in the TVA Reservoir Improvement Program, has resulted in TVA becoming the global leader in tailwater management and restoration. TVA's decision to maintain and improve this program is the most significant commitment and outcome of the ROS review. In general terms, TWRA is opposed to options, or elements of options, the consequences of which are not supportive of or in harmony with tailwater restoration and improvement. If anything, we believe that public support, interest, and enthusiasm for successful restoration projects such as Watauga, South Holton, Douglas, and Cherokee tail waters is under appreciated in the Draft EIS from both a natural resource and economic impact perspective. We recommend to you the recent report by Tennessee Tech University (TTU) entitled "Net Value of Trout Fishing Opportunities in Tennessee Tailwaters", by Williams and Bettoli. **[8]**

Navigation Option:

Fewer than 8% of TVA reservoir users are lakefront property owners. As Tennessee's population grows, this percentage will rapidly diminish at the same time demand for reservoir use increases. Of the options considered, the navigation option provides economic, public safety, and societal benefits for all TVA ratepayers and reservoir users. Although the navigation option appears to have little adverse impact on natural resources, TWRA would prefer to see an independent evaluation of the impact of this option on near-shore and shoreline habitat on both tributary and main-stem reservoirs. If TVA's no adverse impact projections are verified, TWRA would be supportive of adoption of the navigation option. **[9]**

Kentucky Lake:

Kentucky Lake is considered by many to be the crown jewel of the TVA reservoir system. The tremendous biological diversity and productivity found in Kentucky Lake is due largely to continuing riverine characteristics. Kentucky Lake's diverse freshwater mussel fauna includes both federally protected species and commercially harvested mussels that are the foundation of the global cultured pearl industry. Commercial harvest of fish, including paddlefish and their roe, is economically significant. Important sport fish include crappie, sauger, black bass, and catfish.

In the latter half of the 1980's, Kentucky Lake experienced significant problems, including diseased and blemished fish and a sustained die-off of freshwater mussels. These problems were related to drought-induced reductions in flow, elevated water temperatures, lower dissolved oxygen levels, and reduced assimilative capacity. These problems were related to a shift from riverine conditions to typical reservoir conditions. To address this issue, TVA made a commitment in the early 1990's to maintain a 12,000 cubic feet per second (CFS) flow through Kentucky Lake to maintain both water quality and riverine character. **[10]**

Keeping Kentucky Lake at full summer pool into late summer and/or early fall, particularly in years of low to normal inflow, will result in a return of the unacceptable occurrences of the mid to late 1980's. The best scenario for maintaining the biological health of this highly important resource is begin draw down from summer pool earlier than the existing base case and operate Pickwick and Kentucky dams in tandem to maximize Kentucky Lake's riverine character. **[11]**

Should TVA propose an ill-advised extension of summer pool conditions beyond the base case, TWRA will request the U.S. Fish and Wildlife Service (USFWS) to require formal consultation regarding the potential impact on special status species, the preparation of low to normal inflow contingency plan, an extensive biological monitoring program for fish, benthic organisms and freshwater mussels, and extensive mitigation for lost shorebird habitat in the form of artificially flooded shorebird habitat. **[12]**

RESPONSE TO COMMENTS

1. We appreciate TVA's effort to consider the impact of changes in the reservoir operations on reservoir users and TVA ratepayers. Likewise, we appreciate TVA's effort to assess impacts on natural resources including wildlife, fish and aquatic life, and habitat.

Response to Comment 1: Comment noted.

2. In general, we find the least damaging alternative to be the "base case" and elements of the "navigation" operation. We are concerned that the recreation options will result in unacceptable adverse impact to wildlife resources, water quality, and habitat.

Response to Comment 2: Comment noted.

3. We look forward to continued discussions with TVA technical staff regarding preparation of the final EIS and identification of preferred alternatives.

Response to Comment 3: Comment noted.

4. Recreational Benefit Projects: We find the economic analysis upon which the recreational option benefit projections are based to be suspect. Tennessee has approximately 270,000 registered boats; this number of watercraft does not include canoes, kayaks, or various inflatables. Unregistered boats and boats registered in other states routinely utilize Tennessee reservoirs. Assuming full, year-round occupancy of all available commercial boat slips, fewer than thirteen percent of Tennessee's registered watercraft are associated contractually with commercial marinas. The economic data utilized here are unverified. The in-state economic value of boat sales, fuel purchases, boat maintenance, lodging, fishing gear, and travel cost associated with public access boating should be fully and fairly assessed. The majority of boat owners, including those who trailer their boats in pursuit of seasonal sport fishing opportunity, have been given limited consideration. TVA's assumption that the majority of all economic benefit from boating is from or through commercial operations should be verified by an independent economic analysis conducted by an unbiased expert, such as the University of Tennessee. An independent economic evaluation would give TVA a much-needed credible basis for decision-making.

Response to Comment 4: Recreational economic benefits were estimated based on survey data of customers at facilities located on reservoirs (recreationists at locations where water-based recreation is the primary activity), marina operator customers, and reservoir property owners. The study measured changes in recreation value to the Tennessee Valley region that corresponded to changes in reservoir operations; this change would occur primarily through water-based recreation.

The numbers shown for commercial use facilities included boats on trailers that were launching from those facilities, in addition to watercraft moored at the facility.

The EIS recreation analysis and results are consistent with a 2003 recreation study in six counties of East Tennessee conducted by the University of Tennessee's Center for Business and Economic Research, which is available at their web site at http://bus.utk.edu/cber/lakeres.htm. TVA retained nationally recognized recreation experts to lead the analysis of recreation effects.

5. Adverse Impacts: Consideration of the adverse impacts of higher, longer duration reservoir levels on near shore and riparian habitat is inadequate. The adverse impacts on habitat and water quality from higher, longer duration reservoir levels adopted in the 1990's should be addressed as separate components of the current base case. Vegetation required for successful spawning and recruitment of sport fish and as essential riparian habitat has retreated to incrementally higher elevation contours and is unavailable as aquatic habitat for spawning, nursery areas, or as suitable habitat for riparian species such as migratory shore birds. Higher, longer duration reservoir levels above the base case will cause incrementally greater destruction of shoreline habitat. The Draft EIS appears to significantly underestimate the adverse impact of higher, longer summer pool levels, especially on main-stem reservoirs. TWRA is engaged in an innovative agency-citizen project to restore near-shore and shoreline habitat on Kentucky Lake. .It is likely this effort will be negated if TVA initiates higher, longer duration summer pools.

Response to Comment 5: TVA recognizes that higher water levels for longer durations are likely to increase shoreline erosion. Aquatic vegetation along the shoreline is an important factor in the survival of many species and requires a period of regrowth each year to continue its benefits. TVA's Preferred Alternative does not include any operating guide changes for Kentucky Reservoir.

6. TVA should, as part of the Draft EIS, contract with independent habitat analysis expertise, such as the Oak Ridge National Laboratory (ORNL), to develop a comprehensive habitat behavior model relative to reservoir pool elevation and duration. This model should include analysis of the natural resource and economic impact of lost near-shore and shoreline habitat on fish and aquatic life, migratory shorebirds, and waterfowl. This analysis should also consider the impact of extended higher pool levels on shoreline erosion. Exposed mud-flats are essential habitat for wildlife resources.

Response to Comment 6: The effects of the alternatives on flats and other shoreline habitats are an important component of the terrestrial ecology evaluation. The FEIS has been modified to better address these habitats. In addition to the USFWS, a number of other federal and state agencies have worked closely with TVA during the preparation of the ROS and its EIS. These agencies have provided an appropriate level of independent oversight of this effort.

7. Stable Spring Spawning Levels: Fish and aquatic life resources in Tennessee would benefit from stable reservoir surface elevations for spring spawning. Given the variability of spring reservoir inflow and power demands, TVA's commitment to providing stable spring spawning conditions is no stronger than the base case. TWRA request that TVA prepare an option which provides that each tributary and each main-stem reservoir be provided a minimum of one year of stable spring conditions in each four-year cycle. Such a rotation in non-average spring inflow years would greatly assist to prevent the loss of or greatly diminished sport fish opportunity on a given reservoir.

Response to Comment 7: TVA would attempt to stabilize tributary reservoir levels for 2 weeks after the water temperature at 5 feet has reached 60 ºF. Unfortunately, TVA's analysis of flood risks indicates that risks become unacceptable, if the length of the stabilization is longer than 2 weeks—even on a rotational basis.

8. Tailwater Restoration: TVA's agreement with the State of Tennessee as found in the Phased Approach to Tailwater Restoration, later advanced and expanded in the TVA Reservoir Improvement Program, has resulted in TVA becoming the global leader in tailwater management and restoration. TVA's decision to maintain and improve this program is the most significant commitment and outcome of the ROS review. In general terms, TWRA is opposed to options, or elements of options, the consequences of which are not supportive of or in harmony with tailwater restoration and improvement. If anything, we believe that public support, interest, and enthusiasm for successful restoration projects such as Watauga, South Holton, Douglas, and Cherokee tail waters is under appreciated in the Draft EIS from both a natural resource and economic impact perspective. We recommend to you the recent report by Tennessee Tech University (TTU) entitled "Net Value of Trout Fishing Opportunities in Tennessee Tailwaters" by Williams and Bettoli.

Response to Comment 8: TVA plans to meet DO concentrations and minimum flow targets established in the 1990 Lake Improvement Plan. In addition, TVA proposes to commit to minimum flows in the Apalachia Dam Bypass reach (as described in Chapter 3 and Appendix B of the EIS) in order to help restore that tailwater. The independent contractor considered the Williams and Bettoli data in the analysis.

9. Navigation Option: Fewer than 8% of TVA reservoir users are lakefront property owners. As Tennessee's population grows, this percentage will rapidly diminish at the same time demand for reservoir use increases. Of the options considered, the navigation option provides economic, public safety and societal benefits for all TVA ratepayers and reservoir users. Although the navigation option appears to have little adverse impact on natural resources, TWRA would prefer to see an independent evaluation of the impact of this option on near-shore and shoreline habitat on both tributary and mainstem reservoirs. If TVA's no adverse impact projections are verified, TWRA would be supportive of adoption of the navigation option.

Response to Comment 9: TVA retained a number of outside experts in various disciplines to assist in ROS analyses. TVA also worked closely with individuals representing various public stakeholders and federal and state agencies during the preparation of the ROS EIS. These activities ensured an appropriate level of independent oversight of the ROS EIS. TVA's Preferred Alternative now has been identified in the FEIS.

10. Kentucky Lake: Kentucky Lake is considered by many to be the crown jewel of the TVA reservoir system. The tremendous biological diversity and productivity found in Kentucky Lake is due largely to continuing riverine characteristics. Kentucky Lake's diverse freshwater mussel fauna includes both federally protected species and commercially harvested mussels that are the foundation of the global cultured pearl industry. Commercial harvest of fish, including paddlefish and their roe, is economically significant. Important sport fish include crappie, sauger, black bass, and catfish.

In the latter half of the 1980's, Kentucky Lake experienced significant problems, including diseased and blemished fish and a sustained die-off of freshwater mussels. These problems were related to drought-induced reductions in flow, elevated water temperatures, lower dissolved oxygen levels, and reduced assimilative capacity. These problems were related to a shift from riverine conditions to typical reservoir conditions. To address this issue, TVA made a commitment in the early 1990's to maintain a 12,000 cubic feet per second (CFS) flow through Kentucky Lake to maintain both water quality and riverine character.

Response to Comment 10: TVA plans to meet DO concentrations and minimum flow targets established in the 1990 Lake Improvement Plan.

11. Keeping Kentucky Lake at full summer pool into late summer and/or early fall, particularly in years of low to normal inflow, wil1 result in a return of the unacceptable occurrences of the mid to late 1980's. The best scenario for maintaining the biological health of this highly important resource is begin draw down from summer pool earlier than the existing base case and operate Pickwick and Kentucky dams in tandem to maximize Kentucky Lake's riverine character.

Response to Comment 11: As discussed in TVA's responses to the comments from the Corps and others, TVA is not proposing to alter the operating guide curve for Kentucky Reservoir as an element of its Preferred Alternative.

12. Should TVA propose an ill-advised extension of summer pool conditions beyond the base case, TWRA will request the U.S. Fish and Wildlife Service (USFWS) to require formal consultation regarding the potential impact on special status species, the preparation of low to normal inflow contingency plan, an extensive biological monitoring program for fish, benthic organisms and freshwater mussels, and extensive mitigation for lost shorebird habitat in the form of artificially flooded shorebird habitat.

Response to Comment 12: TVA has consulted with USFWS on the potential impacts of the Preferred Alternative on threatened and endangered species. The results of this consultation are incorporated into Section 5.13 and Appendix G of the FEIS. Projected loss of important shoreline habitat, such as flats, has been substantially reduced by the decision to not include operating guide curve changes on Kentucky Reservoir as part of the Preferred Alternative.

Commonwealth of Virginia Department of Environmental Quality, Department of Conservation and Recreation, and Department of Transportation

September 2, 2003

Mr. David Nye
Reservoir Operations Study Project Manager
Tennessee Valley Authority
400 West Summit Hill Drive, WT11A
Knoxville, Tennessee 37902

RE: Draft Programmatic Environmental Impact Statement, Reservoir Operations Study
DEQ-03-130F

Dear Mr. Nye:

The Commonwealth of Virginia has completed its review of the above document (hereinafter Draft PEIS). The Department of Environmental Quality is responsible for coordinating Virginia's review of federal environmental documents and responding to appropriate federal officials on behalf of the Commonwealth. The following agencies took part in this review:

Department of Environmental Quality (hereinafter "DEQ")
Department of Conservation and Recreation
Department of Transportation.

In addition, the Department of Game and Inland Fisheries and the Department of Historic Resources were invited to comment.

<u>Project Description</u>

TVA is evaluating its reservoir operations in order to determine whether they can be improved throughout the Tennessee Valley (Draft PEIS, page ES-3). The watershed includes portions of western Virginia (Draft PEIS, page 1-2, Figure 1.1-01). The document examines the "Base Case" (present operational scheme) and seven alternative schemes, focused on hydropower, recreation, flood control, habitat, and navigation (Draft PEIS, page ES-5; see pages 3-10 through 3-19). TVA has not indicated a preferred alternative; it will make a selection following the receipt of additional public input and articulate that selection in the Final PEIS (Draft PEIS, page ES-24).

Environmental Impacts and Mitigation

1. General Comment. Environmental issues addressed in this document include aquatic habitat, water quality, water quantity, erosion control, protection of threatened or endangered species, wetlands, and other ecologically sensitive areas. The information appears accurate and addresses the complex nature of accommodating the many concerns associated with dam operations. **[1]**

2. Natural Heritage Resources. The Department of Conservation and Recreation (DCR) has searched its Biotics Data System for occurrences of natural heritage resources in the areas covered by the Study. "Natural heritage resources" are defined as the habitat of rare, threatened, or endangered plant and animal species, unique or exemplary natural communities, and significant geologic formations. According to DCR, natural heritage resources are documented in the Study area, but the scope of the schemes under study and the distance to the resources indicate to DCR that the schemes are unlikely to give rise to adverse effects upon the resources.

Under a Memorandum of Agreement between DCR and the Department of Agriculture and Consumer Services (VDACS), DCR has the authority to report for VDACS on state-listed endangered and threatened plant and insect species. According to DCR, the activities undertaken pursuant to the Study would not affect any such species. **[2]**

3. Exotic Species Concern. The Draft PEIS indicates that the commercial navigation alternative would increase shipper savings (by way of raised winter reservoir elevations in the mainstem reservoirs, see page ES-22 and also page 5.11-3, section 5.11.6). The Department of Conservation and Recreation is concerned that increased commercial navigation in the Tennessee River system may facilitate exotic species transmission, especially with larger vessels retaining foreign ballast water. Such species may adversely affect natural heritage resources. The Draft PEIS mentions that colonization of shoreline habitats by red fire ants might result from raised reservoir levels under this alternative; but it states that increased winter reservoir elevations could reduce the spread of some invasive terrestrial plant species (page 5.11-3, section 5.11.6). The Department of Conservation and Recreation recommends that TVA investigate ways to avoid the transmission of invasive species. **[3]**

4. Water Resources and Wetlands. According to DEQ's Water Division, only one of the reservoirs in the TVA system is in Virginia. The northern portion of South Holston Lake is just north of the Tennessee-Virginia border in Washington County, Virginia; the dam which is responsible for the reservoir is in Tennessee.

Fringe wetlands around the South Holston Lake and along other bodies of surface water will be affected by water level adjustments in that lake under any of the alternatives. Some fringe wetlands will re-colonize an area from which they have been removed through either flooding from raised water levels or drying out from lowered water levels. **[4]**

According to DEQ's Water Division, the Washington County Public Service Authority (WCSA) plans to install a water supply intake in the upper reaches of South Holston Lake. Under the current operational scheme, unrestricted drawdown of the lake beginning in August lowers the lake level at the same time that this new intake would be most in demand. The alternative for WCSA would be to take water from the Middle Fork of the Holston River during this low-flow season; that course of action would be harmful to minimum in-stream flow objectives. DEQ's

Water Division recommends that TVA select the preferred alternative with this WCSA project in mind. **[5]**

Of the alternatives presented, it appears that "Reservoir Recreation A" and "Commercial Navigation" alternatives will result in the least impacts to water resources. The Commonwealth would support either of these as the preferred alternative. We would not recommend selection of any of the following alternatives because they would give rise to adverse effects to wetlands and water quality: **[6]**

"Reservoir Recreation B"
"Summer Hydropower"
"Equalized Summer/Winter Flood Risk"
"Tailwater Recreation" or
"Tailwater Habitat."

5. Natural Areas. The Department of Conservation and Recreation indicates that there are no State Natural Area Preserves in the Study area. **[7]**

6. Transportation Impacts. The operational schemes are unlikely to have long-term, negative impacts on traffic, according to the Virginia Department of Transportation (VDOT). Any operational work with the potential to affect roads or other transportation facilities should be coordinated with VDOT's Bristol District Office (Ken Brittle, telephone (276) 669-9903, extension 203). **[8]**

Thank you for the opportunity to review this document. We look forward to reviewing the Final Programmatic EIS for the Reservoir Operations Study. **[9]**

Sincerely,

Ellie L. Irons
Program Manager
Office of Environmental Impact Review

Enclosures

cc: Brian D. Moyer, DGIF
Derral Jones, DCR
Ellen Gilinsky, DEQ-Water
Allen J. Newman, DEQ-SWRO
David V. Grimes, VDOT
Ethel R. Eaton, DHR

RESPONSE TO COMMENTS

1. *General Comment.* Environmental issues addressed in this document include aquatic habitat, water quality, water quantity, erosion control, protection of threatened or endangered species, wetlands, and other ecologically sensitive areas. The information appears accurate and addresses the complex nature of accommodating the many concerns associated with dam operations.

   Response to Comment 1: Comment noted.

2. *Natural Heritage Resources.* The Department of Conservation and Recreation (DCR) has searched its Biotics Data System for occurrences of natural heritage resources in the areas covered by the Study. "Natural heritage resources" are defined as the habitat of rare, threatened, or endangered plant and animal species, unique or exemplary natural communities, and significant geologic formations. According to DCR, natural heritage resources are documented in the Study area, but the scope of the schemes under study and the distance to the resources indicate to DCR that the schemes are unlikely to give rise to adverse effects upon the resources.

   Under a Memorandum of Agreement between DCR and the Department of Agriculture and Consumer Services (VDACS), DCR has the authority to report for VDACS on state-listed endangered and threatened plant and insect species. According to DCR, the activities undertaken pursuant to the Study would not affect any such species.

   Response to Comment 2: As indicated in Section 4.13 and in Appendix D6a, Heritage Database records available to TVA indicated that five federal- and/or state-listed species have been encountered within 1-mile buffers around the TVA reservoirs and regulated stream reaches in Virginia. This relatively large initial search area was used to identify reported occurrences of any listed species that might be affected by changes in the reservoir operations policy. Potential impacts of the alternatives on these species, which are listed in Appendix D, Table D6a-01, are addressed in Section 5.13.

3. *Exotic Species Concern.* The Draft PEIS indicates that the commercial navigation alternative would increase shipper savings (by way of raised winter reservoir elevations in the mainstem reservoirs, see page ES-22 and also page 5.11-3, section 5.11.6). The Department of Conservation and Recreation is concerned that increased commercial navigation in the Tennessee River system may facilitate exotic species transmission, especially with larger vessels retaining foreign ballast water. Such species may adversely affect natural heritage resources. The Draft PEIS mentions that colonization of shoreline habitats by red fire ants might result from raised reservoir levels under this alternative; but it states that increased winter reservoir elevations could reduce the spread of some invasive terrestrial plant species (page 5.11-3, section 5.11.6). The Department of Conservation and Recreation recommends that TVA investigate ways to avoid the transmission of invasive species.

   Response to Comment 3: Larger vessels with the capability of holding ballast water do not typically navigate the Tennessee River system, where barge traffic is the primary means of transport. TVA is working with several groups—locally and regionally—to address these invasive species issues.

4. *Water Resources and Wetlands.* According to DEQ's Water Division, only one of the reservoirs in the TVA system is in Virginia. The northern portion of South Holston Lake is

just north of the Tennessee-Virginia border in Washington County, Virginia; the dam which is responsible for the reservoir is in Tennessee.

Fringe wetlands around the South Holston Lake and along other bodies of surface water will be affected by water level adjustments in that lake under any of the alternatives. Some fringe wetlands will re-colonize an area from which they have been removed through either flooding from raised water levels or drying out from lowered water levels.

Response to Comment 4: Comment noted.

5. According to DEQ's Water Division, the Washington County Public Service Authority (WCSA) plans to install a water supply intake in the upper reaches of South Holston Lake. Under the current operational scheme, unrestricted drawdown of the lake beginning in August lowers the lake level at the same time that this new intake would be most in demand. The alternative for WCSA would be to take water from the Middle Fork of the Holston River during this low-flow season; that course of action would be harmful to minimum in-stream flow objectives. DEQ's Water Division recommends that TVA select the preferred alternative with this WCSA project in mind.

Response to Comment 5: This is a reservoir-specific issue that should be addressed in a context other than this programmatic EIS, which considers system-wide operations policy changes. However, TVA understands that the proposed intake for WCSA has generated debate, and TVA is committed to working with other state and federal agencies to arrive at the best solution. Maintaining higher levels at South Holston Reservoir may appear to be an option but, under dry hydrologic conditions, that might not be possible because there might not be enough water to accomplish that objective. Other alternatives should be explored. For example, because the low flow in the South Fork Holston River appears to be similar to the low flow in the Middle Fork, splitting the withdrawal between the two rivers would lessen the impact on the Middle Fork. An additional alternative would be to move the WCSA intake further down into the South Holston Reservoir, so that it would not be influenced by normal reservoir drawdown.

6. Of the alternatives presented, it appears that "Reservoir Recreation A" and "Commercial Navigation" alternatives will result in the least impacts to water resources. The Commonwealth would support either of these as the preferred alternative. We would not recommend selection of any of the following alternatives because they would give rise to adverse effects to wetlands and water quality:

"Reservoir Recreation B"
"Summer Hydropower"
"Equalized Summer/Winter Flood Risk"
"Tailwater Recreation" or
"Tailwater Habitat."

Response to Comment 6: TVA formulated its Preferred Alternative with the intent of capturing the beneficial elements of the identified alternatives, while lessening adverse impacts—particularly those related to flood control and water quality.

7. *Natural Areas.* The Department of Conservation and Recreation indicates that there are no State Natural Area Preserves in the Study area.

Response to Comment 7: Comment noted.

8. *Transportation Impacts*. The operational schemes are unlikely to have long-term, negative impacts on traffic, according to the Virginia Department of Transportation (VDOT). Any operational work with the potential to affect roads or other transportation facilities should be coordinated with VDOT's Bristol District Office (Ken Brittle, telephone (276) 669-9903, extension 203).

Response to Comment 8: Comment noted.

9. Thank you for the opportunity to review this document. We look forward to reviewing the Final Programmatic EIS for the Reservoir Operations Study.

Response to Comment 9: We appreciate Virginia's continued involvement in the ROS as a member of the Interagency Team.

Tribal Comments (Eastern Band of Cherokee Indians)

September 24th 2003

Mr. David Nye
ROS Project Manager Tennessee Valley Authority
WT 11A
400 West Summit Drive
Knoxville
TN 37902

Re: ROS Comments

Dear Mr. Nye,

I attended the Murphy, NC Workshop and have subsequently obtained hardcopy study documents from your staff. The Tribal Environmental Office is most certainly interested in providing you with our comments on the study, however due to my commitments to the Duke Power FERC re-licensing negotiations I have been unable to formulate our comments in time for your deadline.

I hereby request a sixty day extension past the deadline for our written response. I also understand a similar request has been made by the Tribal Cultural Resources Office to the TVA Cultural Resources Office. **[1]** The Tribal Environmental and Cultural Resources Offices will work together to produce comments on the study that will endeavor to take a holistic approach towards protection of natural and cultural resources.

Sincerely,

Michael Bolt

Eastern Band of Cherokee Indians
TRIBAL UTILITIES
MIKE BOLT
WATER QUALITY STANDARDS
P. O. BOX 547, OLD #4 RD. 828-497-6824
CHEROKEE, N. C. 28719 FAX: 828-497-5419
michbolt@nc-cherokee.com

Cc. Cannen Mclntyre,
TEO Lora K.O. Taylor, THPO
Michelle Hamilton, THPO

RESPONSE TO COMMENT

1. The Tribal Environmental Office is most certainly interested in providing you with our comments on the study, however due to my commitments to the Duke Power FERC re-licensing negotiations I have been unable to formulate our comments in time for your deadline.

I hereby request a sixty day extension past the deadline for our written response. I also understand a similar request has been made by the Tribal Cultural Resources Office to the TVA Cultural Resources Office.

Response to Comment 1: TVA continued to accept comments (through mid-October) from tribes and persons who informed the agency that their comments would be late.

Tribes of the Eastern Oklahoma Region

AUG 29, 2003

Mr. David Nye
ROS Project Manager
Tennessee Valley Authority, WT 11A
400 West Summit Drive
Knoxville, Tennessee 37902

Dear Mr Nye:

On July 14, 2003, the Eastern Oklahoma Regional Office (EORO), Bureau of Indian Affairs (BIA), received a copy of an Environmental Impact Statement (EIS) from the Tennessee Valley Authority, Knoxville, Tennessee, regarding changes in the operating policies for the Tennessee Valley (TV) reservoir. The EIS identified seven alternative operating policies and a "no-action" alternative.

The TV reservoir may be within the aboriginal lands of the following Tribes of the Eastern Oklahoma Region: Muscogce (Creek) Nation, Cherokee Nation of Oklahoma, United Keetoowah Band of Cherokees of Oklahoma, Kialegee Tribal Town, Thlopthlocco Tribal Town and the Alabama-Quassarte Tribal Town. The policy changes may impact cultural and/or religious properties that are significant to these tribes. Your letter will be forwarded to the BIA Agencies/Field Stations, Eastern Oklahoma Region, for distribution to these tribes for review and comments. For your information, a list is enclosed of the formal contact person and the mailing address for each Tribe referenced above. **[1]**

If additional information is needed, please contact Mr. Jimmy Gibson, Acting Branch Chief, Branch of Natural Resources, Eastern Oklahoma Regional Office, at (918) 781-4642.

Respectively,

J. Mannis

Regional Director
U.S. Bureau of Indian Affairs
Eastern Oklahoma Regional Office

Eastern Oklahoma Region Tribes

Honorable Chadwick Smith
Principal Chief, Cherokee Nation
P.O. Box 948
Tahlequah, Oklahoma 74465

Honorable Dallas Proctor
Chief, United Keetoowah Band of Cherokees
P.O. Box 746
Tahlequah, Oklahoma 74465

Honorable Tarpie Yargee
Chief, Alabama-Quassarte Tribal Town
P.O. Box 187
Wetumka, Oklahoma 74883

Honorable Lowell Wesley
Town King, Kialegee Tribal Town
P.O. Box 332
Wetumka, Oklahoma 74883

Honorable R. Perry Beaver
Principal Chief, Muscogee (Creek) Nation
P.O. Box 580
Okmulgee, Oklahoma 74447

Honorable Bryan McGrett
Town King, Thlopthlocco Tribal Town
P.O. Box 188
Okemah, Oklahoma 74859

RESPONSE TO COMMENT

1. The TVA reservoir may be within the aboriginal lands of the following Tribes of the Eastern Oklahoma Region: Muscogce (Creek) Nation, Cherokee Nation of Oklahoma, United Keetoowah Band of Cherokees of Oklahoma, Kialegee Tribal Town, Thlopthlocco Tribal Town and the Alabama-Quassarte Tribal Town. The policy changes may impact cultural and/or religious properties that are significant to these tribes. Your letter will be forwarded to the BIA Agencies/Field Stations, Eastern Oklahoma Region, for distribution to these tribes for review and comments. For your information, a list is enclosed of the formal contact person and the mailing address for each Tribe referenced above.

Response to Comment 1: TVA invited 17 federally recognized Indian tribes to be consulting parties in the process that addressed effects on historic properties, consistent with Section 106 of the National Historic Preservation Act.

From: Lee Clauss [mailto:leerainsclauss@yahoo.com]
Sent: Saturday, August 09, 2003 2:56 PM

THPO's comments/concerns:

Reservoir Operations Study: The EBCI THPO is very interested in this study and has previously requested consulting party status. Just recently, we were provided with the NEPA documents related to this study. We understand that comments are due in early September, but do to the staffing changes, it is highly improbable that such a review will be completed by that date. Furthermore, it is our understanding that the current submission is incomplete, as it lacks the archaeological study. If that study can be provided prior to our commenting, that would make the process much more efficient. Also, because of the EBCI's great interest in the reservoirs included in this study, especially Fontana Reservoir, I think it would be beneficial to TVA to arrange a meeting with the EBCI about the ROS. This meeting should include, at the very least, a representative from Cultural Resources (Russ), Environmental (Carmen McIntyre or Tommy Cabe), and Wastewater (Mike Bolt). Perhaps someone from Fish and Wildlife could also attend. Anyway, I would discuss this suggestion with Russell and have him provide you with the appropriate contact information for the other tribal employees. **[1]**

RESPONSE TO COMMENT

1. Reservoir Operations Study: The EBCI THPO is very interested in this study and has previously requested consulting party status. Just recently, we were provided with the NEPA documents related to this study. We understand that comments are due in early September, but do to the staffing changes, it is highly improbable that such a review will be completed by that date. Furthermore, it is our understanding that the current submission is incomplete, as it lacks the archaeological study. If that study can be provided prior to our commenting, that would make the process much more efficient. Also, because of the EBCI's great interest in the reservoirs included in this study, especially Fontana Reservoir, I think it would be beneficial to TVA to arrange a meeting with the EBCI about the ROS. This meeting should include, at the very least, a representative from Cultural Resources (Russ), Environmental (Carmen McIntyre or Tommy Cabe), and Wastewater (Mike Bolt). Perhaps someone from Fish and Wildlife could also attend. Anyway, I would discuss this suggestion with Russell and have him provide you with the appropriate contact information for the other tribal employees.

   Response to Comment 1: TVA Cultural Resources staff met with the Deputy Tribal Historic Preservation Officer of the Eastern Band of Cherokee Indians (EBCI) to discuss EBCI's concerns regarding impacts on historic properties from reservoir operations. Consistent with the National Historic Preservation Act, TVA is executing a programmatic memorandum with the State Historic Preservation Offices of the seven Tennessee Valley region states and other consulting parties.

The Eastern Band of Cherokee Indians
Tribal Historic Preservation Office
P.O. Box 455, Cherokee, NC 28719
(828) 488-5637 / Fax (828) 488- 5648

October 15, 2003

Danny Olinger
Archaeologist
TVA Cultural Resources
P.O. Box 1589
Norris, TN 37828-1589

RE: DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT: TENNESSEE VALLEY AUTHORITY RESERVOIR OPERATIONS STUDY, VOLUMES I AND II.

Dear Mr. Olinger,

The Eastern Band of Cherokee Indians THPO is in receipt of the above-referenced document and has reviewed the reservoir operations alternatives for their impacts to cultural resources. Obviously, we are in favor of those alternatives which lessen adverse impacts to archaeological resources and historic properties. After reviewing all considered alternatives, we would like to offer the following comments regarding each policy alternative and the Base Case.

Base Case: Current operating policy. Levels of erosion, exposure, development, and visual impact remain the same, and both direct and indirect effects to cultural remain unchanged. Under this option the largest number of known NRHP-eligible sites are exposed during drawdown between summer and winter pools, and the drive and pace of development along the shorelines remains the same because water elevations and drawdown schedules see no change.

Reservoir Recreation A: Summer levels extended through August 1 and Labor Day for 16 specific tributary and mainstem reservoirs, while winter levels on 15 tributary and mainstem reservoirs would be increased. Under this option, the potential for both direct and indirect adverse effects to historic properties and archaeological resources is increased due to increased erosion levels, increased boating and recreational use, and encouragement and acceleration in pace of shoreline development. ***Although fewer archaeological sites would be exposed during drawdown between summer and winter***

***pools, the Eastern Band of Cherokee Indians does not support this alternative because of its accumulated and overall negative impact to cultural resources*.**

Reservoir Recreation B: Summer levels extended through Labor Day for 17 specific tributary and mainstem reservoirs, while winter levels on 15 tributary and mainstem reservoirs would be increased. Under this option, the potential for both direct and indirect adverse effects to historic properties and archaeological resources is increased due to increased erosion levels, increased boating and recreational use, and encouragement and acceleration in pace of shoreline development. ***Although fewer archaeological sites would be exposed during drawdown between summer and winter pools, the Eastern Band of Cherokee Indians does not support this alternative because of its accumulated and overall negative impact to cultural resources.***

Summer Hydropower: On June 1, reservoir releases unrestricted during summer and into fall for hydropower production. Winter levels increased on 10 tributary reservoirs. Under this option, the potential for beneficial impacts to cultural resources is increased. Erosion is decreased due to shorter periods of full summer pool levels, fewer archaeological sites are exposed during drawdowns, and the pace and acceleration of shoreline development may slow due to changes in scenic integrity. ***The Eastern Band of Cherokee Indians supports this option as the first preferred alternative.***

Equalized Summer/Winter Flood Risk: Pool levels lower during the summer and higher during the winter. Under this option, the potential for beneficial impacts to cultural resources is slightly increased. Erosion is decreased due to shorter periods of full summer pool levels (but increased levels during the winter may increase erosion during that period) , fewer archaeological sites are exposed during drawdowns, and shoreline development may slow due to changes in scenic integrity. ***The Eastern Band of Cherokee Indians supports this option as the second preferred alternative.***

Commercial Navigation: Increases navigation channel depth by 2 feet and creates a 13 foot channel for heavier barges. Under this option, the potential for both direct and indirect adverse effects to historic properties and archaeological resources is increased due to continued levels of erosion, increased boating and use, and continuance of acceleration and pace of shoreline development. Like the Base Case, the largest number of known NRHP-eligible sites are exposed during drawdown between summer and winter pools under this alternative. ***The Eastern Band of Cherokee Indians does not support this alternative because of its accumulated and overall negative impact to cultural resources.***

Tailwater Recreation: Similar to Recreation Alternative B, with adjusted tailwater recreational flows.

Under this option, the potential for both direct and indirect adverse effects to historic properties and archaeological resources is increased due to increased erosion levels, increased boating and recreational use, and encouragement and acceleration in pace of shoreline development. ***Although fewer archaeological sites would be exposed during drawdown between summer and winter pools, the Eastern Band of Cherokee Indians does not support this alternative because of its accumulated and overall negative impact to cultural resources.***

Tailwater Habitat: Seventy-five percent of inflows retained to maintain reservoir elevations, while the remaining portion released through the system as continuous flows with no turbine peaking. Under this option, the potential for both direct and indirect adverse effects to historic properties and archaeological resources is increased due to increased erosion levels, increased boating and recreational use, and encouragement and acceleration in pace of shoreline development. ***Although fewer archaeological sites would be exposed during drawdown between summer and winter pools, the Eastern Band of Cherokee Indians does not support this alternative because of its accumulated and overall negative impact to cultural resources.***

The Eastern Band of Cherokee Indians THPO has reviewed the alternatives offered and has concluded that while the majority of alternatives will impact cultural resources in a significant and negative manner, the **Summer Hydropower** and **Equalized Summer/Winter Flood Risk** alternatives results in a beneficial-to-slightly beneficial impact to cultural resources, and these are the options that we support. In addition, the Tribal Environmental Office has reviewed the ROS and concurs with our position as well. **[1]**

We thank you for the opportunity to review and comment on this document, and we look forward to working with you on this project. **[2]** If we can be of further service, or if you have any comments or questions, please direct them to me at (828) 479-1589.

Sincerely,

Michelle Hamilton
Tribal Historic Preservation Specialist
Eastern Band of Cherokee Indians

RESPONSE TO COMMENT

1. The Eastern Band of Cherokee Indians THPO has reviewed the alternatives offered and has concluded that while the majority of alternatives will impact cultural resources in a significant and negative manner, the **Summer Hydropower** and **Equalized Summer/Winter Flood Risk** alternatives results in a beneficial-to-slightly beneficial impact to cultural resources, and these are the options that we support. In addition, the Tribal Environmental Office has reviewed the ROS and concurs with our position as well.

   Response to Comment 1: TVA is executing a programmatic memorandum with the State Historic Preservation Offices of the seven Tennessee Valley region states and other consulting parties, which will guide how TVA further assesses and mitigates potential impacts on cultural resources.

2. We thank you for the opportunity to review and comment on this document, and we look forward to working with you on this project.

   Response to Comment 2: Comment noted.

F4.3 References

Primack, R. B. 1998. Essentials of Conservation Biology. Second Edition. Sinauer Associates Publishers. Sunderland, MA.

Tennessee Valley Authority. 1998. Shoreline Management Initiative: An Assessment of Residential Shoreline Development Impacts in the Tennessee Valley. Norris, TN.

__________. 1990. Lake Improvement Plan, Tennessee River and Reservoir System Operating and Planning Overview. Final Environmental Impact Statement. (TVA/RDG/EQS-91/1.)

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Appendix F5

Commenter Index

TVA

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F5 Commenter Index

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Appendix G

Results of Consultation Performed under Section 7 of the Endangered Species Act

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February 9, 2004

Mr. Jon M. Loney, Manager
NEPA Administration
Tennessee Valley Authority
400 West Summit Hill Drive
Knoxville, Tennessee 37902

Re: FWS #04-0198

Dear Mr. Loney:

This document is the Fish and Wildlife Service's (Service) biological opinion based on our review of the proposed Reservoir Operations Study (ROS) located in the Tennessee River Valley in Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and Virginia, and its effects on the federally threatened snail darter (*Percina tanasi*), pink mucket (*Lampsilis abrupta*), and green pitcher plant (*Sarracenia oreophila*) per section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Your October 24, 2003, request for formal consultation was received on October 24, 2003. The Tennessee Valley Authority (TVA) has made findings for 59 species (Table 1); "likely to adversely affect" the snail darter and "not likely to adversely affect" 58 species, including the pink mucket and green pitcher plant and three Federal candidate species.

FWS Log No: **Application No**:(Action Agency)

Date Started: October 24, 2003 **Ecosystem**: Lower Tennessee/Cumberland; Southern Appalachian

Applicant: N/A **Action Agency**: Tennessee Valley Authority

Project Title: Reservoir Operations Study

County: All counties in the Tennessee River drainage (Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, Virginia)

Table 1. Species and critical habitat evaluated for effects and those where "not likely to be adversely affected" determinations were made.

SPECIES	EVALUATED FOR DIRECT, INDIRECT, AND/OR CUMULATIVE EFFECTS	LIKELY TO ADVERSELY AFFECT	CRITICAL HABITAT DESIGNATED/AFFECTED
Gray bat	YES	NO	NO / NO
Indiana bat	YES	NO	YES / NO
Least tern	YES	NO	NO / NO
Whooping crane	YES	NO	YES / NO
Red-cockaded woodpecker	YES	NO	NO / NO
Wood stork	YES	NO	NO / NO
Bald eagle	YES	NO	NO / NO
Piping plover	YES	NO	YES / NO
Alabama cavefish	YES	NO	YES / NO
Snail darter	YES	YES	NO / NO
Pygmy madtom	YES	NO	NO /NO
Yellowfin madtom	YES	NO	YES / NO
Smoky madtom	YES	NO	YES / NO
Boulder darter	YES	NO	NO / NO
Bluemask darter	YES	NO	NO / NO
Duskytail darter	YES	NO	NO / NO
Slackwater darter	YES	NO	YES / NO
Slender chub	YES	NO	YES / NO

SPECIES	EVALUATED FOR DIRECT, INDIRECT, AND/OR CUMULATIVE EFFECTS	LIKELY TO ADVERSELY AFFECT	CRITICAL HABITAT DESIGNATED/AFFECTED
Spotfin chub	YES	NO	YES / NO
Cumberland bean pearlymussel	YES	NO	NO / NO
Purple bean	YES	NO	NO / NO
Pale lilliput	YES	NO	NO / NO
Cumberland monkeyface	YES	NO	NO / NO
Rough rabbitsfoot	YES	NO	NO* / NO
Fat pocketbook	YES	NO	NO / NO
Rough pigtoe	YES	NO	NO / NO
Cumberland pigtoe	YES	NO	NO / NO
Clubshell	YES	NO	NO / NO
Orangefoot pimpleback	YES	NO	NO / NO
White wartyback	YES	NO	NO / NO
Little-wing pearlymussel	YES	NO	NO / NO
Ring pink	YES	NO	NO / NO
Birdwing pearlymussel	YES	NO	NO / NO
Pink mucket	YES	NO	NO / NO
Cracking pearlymussel	YES	NO	NO / NO
Fine-rayed pigtoe	YES	NO	NO / NO
Shiny pigtoe	YES	NO	NO / NO

SPECIES	EVALUATED FOR DIRECT, INDIRECT, AND/OR CUMULATIVE EFFECTS	LIKELY TO ADVERSELY AFFECT	CRITICAL HABITAT DESIGNATED/AFFECTED
Tan riffleshell	YES	NO	NO / NO
Oyster mussel	YES	NO	NO* / NO
Cumberlandian combshell	YES	NO	NO* / NO
Dromedary pearlymussel	YES	NO	NO / NO
Fanshell	YES	NO	NO / NO
Appalachian elktoe	YES	NO	YES / NO
Armored snail	YES	NO	NO / NO
Noonday globe	YES	NO	NO / NO
Slender campeloma	YES	NO	NO / NO
Anthony's river snail	YES	NO	NO / NO
Tennessee yellow-eyed grass	YES	NO	NO / NO
Virginia spiraea	YES	NO	NO / NO
Mountain skullcap	YES	NO	NO / NO
Green pitcher plant	YES	NO	NO / NO
Ruth's golden aster	YES	NO	NO / NO
Small-whorled pogonia	YES	NO	NO / NO
Leafy prairie clover	YES	NO	NO / NO
Cumberland rosemary	YES	NO	NO / NO
Price's potato bean	YES	NO	NO / NO

*Critical habitat has been proposed, but has not been officially designated. Proposed designation is currently under review.

We concur with TVA's finding of "not likely to adversely affect" for 53 of the above-listed species and critical habitat indicated in Table 1. Those species will not be discussed further in this biological opinion. Upon review of the biological assessment, we concur with the "likely to adversely affect" finding for the snail darter; however, we do not concur with the "not likely to adversely affect" findings for the pink mucket (*Lampsilis abrupta*) and green pitcher plant (*Sarracenia oreophila*). Consequently, those three species will be addressed in this biological opinion. Three Federal candidate species: white fringeless orchid (*Platanthera integrilabia*), slabside pearly mussel (*Lexingtonia dolabelloides*), and the fluted kidneyshell (*Ptychobranchus subtentum*); were also evaluated. We concur that these three species will not be adversely affected by implementation of the preferred alternative. Furthermore, we appreciate that these species were included in the biological assessment, but they currently have no legal protection under the Act and they will not be considered further in this biological opinion.

Although construction of many of the facilities in the TVA water control system pre-dates the consultation requirements of the Act, current operations of those facilities (i.e., the Base Case) have had, and continue to have, adverse effects on a number of federally listed species. However, this biological opinion only addresses the effects to listed species that will occur as a result of implementation of the preferred alternative. Effects of operation and maintenance of the TVA water control system on federally listed species should be addressed in a separate consultation. A recommendation that TVA initiate consultation on operation and maintenance of its water control system was made by the Service in a letter dated December 8, 2003. A response to our letter was received via facsimile from Kathryn J. Jackson, TVA's Executive Vice President for River System Operations and Environment, on February 6, 2004, indicating a willingness to meet as soon as possible to discuss scope for such a consultation. A meeting will be held in the near future between Service and TVA representatives to determine the scope of the consultation.

This biological opinion is based on information provided in the October 24, 2003, project proposal and biological assessment, the June 2003 draft environmental impact statement, and other sources of information. A complete administrative record of this consultation is on file at the Tennessee Ecological Services Field Office, 446 Neal Street, Cookeville, Tennessee 38501; telephone, 931/528-6481.

Consultation History

October 30, 2001 - Wayne Poppe (TVA) met with Lee Barclay, Doug Winford, and Jim Widlak at the Cookeville Office. The purpose of the meeting was to inform Service personnel that TVA was initiating the Reservoir Operations Study, and that the timeline for completing the study, including environmental compliance, was going to be much shorter than that for the Tennessee/Cumberland drainage portion of the broader consultation on operations and maintenance on the Ohio River and its tributaries.

April 25, 2002 - The Endangered Species Working Group met for the first time. The group consisted of the following representatives from TVA and various Service field stations within the Tennessee River drainage:

TVA	Service
John Jenkinson	Steve Alexander
Peggy Shute	Rob Hurt
Bo Baxter	Alice Palmer
Bill Redmond	Mark Cantrell
Carolyn Wells	Bruce Porter
Hill Henry	Jim Widlak
Chuck Nicholson	

TVA presented information about the proposed ROS and how Endangered Species Act compliance would be approached. The group discussed section 7 issues.

July 10, 2002 - Endangered Species Working Group met to discuss the list of species that would be evaluated in the consultation and the approach that would be used to conduct the assessment.

December 9, 2002 - The Endangered Species Working Group met to discuss progress on the biological assessment.

June 25, 2003	-	The Endangered Species Working Group met to discuss progress on the biological assessment.
August 7, 2003	-	John Jenkinson and Peggy Shute met with Jim Widlak in Cookeville to discuss ways to facilitate the ROS consultation. The biological assessment would address 59 species, three of which are candidate species. Additionally, the scope of the proposed action would likely require lengthy discussion of the baseline condition if baseline conditions were included. It was agreed that the language used in the environmental setting section of the draft environmental impact statement could be used largely verbatim for the baseline section of the biological opinion.
October 20, 2003	-	The Endangered Species Working Group met to discuss the draft biological assessment. Joining this meeting from TVA were David Nye, the project manager, Gary Hickman, and Robin Kirsch.
October 24, 2003	-	TVA submitted the biological assessment to the Service, along with a request for initiation of formal consultation.
October 28, 2003	-	The Service submitted a request to TVA, by letter, for further information.
November 7, 2003	-	John Jenkinson, Peggy Shute, Chuck Bach, Morgan Goranflo, Gary Hickman, and Robin Kirsch met with Lee Barclay, Steve Alexander, Jim Widlak, Mark Cantrell (via telephone), and Rob Hurt (via telephone) in Cookeville to discuss the Service's request for more information concerning the formal consultation. TVA representatives agreed to provide further information.
November 12, 2003	-	The Service sent a letter to TVA acknowledging receipt of the consultation package.
November 20, 2003	-	TVA provided additional information in response to Service requests made on October 28, 2003, and during the meeting on November 7, 2003.

BIOLOGICAL OPINION

(*NOTE: Text contained in the "Description of Proposed Action" and "Baseline" sections of this biological opinion came largely from TVA's draft environmental impact statement and subsequent biological assessment*)

DESCRIPTION OF PROPOSED ACTION

In response to changes in public values since completion of the water control system, TVA has periodically evaluated its reservoir operations policy. Currently, TVA is conducting a comprehensive study of its reservoir operations policy-the Reservoir Operations Study-to determine whether changes in operations policy would produce greater overall public benefits. A wide range of policy alternatives for its water control system were analyzed and reviewed, and recommendations for appropriate changes in the reservoir operations policy may be made (**Note:** this biological opinion will, however, only address the preferred alternative). A decision by TVA to change the reservoir operations policy would affect the operation of TVA's water control system and adjust the balance of operating objectives, subject to meeting the purposes of navigation, flood control, and power production.

For the purposes of the ROS, individual water control facilities within the water control system were classified. Each TVA reservoir falls into one of four general categories that are closely related to its characteristics, primary function, and operation in the reservoir system: (1) mainstem storage, (2) mainstem run-of-river, (3) tributary storage, and (4) tributary run-of-river. Because the ecological and geographic characteristics of waterbodies were found to be important to describe the affected environment for the specific resource areas and evaluate potential impacts from changes in the existing reservoir operations policy, an additional waterbody classification was developed. The ROS waterbody classification identifies eight types of waterbodies, ranging from pooled mainstem reaches to warm tributary tailwaters. Each waterbody in the TVA system was defined as a "reach", extending from an upstream boundary to a downstream boundary, and was classified into one of the eight waterbody types. The eight categories reflect several important differences among the waterbodies, including geographic location (physiographic regions), whether the reaches were pooled or flowing, and thermal characteristics (warm, cool, or cold water).

The Tennessee Valley drainage waterbodies, with approximate length of each reach, were classified in each of the following categories:

Flowing Mainstem Reaches (11 Reaches)

1. Kentucky tailwater - 22.4 miles
2. Pickwick tailwater - 95.9 miles

3.	Wilson tailwater	-	14.4 miles
4.	Guntersville tailwater	-	38.3 miles
5.	Nickajack tailwater	-	22.7 miles
6.	Chickamauga tailwater	-	39.9 miles
7.	Watts Bar tailwater	-	23.9 miles
8.	Fort Loudoun tailwater	-	26.3 miles
9.	Fort Loudoun [Inflow]	-	11.2 miles
10.	Clinch River to Melton Hill Dam	-	8.6 miles
11.	Cumberland R.: Barkley Dam tailwater	-	30.6 miles
	Total miles		344.2 miles

Pooled Mainstem Reaches (12 Reaches)

1.	Kentucky Reservoir to Duck River	-	88.4 miles
2.	Pickwick Reservoir to Colbert	-	38.3 miles
3.	Wilson Reservoir	-	15.5 miles
4.	Wheeler Reservoir to Limestone Creek	-	35.8 miles
5.	Guntersville Reservoir to Scottsboro	-	53.0 miles
6.	Nickajack Reservoir to Raccoon Mountain	-	21.3 miles
7.	Chickamauga Reservoir to Gillespie Bend	-	35.0 miles
8.	Watts Bar Reservoir to Paint Rock Creek	-	46.1 miles
9.	Fort Loudoun Reservoir to Peter Blow Bend	-	38.7 miles
10.	Melton Hill Reservoir to Clinton (Route 61)	-	43.2 miles
11.	Tellico Reservoir to Chilhowee Dam	-	33.2 miles
12.	Barkley Reservoir to Cumberland City	-	73.4 miles
	Total miles		521.9 miles

Blue Ridge-Type Tributary Reservoirs (12 Reaches)

1.	Appalachia Reservoir	-	9.8 miles
2.	Hiwassee Reservoir to 19/64 bridge	-	21.0 miles
3.	Chatuge Reservoir	-	12.6 miles
4.	Parksville Reservoir to Ocoee #2 Dam	-	12.3 miles
5.	Ocoee #3 Reservoir	-	6.4 miles
6.	Blue Ridge Reservoir	-	12.0 miles
7.	Nottley Reservoir	-	17.5 miles
8.	Chilhowee to Calderwood Powerhouse	-	8.8 miles

9.	Calderwood Dam to Cheoah Dam	-	7.8 miles
10.	Cheoah Dam to Fontana Dam	-	9.6 miles
11.	Fontana Reservoir	-	28.8 miles
12.	Watauga Reservoir	-	16.3 miles
	Total miles		162.9 miles

Ridge and Valley-Type Tributary Reservoirs (6 Reaches)

1.	Norris Reservoir	-	72.2 miles
2.	Cherokee Reservoir to John Sevier	-	54.4 miles
3.	Fort Patrick Henry Reservoir	-	10.4 miles
4.	Boone Reservoir	-	17.4 miles
5.	South Fork Holston Reservoir	-	24.8 miles
6.	Douglas Reservoir	-	44.2 miles
	Total miles		223.4 miles

Interior Plateau-Type Tributary Reservoirs (7 Reaches)

1.	Normandy Reservoir	-	17.8 miles
2.	Bear Creek Reservoir	-	15.9 miles
3.	Upper Bear Reservoir	-	16.4 miles
4.	Cedar Creek Reservoir	-	16.0 miles
5.	Little Bear Creek Reservoir	-	11.1 miles
6.	Tims Ford Reservoir	-	35.2 miles
7.	Great Falls Reservoir	-	19.4 miles
	Total miles		131.8 miles

Cool/Cold Tributary Tailwaters (6 Reaches)

1.	Mission Dam to Chatuge Dam	-	14.9 miles
2.	Norris Dam tailwater	-	13.5 miles
3.	Calderwood powerhouse to dam	-	1.2 miles
4.	South Fork Holston Dam tailwater	-	13.8 miles
5.	Watauga River: Boone to Wilbur	-	18.2 miles
6.	Wilbur Reservoir	-	2.7 miles
	Total miles		64.3 miles

Cool-to-Warm Tributary Tailwaters (7 Reaches)

1.	Duck River:Shelbyville to Normandy	-	27.2 miles
2.	Elk River:Fayetteville to Tims Ford	-	43.5 miles
3.	Hiwassee River: Ocoee River to Powerhouse	-	18.4 miles
4.	Blue Ridge tailwater	-	17.4 miles
5.	Nottely River to Nottely Dam	-	14.6 miles
6.	Holston River Nance Ferry: Cherokee Dam	-	19.0 miles
7.	Fort Patrick Henry Dam tailwater	-	8.2 miles
	Total miles		148.3 miles

Warm Tributary Tailwaters (17 Reaches)

1.	Duck River to Columbia	-	123.5 miles
2.	Duck River: Columbia to Shelbyville	-	87.9 miles
3.	Bear Creek to Bear Creek Dam	-	60.4 miles
4.	Upper Bear tailwater	-	24.0 miles
5.	Cedar Creek to Little Bear Creek	-	14.9 miles
6.	Cedar Creek Reservoir tailwater	-	8.3 miles
7.	Little Bear Creek to dam	-	11.5 miles
8.	Elk River: to Fayetteville	-	73.8 miles
9.	Hiwassee River to Ocoee River mouth	-	15.9 miles
10.	Hiwassee River: Appalachia cut-off reach	-	13.2 miles
11.	Mission Dam tailwater	-	14.3 miles
12.	Ocoee River: mouth to Parksville Dam	-	11.9 miles
13.	Ocoee #2 Reservoir to Ocoee #3 Dam	-	5.0 miles
14.	Holston River to Nance Ferry	-	33.3 miles
15.	Holston River: John Sevier to North Fork	-	35.5 miles
16.	French Broad River to Douglas Dam	-	32.3 miles
17.	Caney Fork: Great Falls Dam tailwater	-	0.8 mile
	Total miles		566.5 miles

Within and adjacent to the designated waterbody types, the following habitat types were identified: (1) Big rivers; (2) Small rivers/Large creeks; (3) Small creeks; (4) Underground aquifers; (5) Riparian areas along streams/ponds; (6) Gravel bars or boulders in large creeks or rivers; (7) Non-forested seeps, Wetlands, or Meadows; (8) Forested seeps or wetlands; (9) Moist woodlands Xeric hardwood/Coniferous forest/Mountain woods; (10) Prairies, Fields, Roadsides/Early successional woodlands; (11) Limestone, Sandstone, Granite outcrops/Cedar glades, Caves, Sinkholes, Rockhouses, Boulders, Bluffs, Cliff faces.

The following is a summary of the description of the preferred alternative presented in TVA's biological assessment. Under the preferred alternative, drawdown of tributary reservoirs would be restricted from June 1 through Labor Day and summer operating zones would be maintained through Labor Day at four mainstem facilities. Higher winter pool operating ranges would be established at 10 tributary reservoirs. Existing (i.e., Base Case) minimum flows and dissolved oxygen targets adopted under the Lake Improvement Program would continue to be met. Scheduled releases would be provided at five tributary facilities to increase tailwater recreational opportunities; recreational releases are presently not scheduled at these facilities. These releases will be subject to flood control operations and/or extreme drought conditions in the basin.

Elevations at 10 tributary reservoirs would be maintained as close as possible to the flood guides from June 1 through Labor Day subject to each individual facility meeting its own minimum flow requirements and a proportionate share of the system minimum flow requirements. When the volume of stored water is greater than the minimum operations guide curve, weekly average system minimum flow requirement at Chickamauga Dam would be increased each week from 14,000 cubic feet per second during the first week of June to 25,000 cubic feet per second during the last week of July. Beginning on August 1 and continuing through Labor Day, the weekly average flow would be 29,000 cubic feet per second. If the volume of stored water were less than the minimum operations guide curve, weekly average minimum flows at Chickamauga Dam between June 1 and July 31 would be 13,000 cubic feet per second; flows between August 1 and Labor Day would be 25,000 cubic feet per second. Continuous minimum flows would be provided in the Appalachia bypass reach from June 1 through November 30.

Winter flood guide levels under the preferred alternative would be raised at 10 tributary reservoirs based on flood risk analysis. One-half foot to maintain an 11-foot navigation channel would raise minimum winter elevation on Wheeler Reservoir. Steady water releases up to 25,000 cubic feet per second would be provided, as necessary, at Kentucky Dam to maintain tailwater elevation of 301 feet. Great Falls Reservoir would be filled earlier to reach full summer pool level by Memorial Day. The fill period at Fort Loudon, Watts Bar, and Chickamauga reservoirs would follow the existing fill schedule during the first week of April. Filling at these facilities would then be delayed to reach summer operating zone by mid-May.

During critical power system situations such as Power System Alerts or implementation of the Emergency Load Curtailment Plan, reservoir operations would temporarily deviate from preferred alternative operations to meet power system needs. In such situations, stored water would be used to preserve power system reliability.

Under the preferred alternative, TVA would preserve the primary reservoir operating objectives of flood control, navigation, and power generation. It will increase tailwater recreational opportunities, increase the minimum depth of the Tennessee River navigation channel at two locations, maintain power system reliability, maintain minimum tailwater flows and dissolved oxygen content. It would not increase annual average flood damages at any critical location within the Tennessee River Valley, and minimize adverse impacts on reservoir water quality.

Conservation Measures

The Tennessee Valley Authority has committed to maintain established minimum flows and minimum dissolved oxygen levels in tailwaters as part of the Reservoir Operations Study. Over the years, reservoir operations have been changed to reflect an adaptive response that has included substantial monitoring of environmental parameters, evaluation of ongoing environmental impacts, and systematic mitigation for large-scale impacts. An example is the Reservoir Release Improvement Program (RRIP). The RRIP was initiated to improve water quality and aquatic habitat in tributary tailwaters by providing minimum flows and increasing dissolved oxygen content. Under this program, TVA has restored levels of dissolved oxygen in over 300 miles downstream of 16 projects. Implementation of this program was completed in 1996, but ongoing operational activities could be used to mitigate any increases in problems with low dissolved oxygen in project releases. The Tennessee Valley Authority has implemented a variety of programs to improve conditions for aquatic resources.

Another TVA activity attempts to stabilize reservoir levels for a 2-week period when water temperatures reach 65°F at a depth of 5 feet. This fish spawning operation minimizes water level fluctuations during the peak spawning period to avoid more than a 1-foot-per-week change (either lowering or rising) in pool levels. Stabilizing reservoir levels aids fish spawning success. TVA conducts regular ecological monitoring of reservoirs and tailwater fauna.

The Vital Signs Monitoring Program rates environmental conditions in reservoirs using a fish and benthic Index of Biotic Integrity (IBI). TVA also monitors sport fish populations using the Sport Fish Index (SFI), which incorporates the status of population quantity and quality along with available angler catch information. Within a reservoir, SFI scores monitor positive or negative trends in population status, relative to fishing experience. Beyond the SFI monitoring program, TVA operates certain hydropower operations in a manner that provides important flow levels for spring spawning grounds of certain fishes. For example, below Watts Bar reservoir, prescribed spring flows are provided to enhance sauger spawning. These programs may benefit mussel resources in the Tennessee River, including federally listed species because fish play a vital role in the life cycles of mussels.

As part of the ROS, TVA will participate with personnel from the Nature Conservancy in monitoring the green pitcher plant population at Lake Chatuge. Monitoring will be done to determine the hydrology of the site and to determine what effects, if any, implementation of the preferred alternative is having on the plants and their habitat. If declines in numbers of green pitcher plants or degradation of the habitat attributable to implementation of the preferred alternative are observed, TVA will coordinate with the Service to develop means to halt or reverse such declines and or degradation of habitat.

The Service has described the action area to include the waters in the Tennessee River drainage that are part of the TVA water control system (i.e., the main stem of the Tennessee River and its tributaries) (Figure 1). Lands adjacent to and within one mile of those waters are also included for reasons that will be explained and discussed in the "EFFECTS OF THE ACTION" section of this consultation.

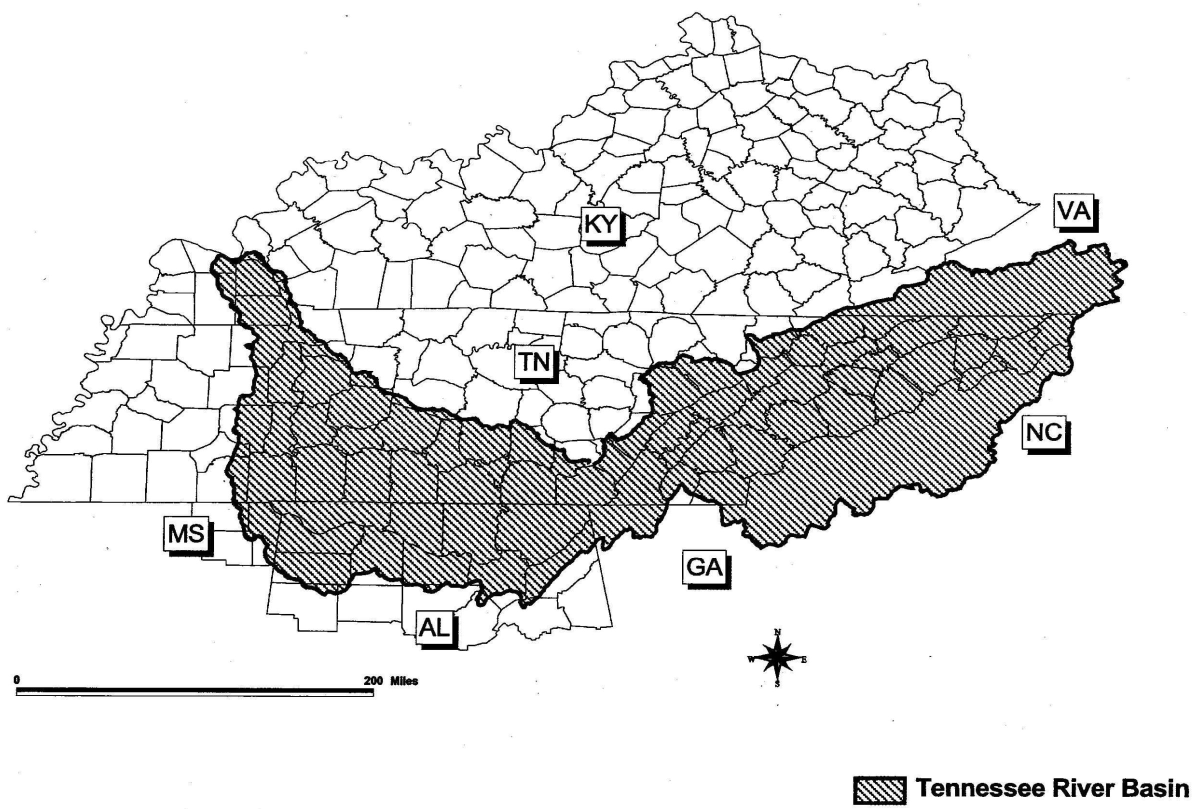
STATUS OF THE SPECIES/CRITICAL HABITAT

Snail darter

The snail darter, *Percina tanasi*, was officially listed on October 12, 1975. Because it was known to occur only in the Little Tennessee River in the vicinity of Tellico Dam, which was under construction, the original listing designated the snail darter as an endangered species. Critical habitat for the species was designated on April 1, 1976, to include the Little Tennessee River from River Mile 0.5 to River Mile 17. Subsequent to listing of the species, additional snail darter populations were discovered and, on July 5, 1984, the snail darter was re-designated as a threatened species. At the same time the critical habitat designation was eliminated because the reach of the Little Tennessee River that was designated as critical habitat was impounded when the Tellico Dam project was completed (Service 1983).

Prior to construction of impoundments in the Tennessee River drainage, the snail darter is thought to have occurred in the mainstem of the Tennessee River and the lower reaches of its major tributaries from Fort Loudon downriver to the confluence of the Paint Rock River in Alabama (Service 1983). Populations likely existed in the Tennessee River and in the lower reaches of the Hiwassee, Clinch, Little Tennessee, French Broad, and Holston Rivers (Service 1983). Surveys conducted by TVA biologists at 120 sites during 1974 and 1975 failed to reveal additional snail darter populations, however, snail darter populations were subsequently found in the Tennessee River and four large tributaries during surveys since 1980. Naturally occurring populations were discovered in the Tennessee River below Watts Bar Dam, Nickajack Dam, and

Figure 1. Reservoir Operations Study Action Area



Chickamauga Dam; Sewee Creek; South Chickamauga Creek (Tennessee and Georgia); Sequatchie River; and Paint Rock River (Alabama) (Service 1983). In 1975 and 1978, snail darters were transplanted from the Little Tennessee River into the lower Hiwassee River and lower Holston River, respectively. Currently, snail darters are relatively abundant in the lower French Broad River, Holston River, Hiwassee River, and Little River. Although the Service considers the status of the snail darter to be uncertain (Service 2003), recent status surveys indicate that the species appears to be increasing in distribution and population size (TVA 2003[a]).

In an effort to offset the loss of the Little Tennessee River population, snail darters were transplanted to several streams prior to completion of Tellico Dam. Populations were re-introduced in the Elk River (Tennessee), Holston River (Tennessee), Hiwassee River (Tennessee), and Nolichucky River (Tennessee); low numbers of snail darters have subsequently been found in the Nolichucky, and Elk, but populations may have become established in the Holston and French Broad Rivers as a result of the transplant into the Holston River.

The snail darter is described as a robust member of the subgenus *Imostoma*, growing to a maximum total length of 85 millimeters. Coloration above the lateral line is generally brown with occasional traces of green. Four prominent dark brown saddles cross the area behind the origin of the dorsal fin. Body color below the lateral line is lighter and is interspersed with dark blotches. The belly is usually white and the dorsal area of the head is dark brown. Cheeks are mottled brown with traces of yellow (Service 1983).

The snail darter inhabits shoal areas having relatively swift flow over mixed substrate of sand, gravel, cobble, and rock ledges. The species inhabits shallow water areas, but may also occur in areas with water depths of 12 to 20 feet (Service 1983). Snails comprise approximately 60 percent of the diet of the species, but caddisfly and black fly larvae are also consumed seasonally (Service 1983).

Approximately 25 percent of snail darter populations reach maturity at one year of age. Mature males migrate to spawning shoals from November through late January. Spawning occurs through mid-March. Eggs are deposited on gravel or cobble substrate and hatch within 20 days. Newly hatched larval snail darters drift with river currents to pool habitats, which serve as nursery areas. Juvenile darters may spend five to seven months in the nursery areas, after which they migrate upstream to shoal and riffle habitats where they spend the remainder of their lives (Service 1983). The action area encompasses the entire known range of the snail darter.

There is currently no designated critical habitat for the snail darter. A recovery plan for the species was approved on May 5, 1983. Recovery criteria are:

Alternative A

Suitable habitat areas of the Tennessee River within the area from the backwaters of Wheeler Reservoir upstream to the headwaters of Watts Bar Reservoir are inhabited by snail darter populations that can survive and reproduce independently of tributary rivers as evidenced by documented reproduction in Watts Bar Reservoir or some other Tennessee River reservoir.

Alternative B

More Tennessee River tributary populations of the species are discovered and existing populations are not lost. The number of additional populations needed to meet this criterion would vary depending on the status of the new populations, but two populations similar to the Sewee Creek, South Chickamauga Creek, or Sequatchie River populations or one comparable to the Hiwassee River population would denote recovery.

Alternative C

Through maintenance of existing populations and/or by expansion of these populations, there exist viable populations of snail darters in five separate streams such as Sewee Creek, Hiwassee River, South Chickamauga Creek, Sequatchie River, and Paint Rock River.

Pink mucket

The pink mucket, *Lampsilis abrupta*, was listed as an endangered species on June 14, 1976. It is an Ohioan species with possibly the widest range known for a listed mussel. Historical records indicate that this species once occurred in large rivers in 12 states. Presently, known populations occur only in the Barren River, Big River, Black River, Clinch River, Cumberland River, Current River, Gasconade River, Green River, Kanawha River, Little Black River, Meramec River, Ohio River, Osage River, Paint Rock River, and Tennessee River (Service 1985, 1992; Parmalee and Bogan 1998). Of these extant populations, only a few have shown recent evidence of recruitment. Some taxonomists have recently postulated that the reproducing populations west of the Mississippi River are not *Lampsilis abrupta*, but rather are more closely related to another endangered species, the Higgins eye pearlymussel (*Lampsilis higginsi*). If this is true, then there are fewer known reproducing populations of *L. abrupta* than originally thought. Although it has a relatively wide distribution and is apparently more tolerant of reservoir-type habitat conditions than other listed mussel species, the pink mucket is reported to occur in low numbers where it occurs.

This species inhabits areas in large rivers with swift currents, depths of 0.5 to 8.0 meters (1.6 feet to 26.2 feet), and mixed sand/gravel/cobble substrate. Notwithstanding this, the pink mucket appears to have adapted to reservoir-type conditions in the upper reaches of some impoundments. Life history aspects of this species are presently unknown, although it is probably a long-term breeder, as are other *Lampsilis* species. The glochidia are undescribed and the fish host is unknown (Service 1985, 1992; Parmalee and Bogan 1998).

In the Tennessee River drainage, live pink muckets have been recently collected from below the following TVA facilities: Wilson Dam, Pickwick Landing Dam (from the dam to the headwaters of Kentucky Lake), Kentucky Dam, Guntersville Dam, Nickajack Dam, Chickamauga Dam, Fort Loudon Dam, and Watts Bar Dam. Individuals were also found recently in the Holston River below Cherokee Dam, French Broad River below Douglas Dam, in the Clinch River below Melton Hill Dam and in Claiborne County, and below Bear Creek Dam and Wheeler Dam in Alabama (TVA 2003[a]).

There is no designated critical habitat for this species. A recovery plan was approved for the pink mucket on January 24, 1985. This species will be considered recovered when:

1. Two additional viable populations are found in any two rivers other than the Tennessee River, Cumberland River, and Meramec River. Populations in those two rivers will be distributed such that a single catastrophic event would likely not result in elimination of the population. Survey data must show at least five viable populations with each having a minimum of two year classes between four and 10 years of age.

2. Additional mussel sanctuaries must be established or expanded in river systems containing known populations of the pink mucket.

3. An education program must be established for the public with major emphasis toward commercial mussel harvesters.

4. The species and its habitat are protected from present and foreseeable human-related and natural threats that might interfere with survival of any of the populations.

Green pitcher plant

The green pitcher plant, *Sarracenia oreophila*, was listed as an endangered species on September 21, 1979. It is currently restricted in range to areas of the Cumberland Plateau in Alabama; and Blue Ridge and Valley and Ridge areas in Georgia and North Carolina (Service 1994). Green pitcher plant populations historically existed in the Coastal Plain and Piedmont areas in Alabama and Georgia, and in the Cumberland Plateau in eastern Tennessee. Extant populations occur at an estimated 35 sites in northeastern Alabama, northeastern Georgia, and southwestern North Carolina; population sizes range from one to several thousand plants (Service 1994). No critical habitat was designated for this species.

The green pitcher plant occurs in various types of habitat. Some populations occur in moist upland sites and seepage bogs, while others exist in boggy, sandy streambanks. Soils are acidic and consist of sandy clays and loams in upland sites or nearly pure sand along streams. Suitable habitat, consisting of relatively open canopy, is maintained by the saturated acidic, or poor nutrient, soils and periodic moderate fire that maintains which prevents encroachment of competitive species. Flood events are thought to maintain or create streambank sites. Predominant plants associated with green pitcher plant include alder, mountain laurel, red maple, and rhododendron on streambank sites. Various oak and pine species, which provide sparse canopy, occur on upland sites (Service 1994). Sphagnum and cinnamon fern are typically associated with this species at all sites. The herbaceous layer is typically diverse, with a mixture of grasses, sedges, and forbs. The more diverse sites are those that are frequently burned.

Green pitcher plants reproduce by seed and by rhizomes. The plants are pollinated by bumblebees, but at some sites having low numbers of plants, pollinator success was found to be low (Service 1994). Weather, particularly rainfall is considered to be an important limiting factor in flowering and vegetative growth. Flower buds are formed in fall, gradually enlarging throughout winter; bud enlargement is dependent on temperature. The plants flower from late April through late May and is affected by elevation and local climatic conditions. Fruit maturation typically occurs by late August, and seeds are released in mid to late September through early spring (Service 1994). Seedlings require high soil moisture, open mineral soil, and high light intensity for first year growth.

Green pitcher plant populations have been lost, and continue to be threatened by loss of suitable habitat. Clearing and degradation of habitat are thought to be the primary threats. Populations are thought to have been lost due to inundation at Lake Weiss and Lake Chatuge. Road construction, coal mining, intensive grazing and trampling by livestock, fire suppression resulting in encroachment by competitive plant species, and use of fertilizers and pesticides have had adverse effects on other green pitcher plant populations. Over-collecting by commercial dealers has resulted in complete elimination of many populations, and continues to be a major threat to the species (Service 1994).

A recovery plan was approved for the green pitcher plant on May 11, 1983; revised plans were approved on April 5, 1985 and on December 12, 1994. The species will be considered recovered when:

1. A minimum of 18 viable populations, representing the diversity of habitats and the geographic range of the species, are protected and managed as necessary to ensure their continued existence. Colonies should also include the wide spectrum of current genetic variation found in the species, which will be investigated as a recovery task. Of the 18 populations, at least three colonies should be located within each of the following four geographic areas: Coosa Valley, Lookout Mountain, East Sand Mountain, West Sand Mountain, and Lake Chatuge.

2. A population will be considered protected when it is legally protected from any present or foreseeable threats and is actively managed. A population will be considered viable if it is successfully sexually reproducing and the population's size is stable or increasing. A successfully sexually reproducing population is one which has consistent seed production followed by seedling establishment. Population viability should be confirmed through long-term monitoring (20 to 30 year period) before a final assessment of its eligibility for delisting is made.

A list of formal consultations completed for the species addressed in this biological opinion is attached (Appendix 1).

TVA evaluated a total of 59 species in its biological assessment for the Reservoir Operations Study. Three of those species: slabside pearlymussel, fluted kidneyshell, and white fringeless orchid: are Federal candidate species. They have no Federal protection and the consultation requirements of the Act do not apply to them. Consequently, those three species will not be addressed further in this biological opinion. All of the remaining 56 listed species are known to occur in the action area, however, implementation of the proposed alternative is not likely to result in changes that are likely to adversely affect 53 of those species (see Table 1) or their habitats. We will therefore not address those species further in this biological opinion. The snail darter, pink mucket, and green pitcher plant are likely to be adversely affected by implementation of the proposed action. Changes resulting from implementation of the preferred alternative (Blend 8) will alter water temperatures, water levels, and/or flows in some reservoirs and /or tailwater reaches that could potentially alter suitable habitat, affect reproduction, or have adverse effects on normal behavioral activities of populations of those three species in the affected areas. Therefore, these three species will be addressed in subsequent sections of this biological opinion.

ENVIRONMENTAL BASELINE

The TVA is a multipurpose federal corporation responsible for managing a range of programs in the Tennessee River Valley for the use, conservation, and development of the water resources related to the Tennessee River. In carrying out this mission, TVA operates a system of dams and reservoirs with associated facilities-its water control system-to manage the storage and flow of water within the system. This system is used to manage the water resources of the Tennessee River for the purposes of navigation, flood control, power production, and a wide range of other public benefits.

The water control system provides the cooling water supply for TVA's fossil and nuclear power plants located adjacent to TVA reservoirs. Additionally, TVA owns and manages approximately 293,000 acres of land in the Tennessee River Valley, much of which is along the shorelines of the reservoirs. Policies have been established for the development of reservoir shorelines and adjacent TVA lands, and reservoir levels influence development and management of these lands and activities and river flows. Reservoir operations policy for the water control system - i.e., the dams, reservoirs, and regulated river segments-guides the day-to-day operation of the Tennessee River system.

The Tennessee River drainage covers approximately 41,000 square miles. This area includes 125 counties within much of Tennessee and parts of Alabama, Kentucky, Georgia, Mississippi, North Carolina, and Virginia. The larger TVA Power Service Area covers 80,000 square miles and includes 201 counties in the same seven states. The TVA watershed includes 42,000 miles of streams that drain to the Tennessee River, 480,000 acres of reservoirs, and 300,000 acres of TVA-managed land.

The Tennessee River drainage begins with headwaters in the mountains of western Virginia and North Carolina, eastern Tennessee, and northern Georgia. At Knoxville, Tennessee, the Holston and French Broad Rivers join to form the Tennessee River, which then flows southwest through the state, gaining water from three other large tributaries: the Little Tennessee River, Clinch River, and Hiwassee River. The Tennessee River eventually flows into Alabama, where it picks up another large tributary, the Elk River. At the northeast corner of Mississippi, the river turns north, re-enters Tennessee, picking up the Duck River, and continues flowing north to Paducah, Kentucky, where it enters the Ohio River at Ohio River Mile 932.

The total river elevation change from the maximum reservoir surface elevation at Watauga Dam (highest elevation on the system) to the minimum tailwater surface elevation at Kentucky Dam (lowest elevation on the system) is 1,675 feet in 828.6 river miles. The mainstem of the Tennessee River, has a fall of 515 feet in 579.9 river miles from the top of the Fort Loudoun Dam gates to the minimum tailwater elevation at Kentucky Dam. The mainstem fall is gradual except in the Muscle Shoals area of Alabama, where a drop of 100 feet is found in a stretch of less than 20 miles.

The eastern half of the Tennessee Valley includes the slopes of the Blue Ridge and Great Smoky Mountains, where an abundant growth of timber covers the ground. The western half of the Valley is less rugged, with substantial areas of flat or rolling land occurring in middle Tennessee and along the western edge. Reservoirs and the associated tailwaters of the Tennessee River Valley span six physiographic regions, including the Highland Rim, Coastal Plain, Cumberland Plateau, Blue Ridge, Central Basin, and Valley and Ridge. Thirty-nine percent of the TVA region is in the Highland Rim, and 40 percent in the Coastal Plain.

The eastern portion of the Tennessee River watershed is located in the Blue Ridge Physiographic Region (Unaka Mountains) and the Valley and Ridge Physiographic Region. The headwaters of the Tennessee River originate in the rugged Unaka Mountains in North Carolina and eastern Tennessee. This region has undergone multiple mountain-building events and is underlain by folded and faulted complexes of igneous, metamorphic or sedimentary rocks dating from the Precambrian and Paleozoic Eras. The soils of the Blue Ridge Physiographic Region consist of highly weatherable material. The depth of soil varies from 1 to 3 feet at higher elevations and from to 3 to 7 feet on the lower side slopes. The valleys contain a variety of soils and are generally productive. Soil depths of the Valley and Ridge Physiographic Region range from shallow over shales and sandstones to very deep over the dolomitic limestone. The upland soils are primarily highly leached, and strongly acidic with low fertility. Because of the variable landscape, soils properties vary over short distances, resulting in small patches of productive land intermixed with average land or large tracts of rough land.

The Tennessee River flows southwest from the Valley and Ridge Physiographic Region into the Cumberland Plateau Physiographic Region. This region consists of a high tableland that is underlain by nearly flat-lying sedimentary rocks of Paleozoic age. The Plateau is highly dissected by streams and rivers, forming valleys with moderate to high relief. Because limestone underlies portions of this region, karst (an irregular limestone region with sinks, underground streams, and caverns) landscapes and extensive cave systems have developed. The Cumberland Plateau is bounded on the west and east by escarpments. The terrain is gently rolling to hilly highland with deeply cut gorges.

From the Cumberland Plateau, the Tennessee River flows northwest through the Highland Rim Physiographic Region. This region consists of a highly dissected flat-lying tableland that is underlain by nearly flat-lying Paleozoic age limestone. Due to the presence of limestone, an extensive karst plain has developed, with numerous sinkholes, disappearing streams, and cave systems. The hill slope soils were formed from limestone and have clayey and cherty subsoils. The more level areas and hill caps have soils formed from thin loess (windblown material) and limestone residuum. The soils are highly leached and strongly acid with low fertility, except near the Kentucky/Tennessee border.

The Central Basin Physiographic Region is within the Highland Rim. The Central Basin is one of the smaller physiographic regions of the Tennessee Valley watershed and includes parts of the Duck River and Cumberland River drainages. The Basin is underlain by up-warped Paleozoic age limestone that has been eroded to form a basin surrounded by the Highland Rim. The inner portion of the Basin is relatively flat lying with low relief, and is bordered by large hills and ridges along its outer edge. Due to the weathering and erosion of the underlying limestone, karst topography is present in this region.

From the Highland Rim, the Tennessee River flows north through the Coastal Plain Physiographic Region. The portion of this region that lies within the Tennessee Valley is almost entirely west or southwest of the Tennessee River and includes the drainages of the Beech River and Bear Creek. The relief within this area is generally low; consequently, stream gradients are very low. Their valleys are broad and flat and filled with thick accumulations of alluvium. The rocks exposed in the Gulf Coastal Plain are all unconsolidated sediments, with Paleozoic rocks underlying the whole area at great depth. The soils of the Coastal Plain Physiographic Region are highly leached, low in fertility, and strongly acid. Control of erosion is of major concern, as evidenced by deep gullies that are common on some hillsides.

Aquatic resources occurring in the Tennessee Valley region are important from local, national, and global perspectives and add value to the lives of citizens of the Tennessee River basin. Tennessee has approximately 319 fish species, including native and introduced species, and 129 freshwater mussels. The Tennessee-Cumberland River eco-regions have the highest number of fish, mussels, crayfish, and endemic species in North America. This is the most diverse temperate freshwater ecosystem in the world.

Prior to construction of the TVA reservoir system, aquatic communities were structured by water quality and physical habitat condition, which were driven by physiographic region and climate. Stream flow was proportional to rainfall, and flow regime (pattern) followed the same trends as the annual rainfall pattern. Flow established physical habitat conditions (e.g., depth, velocity) within a stream and maintained stream shape and other habitat conditions (substrate). Relatively infrequent high-flow events (i.e., flows that only occur every 1 to 2 years) were responsible for maintaining large-scale habitat patterns such as the number of riffles or pools. High flows clean substrate by flushing out fine sediments, which may suffocate fish eggs or mussels and fill in the spaces between rocks needed by aquatic insects. Because historical flow was proportional to rainfall, over short time intervals, such as days, flow was relatively predictable meaning that yesterday's flow was likely to be similar to today's flow and from hour to hour there was little change, except during storm events.

Floods were common during spring, and flows decreased throughout the year with the lowest flows typically occurring August through October, the warmest part of the year. Spring flooding was an important component in the life cycles of some fish species that use flooded overbank areas for spawning or nursery areas. The Tennessee River was shallow, with expansive areas of rocky or gravel shoals critical features contributing to the great diversity of aquatic life. Two of the purposes of TVA system dams and reservoirs were to provide year-round navigation on the river and control flooding. Achieving these objectives required modifying the river environment described above to which the pre-impoundment aquatic community was adapted. For example, most of the shoal habitat was eliminated by impoundments, and seasonal flow patterns were greatly modified by capturing high spring flows in upstream impoundments and increased late summer/fall flows with drawdown releases from those reservoirs.

The construction of the TVA reservoir system significantly altered both the water quality and physical environment of the Tennessee River, with little regard at the time for aquatic resources. Aquatic resources were generally not a consideration for many types of river projects then because flood control, navigation, and cheap hydroelectric power for economic stimulation were more highly valued.

The primary impact of the reservoir system was to convert free-flowing river habitat into reservoir pools. Virtually all of the mainstem Tennessee River was impounded to maintain navigation channel depth. The dams became obstacles to migratory species. Differences in goals and, consequently, operation of reservoirs became important factors in determining water quality and associated impacts on resident aquatic communities in tributary and mainstem reservoirs and downstream tailwaters. Low levels of dissolved oxygen in summer and fall virtually eliminated aquatic communities from the pool area in the lowest layer of the reservoir that is characterized by relatively cool water. Before the RRI Program, similar impacts occurred in downstream tailwaters because water was released from the lower layer of the upstream reservoir.

The large differences between summer and winter pool levels of some tributary reservoirs also created environmental hardships for aquatic resources in these reservoirs. Benthic organisms requiring re-colonization each summer cannot survive in bottom areas exposed to drying during winter. This exposure, in association with dissolved oxygen stratification impacts, severely limits benthic communities in many tributary reservoirs. Aquatic communities in and downstream of mainstem reservoirs are also affected by poor water quality conditions, but impacts are less severe. Taking advantage of modified habitat conditions (i.e., reservoir pools and dam tailwaters), state agencies introduced numerous sport and some prey fishes, including rainbow trout, brown trout, lake trout, cutthroat trout, kokanee, striped bass, striped bass hybrids, muskellunge, northern pike, cisco, rainbow smelt, alewife, yellow perch, and walleye (northern strains). Not all introductions have led to self-sustaining populations; state agencies continue stocking many popular fishes. Stocking has in itself led to changes to aquatic communities or created new community types in areas they did not exist (e.g., trout in tailwater river reaches).

Completion of TVA's water control system resulted in the following impacts to the aquatic system: (1) Conversion of riverine habitat to reservoir pool habitat; (2) Loss of riverine habitat and associated species; (3) Conversion of floodplain to reservoir pool; (4) Loss of seasonal floodplain habitat and associated species; (5) Fragmentation of riverine sections; (6) Disruption of fish migrations; (7) Seasonal fluctuations of pool levels; seasonal drying of habitat reduces abundance and diversity of species; (8) Strong stratification (layering) of temperature for certain dam types; (9) Stress or mortality of organisms or sensitive life stages; (10) Seasonal dissolved oxygen depletion in temperature stratified water; (11) Ammonia release created by presence of dissolved oxygen-depleted water; (12) Disruption of stream transport of sediment; (13) Trapping of sediment; (14) Capture of toxic substances associated with substrate; (15) Toxic substances release created by presence of dissolved oxygen-depleted water; (16) Enrichment of nutrients (eutrophication) with consequent increases in productivity, plant and algae growth, and changes in habitat quality and associated species.

Status of the species within the action area

The action area encompasses the entire range of the snail darter. Populations of snail darters persist despite construction of the water control facilities on the mainstem of the Tennessee River and its large tributaries.

Snail darter populations have expanded since the species was listed. New populations have been found or reported in the Holston River, French Broad River, Hiwassee River, Tennessee River below Watts Bar Dam and Nickajack Dam, Paint Rock River, Sewee Creek, Sequatchie River, Ocoee River, and South Chickamauga Creek. These populations were either newly discovered natural populations or the successful result of transplant efforts. Efforts to establish self-sustaining populations by transplants failed to succeed in the Nolichucky River and the Elk River.

In the action area, the pink mucket is known to occur in the Tennessee River below Kentucky Dam, Pickwick Landing Dam, and Wilson Dam; in the French Broad River below Douglas Dam; and in the Holston River below Cherokee Dam. Smaller populations or scattered individuals may still persist below other dams on the mainstem of the Tennessee River and in the Clinch River above Knoxville. Historical records from within the action area indicate that the pink mucket occurred in the Flint River, Limestone Creek, and the Duck River.

Green pitcher plant populations currently exist within the action area only in Towns County, Georgia, and Clay County, North Carolina. The Nature Conservancy owns two sites on which this species occurs.

Factors affecting species environment within the action area

Stream and river reaches within the action area containing snail darter populations are being affected by a variety of activities. Dams block spawning migrations of fish, including snail darters; these structures may also be a barrier to newly hatched fry, which drift downstream to nursery habitats. Erosion of streambanks resulting from poor land use practices and water level fluctuations from hydropower releases has likely increased the sediment input into the streams. Sediment compacting the substrate can affect reproductive success by smothering eggs deposited in the gravel or on rocks. Runoff from agricultural areas may contain pesticides, fertilizers, and other agricultural chemicals that degrade water quality. Runoff from coal mining activities may be affecting the species in the Sequatchie River drainage as a result of sediment and acidic discharges. Dredging and construction of barge facilities could potentially have adverse effects to snail darter populations in the Tennessee River. Sand and gravel dredging could affect the species by removing or disturbing important spawning shoals.

Impoundment of the Tennessee River and its tributaries has likely had the most extensive adverse impacts on populations of the pink mucket. Construction of dams converted large reaches of free-flowing riverine habitat to lake-like conditions. Along with alteration of the physical habitat, this change also resulted in changes in the fish fauna. Fish species adapted to lake habitats replaced native riverine fishes that served as fish hosts for the mussels.

Many of the activities that affected snail darter populations have also adversely affected populations of the pink mucket. Streambank erosion, poor land use practices, dredging, municipal and industrial discharges, and development along the river have disturbed, altered, or destroyed habitat used by the pink mucket.

The greatest adverse effect to the green pitcher plant within the action area has resulted from loss of habitat resulting from clearing for agricultural, residential, industrial, and silvicultural purposes. Trampling by grazing cattle and use of herbicides has affected some populations. Suppression of natural fire has resulted in encroachment by competitive plant species. Alteration of natural hydrological conditions has also resulted in loss or significant reductions of some populations. In addition, the carnivorous nature of the green pitcher plant has made it attractive to plant enthusiasts. Collection of plants has resulted in complete loss or significant reduction of some populations.

EFFECTS OF THE ACTION

Factors to be considered

Implementation of the preferred alternative, throughout most of the action area, is not anticipated to result in significant changes in conditions from those occurring under current operations. The Tennessee Valley Authority is committed to maintaining minimum flows and dissolved oxygen levels established under the Reservoir Release Improvement Program and the Lake Improvement Program. If implementation of the preferred alternative results in changes in flows or dissolved oxygen in tailwater reaches below TVA dams included in the RRI program, appropriate actions will be taken to restore and maintain minimum flow and dissolved oxygen levels.

One anticipated change in conditions from current operations is a decrease in water temperatures in the Holston River below Cherokee Dam. During years of normal climatic conditions, temperatures are expected to decrease during the latter part of August and will be from one to six degrees (Celsius) lower than those under current operations and will extend an undetermined distance downriver.

Another change will occur as a result of maintaining summer pool levels in reservoirs later in the season during normal years. Under the preferred alternative, median reservoir pool elevations in Chatuge Lake will be approximately 1.5 feet higher than those under current operations from July through Labor Day; median elevations will be one-half foot lower than current conditions from April through June.

Analyses for effects of the action

Implementation of the preferred alternative may directly affect populations of the snail darter and pink mucket in the Holston River. The pink mucket is a long-term breeder; eggs are fertilized and larvae develop during spring and summer; females retain larvae for release the following spring. Decreases in water temperature during late summer could potentially effect the development of larval mussels or attachment of larval mussels to suitable fish hosts. Such a change could indirectly affect the mussels if changes in water temperature changed the activity or presence of the species’ fish host.

The snail darter is a winter spawner. Eggs are laid in mid to late winter and the fry hatch during early spring. Lower water temperatures during late summer could possibly affect the species if such changes altered the feeding activity of reproductive individuals. Changes in water temperature may also affect gamete production, thus affecting spawning success and recruitment.

The green pitcher plant population at Chatuge Lake could potentially be affected by the anticipated change in summer pool level that will result from implementation of the preferred alternative. There appears to be some uncertainty about the hydrologic conditions of the site at which the plants exist. If lake levels drive the hydrology of the site, the site will be exposed to water levels 1.5 feet higher than presently occurs during the summer. What effect this might have on flowering, fruit formation, and seed dispersal are unknown at this time.

Species' response to a proposed action

Subsequent to inundation of the Little Tennessee River site, snail darters were stocked, or new populations were subsequently found in the Holston River; French Broad River; Sequatchie River; Tennessee River below Watts Bar Dam, Chickamauga Dam, and Nickajack Dam; Sewee Creek; Nolichucky River; Hiwassee River; Ocoee River; Elk River; and South Chickamauga Creek. Some of these populations appear to be reproducing and increasing in numbers while others have declined. Current estimates of population size are not available.

The snail darter has demonstrated a certain degree of resilience to changes in its habitat, evidently having adapted to current conditions within the action area. Construction of reservoirs has isolated some populations, but many of the extant populations continue to thrive.

Pink mucket populations currently exist in the action area below Kentucky Dam, Pickwick Landing Dam, Wilson Dam, Cherokee Dam, and Douglas Dam. Population estimates are not available, but individuals likely are scattered at low densities throughout the tailwaters below those dams in areas containing suitable habitat. This species has low resilience to changes in its habitat. Although it has adapted to lake-like conditions (individuals have been found in the upper reaches of some reservoirs), construction of impoundments has destroyed miles of its riverine habitat. Additionally, coldwater releases from some dams has resulted in elimination some populations. Even if the action area was restored to pre-impoundment conditions, it is unlikely that the pink mucket would re-colonize those disturbed areas in the foreseeable future.

The green pitcher plant currently occurs in the action area only at sites around Lake Chatuge in southwestern North Carolina and northern Georgia. Population estimates range from one plant to more than 2,000 plants. This species is not resilient to changes in habitat. Disturbance, or lack thereof, generally results in declines in numbers or elimination of entire populations. Depending on the type and degree of habitat disturbance, the green pitcher plant may or may not recover in a restored habitat.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local and/or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation under section 7 of the Act.

The area in which the proposed action will be conducted is currently being affected by a variety of actions and activities. Major urban areas exist throughout the action area; those areas are likely affecting the species and habitats within the mainstem of the Tennessee River and its tributaries. Large recreational boats and barge traffic that move upriver and downriver through the action area likely have some effect on aquatic species and habitats; propeller wash creates waves that erode the riverbanks, resulting in sediment deposit on the river bottom. Runoff from adjacent agricultural fields may contain fertilizers and/or pesticides that can affect aquatic organisms. Residential, commercial, and industrial development around some of the reservoirs, particularly those located near major urban centers, have increased over time and is likely to continue; resulting in destruction or alteration of aquatic and terrestrial habitats. These effects have occurred over many years and are likely to continue.

CONCLUSION

After reviewing the current status of the snail darter, pink mucket, and green pitcher plant, the environmental baseline for the action area, the effects of the proposed ROS, and the cumulative effects, it is the Service's biological opinion that implementation of the preferred alternative (Blend 8), as proposed, is not likely to jeopardize the continued existence of the snail darter, pink mucket, or green pitcher plant, and is not likely to destroy or adversely modify designated critical habitat. No critical habitat is currently designated for these species, therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations under section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. *Take* is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. *Harm* is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. *Harass* is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. *Incidental take* is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by TVA so that they become binding conditions of the Reservoir Operations Study for the exemption in section 7(o)(2) to apply. The Tennessee Valley Authority has a continuing duty to regulate the activity covered by this incidental take statement. If TVA fails to accept and implement the terms and conditions of the incidental take statement, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, TVA must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement. [50 CFR §402.14(I)(3)]

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed <u>endangered</u> plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulation or in the course of any violation of a State criminal trespass law.

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The Service expects incidental take of the snail darter and the pink mucket will be difficult to detect for the following reasons: (1) the snail darter is a small, secretive fish that typically occurs under rocks or other cover on the bottom of rivers or large streams. If a snail darter dies, it likely would remain under cover, be quickly swept downstream, or consumed by scavengers. Finding a dead individual would thus be highly unlikely; (2) in the event that a dead or impaired individual snail darter is found, attributing death or impairment to implementation of the preferred alternative would be extremely difficult; (3) the pink mucket spends its entire lifetime burrowed into the substrate in large rivers; when an individual dies, it likely remains in place, thus finding a dead individual would be unlikely unless the river was periodically monitored by divers; (4) attributing death of an individual pink mucket to operations under the preferred alternative would be difficult; (5) the pink mucket is rare; individuals are generally scattered randomly over the river bottom in areas containing suitable habitat; finding an individual, live or dead, typically requires intensive searching. However, the following level of incidental take of these species can be expected by loss, alteration, or degradation of their habitats resulting from implementation of the preferred alternative. Changes in water temperature below Cherokee Dam during the latter part of August could disrupt normal reproductive behavior and result in take of all or portions of the following season's year class. Cooler water could also result in take by affecting feeding and thus inhibiting the development of juveniles.

The snail darter currently occurs in the Hiwassee River. The population in that river appears to be stable and reproducing. Late summer temperatures in the Hiwassee River below Appalachia Dam are currently similar to those projected during late summer in the Holston River under the preferred alternative. Thus, it appears that the snail darter is tolerant of water temperatures that may occur (i.e., four to five degrees Celsius cooler than current temperatures) from implementation of the preferred alternative. Consequently, incidental take of snail darters is not anticipated unless more severe water temperature decreases occur.

Based on available records, the pink mucket currently occurs in the Holston River upriver to approximately River Mile 30. We assume that this is presently the upstream limit of the distribution of this species in the Holston River. Temperature tolerance of the pink mucket is not known, therefore it is assumed that there could be incidental take of the species resulting from decreases in water temperature. We assume that take would occur downriver from River Mile 30, and that all pink muckets in the lower thirty miles of the river would be susceptible to take.

Table 2. The incidental take estimated and critical habitat destroyed for the proposed project.

SPECIES	INDIVIDUALS	TAKE TYPE	CH DESTROYED
Snail darter	Cannot be Determined	Harm, Harass	N/A
Pink mucket	Cannot be Determined	Harm, Harass	N/A

Table 3. How the incidental take will be monitored if the specific number of individuals cannot be determined.

SPECIES	CRITICAL HABITAT	HABITAT	OTHER
Snail darter	N/A	Change (decrease) in water temperature downriver from HRM 30.0	
Pink mucket	N/A	Change (decrease) in water temperature downriver from HRM 30.0	

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of expected take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary to minimize impacts of incidental take of the snail darter and/or pink mucket:

1. Water temperature in the Holston River below Cherokee Dam will be monitored to ensure that temperature variations do not exceed those modeled for the ROS.

2. The snail darter population in the Holston River below Cherokee Dam will be monitored. Surrogate species will be selected for monitoring in place of the pink mucket due to its rarity in the Holston River.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Tennessee Valley Authority must comply with the following terms and conditions, which carry out the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. Annually between August 15 and September 30, TVA personnel will collect water temperature data from the Holston River below Cherokee Dam. Temperature data will be collected at approximately River Mile 48.0, River Mile 30.0, River Mile 20.0, and River Mile 5.0. Instream data loggers will be placed at each site prior to August 15 to record temperature data over the entire 45-day period. Readings will be taken continuously to provide daily average temperature with variation. If water temperatures at any of the sites decrease by more than two degrees (Celsius) beyond those predicted by the model (e.g., if the model predicted that water temperature would be 18 degrees Celsius during late August at River Mile 30, and the actual temperature at that site is 16 degrees, or lower), the Cookeville Field Office will be contacted. Data will be provided to the Cookeville Field Office supervisor each year at the middle and at the end of this 45-day period. Water temperature monitoring will be conducted for a minimum of four years.

2. TVA personnel will monitor the snail darter population in the Holston River. If declines in numbers, recruitment, or general health of the snail darter population are observed and are attributable to the changes in water temperature beyond

those predicted by the model, the Cookeville Field Office will be notified immediately. Monitoring of the snail darter population will be conducted for a minimum of four years.

3. Because of its rarity in the lower Holston River, it would be difficult to monitor the pink mucket population specifically. Therefore, benthic invertebrates will be monitored as surrogates for the pink mucket. If declines in numbers, recruitment, or general health of the populations are observed and are attributable to changes in water temperature beyond those predicted by the model, the Cookeville Field Office will be notified immediately. Benthic invertebrate monitoring will be conducted for a minimum of four years.

Upon locating a dead, injured, or sick individual of an endangered or threatened species, initial notification must be made to the Fish and Wildlife Service Law Enforcement Office at (Mr. Steve Middleton, Senior Resident Agent; 220 Great Circle Road, Nashville, TN 37228; telephone 615/736-5532). Additional notification must be made to the Fish and Wildlife Service Ecological Services Field Office in Cookeville, Tennessee. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. Loss of or declines in numbers of populations of temperature-sensitive invertebrates will be assumed to be comparable to loss of or declines in numbers (i.e., incidental take) of pink muckets. If, during the course of the action, populations of monitored invertebrates or snail darters decline by more than 25 percent, and the declines are attributable to changes in water temperature as a result of implementation of the preferred alternative, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Table 4. The incidental take reduced, based on the best available commercial and scientific information, as a result of the implementation of the RPMs.

SPECIES	INDIVIDUALS	
	Project Take	RPM Lowered**
Snail darter	None anticipated	N/A
Pink mucket	All individuals in the Holston River from HRM 30.0 to HRM 0.0	All individuals in the Holston River from HRM 30.0 to HRM 0.0

** The number that the project takes will be reduced as a result of implementation of the RPMs.

Table 5. The index to monitor the level of take and how much the RPMs reduced, based on the best available commercial and scientific information, that level of take.

SPECIES	HABITAT			OTHER	
	Amount Present on Project Site	Amount Project Destroyed or Impacted	Amount that RPM's Lowered the Level of Impact**	Amount Project Impacted	RPM Lowered**
Snail darter	Populations present in Holston, French Broad, Hiwassee, Tennessee rivers; Sewee Creek, South Chickamauga Creek	None anticipated	N/A	None anticipated	N/A
Pink mucket	Populations in the Tennessee R., Clinch R., Holston R., French Broad R., Nolichucky R.	30 river miles in the Holston River	Impact not lowered	Holston River below Cherokee Dam	Impact not lowered

** The amount of habitat or other measurement, used to monitor the level of take for this opinion and species that will be reduced as a result of implementation of the RPMs.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help carry out recovery plans, or to develop information.

We offer the following conservation recommendations for consideration:

1. The Tennessee Valley Authority should continue to maintain its existing database regarding the 59 species evaluated in the biological assessment. Changes in the species' status and distribution should be monitored and recorded. Data should be collected on the status and distribution of other rare, but currently unlisted, species in the Tennessee River drainage as well.

2. The Tennessee Valley Authority should continue to collect data regarding the populations of endangered and threatened species throughout the area under its jurisdiction. Periodic surveys should be conducted to maintain up-to-date information regarding the status of populations of those species. Data collection and surveys should be initiated for other species as they are added to the Service's list of endangered and threatened species.

3. The Tennessee Valley Authority should continue existing programs initiated for the protection of endangered and threatened species and their habitats throughout the area under its jurisdiction. The agency should adopt or maintain an adaptive management approach to management of the Tennessee River Valley system. This will allow for changes to be made as new species are listed or as new information becomes available concerning species already on the Service's list.

4. The Tennessee Valley Authority should begin outreach programs or continue existing outreach programs to educate the public about the importance of, and protection and recovery of, endangered and threatened species in the Tennessee River drainage. These programs should be presented or distributed to schools, civic groups, and local governments in the drainage.

5. The Tennessee Valley Authority should continue to work closely with personnel from the Service, state fish and wildlife agencies, and other conservation organizations to ensure that operation of the Tennessee River Valley system is conducted in a way that will protect terrestrial and aquatic species and their habitats in the Tennessee River drainage.

6. Nutrient enrichment has been identified as a potential problem in the river reach from Guntersville Dam downriver to Decatur, Alabama. TVA should initiate monitoring within that river reach to determine if eutrophication is adversely affecting federally listed mussel species. If this is identified as a problem, TVA should investigate means to reduce enrichment within this reach of the river.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the conservation recommendations carried out.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the consultation request. As written in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary TVA involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the TVA action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the TVA action is later modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease until reinitiation.

For this biological opinion the incidental take would be exceeded when the take exceeds more than 25 percent of the snail darter population or more than 25 percent of the surrogate invertebrates in the lower 30 miles of the Holston River, which is what has been exempted from the prohibitions of section 9 by this opinion. The Service appreciates the cooperation of TVA personnel during this consultation. We would like to continue working with you and your staff regarding the Reservoir Operations Study. For further coordination please contact Mr. Steve Alexander or Jim Widlak of this office at 931/528-6481, ext. 210 or 202, respectively.

Lee A. Barclay, Field Supervisor — 2/09/04 Date

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APPENDIX 1: Previous Biological Opinions Completed by Fish and Wildlife Service Biologists for the Endangered and Threatened Species Addressed in the Biological Opinion for the TVA Proposed Reservoir Operations Study.

SPECIES	YEAR	INCIDENTAL TAKE NUMBER
Pink mucket	1987	Take not anticipated
Pink mucket	1990	2 individuals
Pink mucket	1991	7 individuals
Pink mucket	1991	Not able to determine
Pink mucket	1992	Incidental take not anticipated with implementation of RPA
Pink mucket	1993	No take authorized
Pink mucket	1993	Not able to determine
Pink mucket	1994	Not able to determine
Pink mucket	1994	Not able to determine
Pink mucket	1994	Not able to determine
Snail darter	1995	One individual
Pink mucket	1996	Six individuals each species over and above 30 allowed for “rescue”
Pink mucket	1999	Not able to determine
Pink mucket	2000	Not able to determine
Pink mucket	2001	Two individuals
Snail darter	2002	No take anticipated
Pink mucket	2002	No take anticipated
Pink mucket	1994	One individual
Pink mucket	1998	One individual
Pink mucket	2000	17 individuals

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Appendix H

Results of Consultation Performed under the National Historic Preservation Act

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PROGRAMMATIC AGREEMENT
AMONG THE TENNESSEE VALLEY AUTHORITY AND THE ALABAMA, GEORGIA, MISSISSIPPI, NORTH CAROLINA, TENNESSEE, AND VIRGINIA STATE HISTORIC PRESERVATION OFFICERS

Revised 2/11/2004

WHEREAS, the Tennessee Valley Authority (TVA) operates a system of dams and reservoirs on the Tennessee River and its tributaries; and

WHEREAS, TVA proposes to revise its reservoir operating policy ("Undertaking") to provide greater overall public benefit as more fully described in Appendix A to this agreement; and

WHEREAS, the reservoirs affected by the undertaking are Watauga, South Holston, Boone, Cherokee, Douglas, Norris, and Pickwick in the state of Tennessee; Fontana, Chatuge and Hiwassee in the state of North Carolina; Chatuge, Nottely, and Blue Ridge in the state of Georgia; Wheeler and Pickwick in the State of Alabama; Pickwick in the state of Mississippi; and South Holston in the state of Virginia; and

WHEREAS, TVA has consulted with the State Historic Preservation Officers (SHPO) for the states of Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee and Virginia, and has determined the Area of Potential Effect (APE) for the Undertaking which consists of two parts, the shoreline erosion zone (direct APE) and the private development zone (indirect APE); and

WHEREAS, TVA has performed historic property identification surveys of portions (Appendix B) of the APE and has identified numerous historic properties eligible for listing in the National Register of Historic Places (Historic Properties); and

WHEREAS, TVA has determined that the revised reservoir operating policy could have an adverse effect on Historic Properties pursuant to 36 CFR Part 800, regulations effective January 11, 2001, implementing Section 106 of the National Historic Preservation Act (16 USC 470f); and

WHEREAS, TVA has invited the Cherokee Nation, Eastern Band of Cherokee Indians, United Keetoowah Band, Muscogee (Creek) Nation of Oklahoma, Kialegee Tribal Town, Thlopthlocco Tribal Town, Alabama Quassarte Tribal Town, Alabama-Coushatta Tribe, Chickasaw Nation, Poarch Band of Creek Indians, Choctaw Nation of Oklahoma, Jena Band of Choctaw Indians, Seminole Nation of Oklahoma, Seminole Indian Tribe, the Shawnee Tribe, and the Eastern Shawnee Tribe of Oklahoma to be consulting parties; and

WHEREAS, the Eastern Band of Cherokee Indians has requested to be a concurring party to this agreement;

NOW THEREFORE, TVA and the Alabama, Georgia, Mississippi, North Carolina, Tennessee and Virginia SHPOs agree that the Undertaking shall be implemented in accordance with the following stipulations in order to take into account the effects of the Undertaking on National Register listed or eligible historic properties, and that these stipulations shall govern the Undertaking and all of its parts until this Programmatic Agreement expires or is terminated.

STIPULATIONS

TVA will ensure that the following measures are carried out:

I. Identification of Historic Properties

A. Identification Plan. In consultation with the SHPOs, TVA will develop and implement a Historic Property identification plan ("Identification Plan") for evaluating TVA-managed shoreline property within the APE not yet investigated for the presence of historic properties. The Identification Plan shall specify a schedule for investigation of affected reservoirs in consultation with the appropriate SHPOs and other signatories. Contingent upon availability of funds, TVA will seek to complete the survey of affected reservoir shorelines within five years after execution of this agreement. TVA shall submit the Identification Plan to the signatories for review and comment within six (6) months of execution of this agreement or implementation of the undertaking, whichever occurs later.

B. Identification Reports. Reports documenting the results of identification surveys will be submitted to the appropriate SHPOs and other signatories annually along with an annual assessment of erosion activity (see Stipulation II).

II. Erosion Monitoring and Assessment

A. Monitoring Plan. In consultation with the SHPOs, TVA will develop and implement a plan ("Monitoring Plan") to monitor the rate of shoreline erosion at sites on affected TVA reservoirs where historic properties are located. This plan would help monitor any increased rate of erosion resulting from this undertaking's incremental operational changes. The Monitoring Plan shall specify a schedule for inspecting affected reservoirs at an interval of no greater than five years to determine the condition of Historic Properties within the APE. The Monitoring Plan will specify criteria for assessing the incremental erosion impacts on historic properties. TVA shall submit the Monitoring Plan to the signatories for review and comment within six (6) months of execution of this agreement or implementation of the undertaking, whichever occurs later.

B. Erosion Assessment. Under the Monitoring Plan, TVA will conduct an inspection of Historic Properties on the affected reservoirs to further assess the impacts of the incremental changes in reservoir operations. Sites determined to be adversely affected by increased erosion will be evaluated to determine an appropriate treatment measure. A report of these investigations will be prepared and sent to all signatories for review. Erosion assessments will be made in consultation with the appropriate SHPO and other consulting parties.

II. Erosion Treatment

A. Treatment Criteria. Historic Properties identified as being adversely affected by erosion will be evaluated to determine an appropriate treatment measure. Site-specific treatment measures will be reviewed and commented upon by the appropriate SHPO and other signatories. TVA will take these comments into account as it addresses appropriate treatment.

B. Treatment Alternatives. In consultation with the appropriate SHPO and other signatories, TVA will determine the appropriate treatment measure to be applied to Historic Properties found to be adversely affected by reservoir shoreline erosion. Treatment alternatives include but are not limited to:

1. Shoreline stabilization using riprap, bio-engineering, or other methods as determined appropriate
2. Data recovery excavations

III. Treatment of Human Remains:

TVA shall ensure that the treatment of any human remains and associated funerary objects discovered within the project area complies with all applicable state and federal laws, including the Native American Graves Protection and Repatriation Act (NAGPRA), concerning treatment of human remains. Should human remains be encountered on federal land during monitoring investigations, TVA shall immediately notify federally recognized Indian tribes that may have a cultural affiliation with the remains pursuant to the provisions of NAGPRA. TVA will consult with these tribes regarding the appropriate disposition of these remains.

IV. Historic Properties on Private lands

Although TVA has no control over adjacent private lands where reservoir-related development may occur, TVA has authority under Section 26a of the TVA Act to regulate activities that could affect flood control, navigation or public lands. To the extent allowable under this authority, TVA will seek to assist private developers to avoid adversely affecting historic properties within the indirect APE of the ROS.

V. Reports

TVA shall prepare an annual report on its Historic Property identification and shoreline erosion monitoring activity, and shall submit this report to the SHPOs and other signatories for review and comments. This report will include a description of all shorelines surveyed and monitored, and of any assessments conducted of the conditions of historic sites existing within these areas. The assessment will compare site condition to previously reported assessments of site condition, and will include a rating of treatment need according to criteria established in the monitoring plan. All parties shall be afforded thirty (30) days to review and comment on these reports.

VI. Administrative Conditions

1. If the commencement of implementation of Stipulations I-IV has not occurred within one (1) year from the date of this agreement's execution or implementation of the undertaking, whichever occurs later, TVA, the SHPOs, and other signatories shall review the agreement to determine whether the agreement should be extended. If an extension is deemed necessary, TVA, the SHPOs, and other signatories will consult to make appropriate revisions to the agreement in accordance with 36 CFR § 800.6(c).

2. If the commencement of implementation of Stipulations I-IV has not occurred within three (3) years from the date of this agreement's execution or implementation of the undertaking, whichever occurs later, this agreement shall be considered null and void, unless the signatories have agreed in writing as provided in Paragraph VI (1) above to an extension for carrying out its terms. Upon the agreement's becoming null and void, TVA, the SHPOs, and the consulting parties will resume consultation pursuant to 36 CFR § 800.

3. The signatories to this agreement may agree to amend the terms of the agreement. Such amendment shall be effective upon the signatures of all signatories to this agreement, and the amendment shall be appended to the agreement as an attachment.

4. Should any signatory object within thirty (30) days after receipt of any plans, specifications, contracts, or other documents provided for review pursuant to this agreement, TVA shall consult with the objecting party to resolve the objection.

5. If any signatory to this agreement determines that the terms of the agreement cannot be or are not being carried out, the signatories shall consult to seek an amendment to the agreement. If the agreement is not amended, TVA or any individual SHPO may terminate the agreement, except that termination by an individual SHPO shall only terminate the application of the agreement within the jurisdiction of that SHPO.

EXECUTION of this Programmatic Agreement by the Tennessee Valley Authority and the Alabama, Georgia, Mississippi, North Carolina, Tennessee and Virginia State Historic Preservation Officers, the submission of documentation and filing of this Agreement with the Advisory Council, and implementation of its terms evidence that TVA has, in accordance with Section 106 of the National Historic Preservation Act, taken into account the effects of this undertaking on historic properties and afforded the Advisory Council an opportunity to comment.

SIGNATORY PARTIES:

TENNESSEE VALLEY AUTHORITY

By: ____ Date: _____________
Kathryn J. Jackson, Executive Vice President, River System Operations and Environment

ALABAMA STATE HISTORIC PRESERVATION OFFICER

By: ____ Date: _____________

GEORGIA STATE HISTORIC PRESERVATION OFFICER

By: ____ Date: _____________

MISSISSIPPI STATE HISTORIC PRESERVATION OFFICER

By: ____ Date: _____________

NORTH CAROLINA STATE HISTORIC PRESERVATION OFFICER

By: ____ Date: _____________

TENNESSEE STATE HISTORIC PRESERVATION OFFICER

By: ____ Date: _____________

VIRGINIA STATE HISTORIC PRESERVATION OFFICER

By: ____ Date: _____________

CONCURRING PARTIES:

EASTERN BAND OF CHEROKEE INDIANS

By: ____ Date: ______________
Title:

____

By: ____ Date: ______________
Title:

____

By: ____ Date: ______________
Title:

____

By: ____ Date: ______________
Title:

Appendix A
Preferred Reservoir Operating Policy Alternative

Purpose. The purpose of the Preferred Alternative is to capture the balance of public benefits that would result if the reservoir system is operated to increase both reservoir and tailwater recreational opportunities. This alternative was created after extensive public review of the Draft Environmental Impact Statement (DEIS) and additional analyses. The goal was to enhance public value while minimizing impacts to the environment and to other operating objectives. The alternative combines and adjusts desirable features of the alternatives identified in the DEIS to create a more feasible, publicly responsive alternative.

A central component in formulating the Preferred Alternative was flood risk. With the exception of the No Action Alternative (Base Case), detailed analyses indicated that all of the alternatives evaluated in the DEIS would result in unacceptable increases in the risk of flooding at one or more critical locations in the Tennessee Valley. Addressing flood risk was the first step in creating the Preferred Alternative.

DEIS Reservoir Recreation A Alternative was used as a baseline for developing the first in a series of eight Preferred alternatives. TVA used this series of alternatives to eliminate increases in average annual flood damages at critical locations. TVA also used this series of alternatives to develop a more equitable way of balancing pool levels among the tributary reservoirs. Each successive alternative included modifications to individual project flood guides and/or regulating zones that were intended to address problem areas while providing changes in reservoir pool levels that would enhance a range of benefits. Changes to individual project guide curves were made both to resolve flood damage issues immediately downstream from that project, as well as downstream at damage centers such as Chattanooga and Savannah, Tennessee. As the flood risk issues were addressed, TVA included enhancements to reservoir and tailwater recreation and navigation, while considering impacts to low-cost/reliable electricity, water quality, and water supply. As part of these simulations, TVA investigated using both flow constraints and target reservoir elevation constraints as the mechanism for restricting drawdown from June through Labor Day. Based on the results of these simulations, TVA has determined that operating objectives could best be met by using flow constraints that reduce impacts to water quality and power system costs. Flood risk considerations indicated that earlier fill of tributary and main river projects was not feasible. No changes in seasonal water levels on Kentucky Reservoir were included as part of this alternative, responding to concerns expressed by the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, state agencies, and some members of the public.

Changes in Operations. Under the Preferred Alternative, tributary reservoir drawdown would be restricted June 1 through Labor Day, summer operating zones would be maintained through Labor Day at four additional main river projects, and higher winter pool operating ranges would be established at 10 tributary reservoirs. Base Case minimum flows, except for the increases noted below, and the dissolved oxygen (DO) targets adopted following completion of the 1990 Lake Improvement Plan would continue to be met.

Subject to flood control operations or extreme drought conditions, scheduled releases would be provided at five additional tributary projects to increase tailwater recreational opportunities. (Under the No Action Alternative, recreational releases are not formally scheduled at these five projects and are made only after other operating requirements have been met.)

Subject to each project meeting its own minimum flow requirements and a proportionate share of the system minimum flow requirements, elevations on 10 tributary reservoirs would be maintained as close as possible to the flood guides from June 1 through Labor Day. When the volume of water in storage is more than the system minimum operations guide curve, the weekly average system minimum flow requirement measured at Chickamauga Dam would be increased each week from 14,000 cubic feet per second (cfs) the first week of June to 25,000 cfs the last week of July. Beginning August 1 and continuing through Labor Day, the weekly average flow requirement would be 29,000 cfs. If the volume of water in storage is less than the system minimum operations guide (MOG) curve, only 13,000 cfs weekly average minimum flows would be released from Chickamauga Dam between June 1 and July 31, and only 25,000 cfs weekly average minimum flows would be released from August 1 through Labor Day. Continuous minimum flows would be provided in the Apalachia bypass reach from June 1 through November 30.

Under the Preferred Alternative, the winter flood guide levels would be raised on 10 tributary reservoirs based on flood risk analysis. On Wheeler Reservoir, the minimum winter elevation would be raised by 0.5 foot to better ensure an 11-foot minimum depth in the navigation channel. Steady water releases up to 25,000 cfs of flow would be provided as necessary at Kentucky Dam to maintain a tailwater elevation of 301. Great Falls Reservoir would be filled earlier to reach full summer pool by Memorial Day. On Fort Loudoun, Watts Bar, and Chickamauga reservoirs, the fill period would follow the Base Case fill schedule during the first week in April. The fill schedule on these three reservoirs then would be delayed to reach summer operating zone by mid-May. Specific details of the Preferred Alternative are presented in Tables 1 and 2.

During critical power system situations, reservoir operations may temporarily deviate from these operating guidelines to meet power system needs. In such situations, water stored in the reservoirs would be used to preserve the reliability of the power system.

Achievement of Objectives. The Preferred Alternative was developed to combine the desirable features of the alternatives identified in the DEIS. Responding to the values and objectives expressed by the public during the EIS review process, this alternative was designed to re-balance operating system priorities to achieve TVA's goal of increasing the overall public value of the reservoir system consistent with, but not limited to, the operating priorities established by the TVA Act.

Under the Preferred Alternative, TVA would preserve the primary reservoir system operating objectives of flood control, navigation, and power generation. It would increase reservoir and tailwater recreation opportunities. This alternative would not increase annual average flood damages at any critical location within the Tennessee Valley, including Chattanooga. Adoption of the Preferred Alternative would increase the minimum depth of the Tennessee River navigation channel at two locations and would maintain power system reliability while lessening impacts to delivered cost of power compared to other alternatives. This alternative also would maintain tailwater minimum flows and dissolved oxygen targets while minimizing impacts on reservoir water quality, and would provide for more balanced tributary reservoir levels across the system.

Table 1. General description of operations under the Preferred Alternative. [to be incorporated into EIS Table 3.3-01]

Policy Alternative	Changes to Reservoir Operating Guidelines (Guide Curves)	Changes to Water Release Guidelines
Preferred Alternative	• Subject to each project meeting its minimum flow requirements and a proportionate share of the system minimum flow requirements, maintain tributary reservoir elevations as close as possible to the flood guides during the summer (June 1 through Labor Day) • Begin unrestricted tributary reservoir drawdown after Labor Day • Maintain Base Case summer operating zone through Labor Day for Chickamauga, Guntersville, Pickwick, and Wheeler • Raise winter flood guide to elevations based on flood risk analysis for 10 tributary reservoir projects • Great Falls—Fill reservoir to summer pool by Memorial Day • Raise minimum winter pool elevation by 0.5 foot at Wheeler • Follow the Base Case fill schedule during the first week in April for Fort Loudoun, Watts Bar, and Chickamauga. Then, delay the fill to reach summer operating zone by mid-May	• If above system MOG curve, increase weekly average minimum flow from Chickamauga each week during June and July (beginning with 14,000 cfs the 1st week in June increasing to 25,000 the last week in July) • If below system MOG curve, release 13,000 cfs weekly average minimum flow from Chickamauga during June and July • Release 29,000 cfs weekly average minimum flow from Chickamauga from August 1 through Labor Day if above system MOG or 25,000 cfs if below system MOG curve • Provide continuous minimum flows up to 25,000 cfs at Kentucky, as needed, to maintain minimum tailwater elevation of 301 • Maintain Base Case minimum flow commitments with additional scheduled tailwater recreation releases • Provide 25 cfs in Apalachia bypass reach from June 1 through November 1

Table 2. Components of the Preferred Alternative. [to be incorporated into EIS Appendix B]

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs

Modify summer reservoir elevations and/or drawdown dates	• Subject to each project meeting its minimum flow requirements and a proportionate share of the system minimum flow requirements, maintain elevations as close as possible to the flood guides during the summer (June 1 through Labor Day) for Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Nottely, Hiwassee, Norris, South Holston, and Watauga
	• No changes to the following reservoirs for the reasons described:
	  • Apalachia—run-of-river project
	  • Bear Creek—maintains summer elevations to mid-November
	  • Boone—maintains summer elevations through Labor Day.
	  • Cedar Creek—maintains summer elevations through October 31
	  • Fort Patrick Henry—run-of-river project
	  • Great Falls—maintains summer elevations through September 30
	  • Little Bear Creek—maintains summer elevations through October 31
	  • Melton Hill—run-of-river project
	  • Normandy—subject to meeting downstream minimum flows summer elevations are maintained through mid-October
	  • Ocoee #1—maintains summer elevations through October 31
	  • Tims Ford—maintains summer elevations through mid-October
	  • Upper Bear Creek—maintains the same fluctuation range year round
	  • Wilbur—run-of-river project
		• Maintain Base Case summer operating zone through Labor Day for Chickamauga, Guntersville, Pickwick, and Wheeler
		• Eliminate 1 foot drawdown from August 1 to November 1 for Watts Bar
		• No changes to the following reservoirs for the reasons described
		  • Fort Loudoun—maintains summer operating zone through October 31
		  • Nickajack—run-of-river project
		  • Wilson—maintains summer operating zone through November 30
		  • Kentucky – potential resource and flood risk impacts

Table 2. (Continued)

Alternative Characteristics	• Tributary Reservoirs	Mainstem Reservoirs
Modify winter reservoir elevations and/or fill dates	• Raise winter flood guide to elevations based on flood risk analysis for Boone, Chatuge, Cherokee, Douglas, Fontana, Hiwassee, Norris, Nottely, South Holston, and Watauga • Great Falls—Fill reservoir to summer pool by Memorial Day	• Raise minimum winter pool elevation by 0.5 foot at Wheeler • Follow the Base Case fill schedule during the first week in April for Fort Loudoun, Watts Bar, and Chickamauga. Then, delay the fill to reach summer operating zone by mid-May
Modify drawdown restrictions	• Restrict drawdown June 1 through Labor Day and proportion withdrawals to meet system minimum flows to keep tributary reservoir pool elevations as close as possible to the flood guides	• Maintain Base Case summer operating zone at Chickamauga, Guntersville, Wheeler and Pickwick through Labor Day
Modify water releases	• Same as Base Case minimum flow commitments except for additional scheduled tailwater recreation releases as shown below • Apalachia -- provide 25 cfs continuous minimum flow in bypass reach from June 1 through November 30	• If above system MOG curve, increase weekly average minimum flow from Chickamauga each week during June and July (beginning with 14,000 cfs the 1st week in June increasing 1,000 cfs each week for the next 3 weeks, then increasing 2,000 cfs each week for the next 4 weeks and ending with 25,000 the last week in July) • If below system MOG curve, release 13,000 cfs weekly average minimum flow from Chickamauga during June and July • Release 29,000 cfs weekly average minimum flow from Chickamauga from August 1 through Labor Day if above system MOG or 25,000 cfs if below system MOG curve • Provide continuous minimum flows up to 25,000 cfs at Kentucky, as needed, to maintain minimum tailwater elevation of 301

Table 2. (Continued)

Alternative Characteristics	Tributary Reservoirs	Mainstem Reservoirs
Modify tailwater recreation releases	• No change in tailwater recreation releases below Great Falls, Ocoee #2, Ocoee #3, Tims Ford, and Upper Bear Creek reservoirs • Provide tailwater recreation flows for the projects as described below: • Apalachia May 1 through October 31 (Saturdays and Sundays only) Minimum flow only prior to 10 a.m. Memorial Day through Labor Day (7 days per week) 1 unit use from 10 a.m. – 11 a.m. 2 unit use from 11 a.m. – 7 p.m. (8 hours) Labor Day through October 31 (Saturdays only) 1 unit use from 10 a.m. – 11 a.m. 2 unit use from 11 a.m. – 3 p.m. (4 hours) • Norris May 1 through October 31 (Saturdays and Sundays only) Minimum flow only prior to 10 a.m. Memorial Day through Labor Day (Saturdays and Sundays only) 1 unit use from 10 a.m. – 2 p.m. (4 hours) 2 unit use from 2 p.m. – 6 p.m. (4 hours) Labor Day through October 31 (Saturday only) 1 unit use from 10 a.m. – 1 p.m. (3 hours) 2 unit use from 1 p.m. – 4 p.m. (3 hours) • Ocoee #1 June 1 through August 31 (Tuesdays and Wednesdays only) Minimum flow only until 11 a.m. Minimum 2 unit use from11 a.m. to 5 p.m. (6 hours) • South Holston April 1 through October 31 Increase minimum flow below the weir to 150 cfs • Watauga operation for recreation flows below Wilbur Memorial Day through Labor Day Mondays – Fridays - 1 unit use from 1 p.m. – 6 p.m. (5 hours) Saturdays – 1 unit use from 12 p.m. – 1 p.m. 2 unit use from 1 p.m. – 5 p.m. (4 hours) 1 unit use from 5 p.m. – 6 p.m. Labor Day through October 31 Saturdays only - 1 unit use from 1 p.m. – 6 p.m. (5 hours)	No change

Appendix B
Status of Archaeological Survey of the Area of Potential Effect

Status of Affected Reservoir Shoreline Survey.

Reservoir	Surveyed*	Unsurveyed**	Total***	% Surveyed
Blue Ridge	51.2	16.9 (1)	68.1	75.2%
Chatuge	39.9	88.1	128	31.2%
Cherokee	199.4	195.1	394.5	50.5%
Fontana	26.8	211	237.8	11.3%
Hiwassee	126.1	55.4 (1)	181.5	69.5%
Norris	223	585.4	808.4	27.6%
Nottley	49.3	52.8	102.1	48.3%
Pickwick	293.9	196.7	490.6	59.9%
South Holston	48.6	133.3	181.9	26.7%
Watuaga	41.7	63.3	105	39.7%
Wheeler	566.9	470.3	1027.2	55.2%
Total	**1756.1**	**2105.6**	**3851.7**	**45.6%**

Numbers reflect mileage along shoreline per reservoir

*This survey data was based on the shoreline information coded 1, 2 and 3 in the database. This data includes buffers for protection/reliability of original recordation. Therefore includes some areas that have not been considered surveyed, but should not be of an amount that would dramatically effect these numbers.
**This data was obtained by subtracting Surveyed from Total.
***Shoreline mileage obtained from Shoreline Management Initiative Table.
(1) Approximately 90% of the unsurveyed shorelines on these two reservoirs consist of slopes greater than 20% and are therefore regarded to have a very low potential to contain archaeological resources.

Status of Shoreline Survey on Multi-State Reservoirs

Reservoir	Total Miles	Surveyed	Unsurveyed	% Surveyed
Chatuge	**GA**	**GA**	**GA**	**GA**
	70.6	35.5	35.1	50.3%
	NC	**NC**	**NC**	**NC**
	57.4	4.8	52.6	8.4%
Pickwick	**TN**	**TN**	**TN**	**TN**
	48.8	41.8	6.9	85.8%
	MS	**MS**	**MS**	**MS**
	71.7	48.7	22.9	68.0%
	AL	**AL**	**AL**	**AL**
	370.1	203.4	166.9	55.0%
South Holston	**TN**	**TN**	**TN**	**TN**
	134.2	10.9	123.3	8.1%
	VA	**VA**	**VA**	**VA**
	47.7	37.7	10	79.0%

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