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TRANSMISSION SYSTEM VEGETATION MANAGEMENT

FINAL PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

Prepared by:
TENNESSEE VALLEY AUTHORITY
Chattanooga, Tennessee

Cooperating Agencies:
NATIONAL PARK SERVICE AND
U.S. FOREST SERVICE

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COVER SHEET

Transmission System Vegetation Management Programmatic Environmental Impact Statement

Proposed Action: The Tennessee Valley Authority (TVA) has prepared this Programmatic Environmental Impact Statement (PEIS) to address potential environmental, social, and economic impacts associated with the proposed management of vegetation within its existing active transmission line rights-of-way (ROW).

Type of document: Programmatic Environmental Impact Statement

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Abstract:

TVA needs to decide which of four alternatives would be used to guide the management of vegetation within its active transmission ROW. Each of the four alternatives under consideration includes routine assessment methods to establish a basis for vegetation control measures. Vegetation management under the No Action Alternative (Alternative A) is prescribed by a July 31, 2017 court injunction order currently in place in the *Sherwood v. TVA* litigation, and there would be no change to this process under this alternative. Due to the *Sherwood v. TVA* litigation, TVA has stopped removing woody vegetation (except for trees that are an immediate hazard). As a result, buffer zones within the existing ROW continue to contain vegetation incompatible with TVAs transmission system. The volume of non-compatible woody vegetation is also increasing within the previously-cleared ROWs due to the court injunction order. Therefore, to assure the safe and reliable operation of the transmission facilities and to improve the effectiveness of vegetation management, Alternatives B, C and D would include an initial woody vegetation removal within buffer areas (leaving grasses, forbs, and some small shrubs) within the full extent of the ROW. Following initial woody vegetation removal, the full extent of the ROW would be maintained to a low height on a recurring cycle under Alternative B and to a meadow-like end-state under Alternative C. Under Alternative D the buffer zone would be managed to an end-state consisting of compatible vegetation that is variable by zone (compatible shrubs and trees in the border zone). Under Alternatives C and D, compatible trees and shrubs would be allowed in areas maintained actively by others. TVA's preferred alternative is Alternative C. The PEIS document is prepared at the programmatic level to encompass ROW vegetation management across TVA's transmission system. The management of individual transmission line segments will tier from the PEIS as needed and provide more site-specific review and analysis.

Summary

Introduction

The Tennessee Valley Authority (TVA) has prepared this Programmatic Environmental Impact Statement (PEIS) to address potential environmental, social, and economic impacts associated with the proposed management of vegetation within its transmission rights-of-way (ROW). Accordingly, the analysis of impacts in the PEIS adopts a regional perspective and presents impacts in a comparative manner. Following the completion of the PEIS and the issuance of the Record of Decision, individual transmission line segments that undergo vegetation management practices will tier from the programmatic EIS as appropriate and provide more site-specific review and analysis.

TVA's transmission system serves nearly ten million residents in a more than 82,000-square-mile area. For vegetation management purposes this area is divided into six regions consisting of a total of 12 sectors. TVA develops a plan to maintain active transmission line ROWs within each of the 12 sectors. This area, shown on Figure S-1, comprises the study area for this PEIS as this area is inclusive of all areas where TVA maintains ROW or could acquire and build transmission line within the newly acquired ROW.

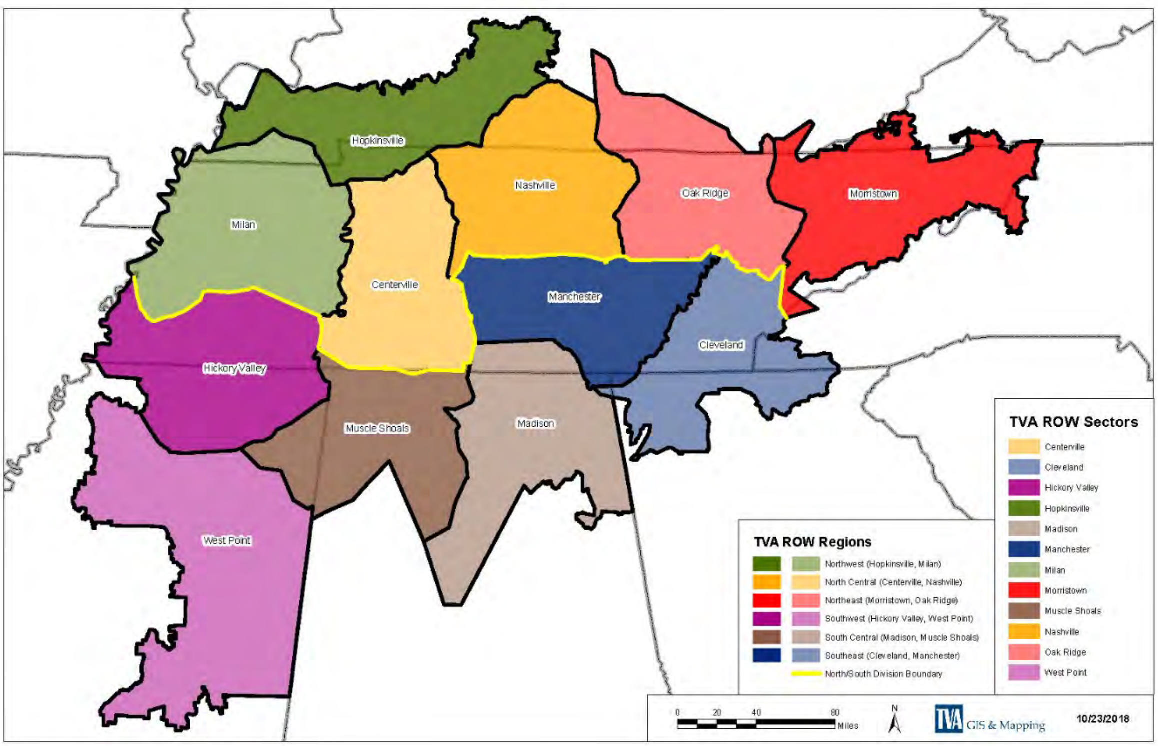

Figure S-1. TVA's Programmatic Environmental Impact Statement Study Area

TVA's transmission system consists of a network of more than 16,000 miles of electric transmission lines and approximately 500 power substations all contained within approximately 238,000 acres of utility ROW. Most of TVA's transmission system is located on private lands. With respect to TVA's transmission system, TVA typically acquires perpetual rights through purchased easements to manage vegetation in order to protect transmission lines. TVA inspects its transmission line ROWs as TVA has the ultimate responsibility for electric reliability. TVA, however, only actively maintains approximately 46 percent (110,752 acres) because approximately 51 percent of the transmission ROW is used as cropland, golf courses, orchards or similar uses, which are primarily maintained by the landowner. While the floor of the ROW is often maintained by others in these areas, TVA conducts routine inspections and vegetation management of ditch banks, fence rows, towers, and other features. A relatively small amount of the TVA transmission system ROW (4,720 acres) does not require routine vegetation management by anyone. These areas include ROW that spans open water or deep valleys where vegetation growing at lower elevations does not threaten the transmission line. Trees tall enough to fall within or grow to an unsafe distance of transmission lines under maximum sag and blowout conditions are managed on all lands within and adjacent to the TVA ROW.

TVA's vegetation management program along its transmission ROW consists of the following basic components:

- *Floor work* – Vegetation management activities that target previously cleared or maintained areas along the ROWs. Typically, floor activities consist of mechanical control (e.g., brush hogging; this term is also known as bush hogging and will be referred to as brush hogging in this document) and herbicide application.
- *Tree work* – Vegetation management activities which focus on tree removal and trimming. Typically, tree activities consist of manual controls (e.g., chainsaw) and mechanical control (e.g., equipment mounted saws and other devices).
- *Inspections* – Periodic review of ROW condition to determine maintenance needs, and any need to adjust the cycle of scheduled work due to emergent conditions.
- *Planning and Support* – The ROW manager develops plans to maintain his or her respective ROWs in a cost-effective, efficient, and environmentally responsible manner to minimize vegetation-related interruptions.
- *Communication* – Notification of, communication to, and education for the property owner.
- *Reliability and Compliance* – Vegetation management activities maximize reliability of the transmission system. Vegetation management activities also must be compliant where applicable with the North American Electric Reliability Corporation (NERC) Reliability Standard FAC-003.

Purpose and Need

Energy companies such as TVA are typically interconnected to bordering energy companies, thus creating a larger interconnected transmission grid or network. While the interconnectedness of the grid brings many benefits, it also means that an interruption, especially an outage caused by vegetation, can have impacts larger than the service area within which it occurs. For example, in August 2003, a single tree contacted a transmission line in Ohio that initiated a series of events that triggered transmission line failures and blackouts from Ontario, Canada, to the northeastern United States that affected 55 million people and resulted in an economic impact estimated at $6 billion. In response to these widespread outages, Congress enacted the Energy Policy Act of 2005 (Public Law 109-58), which authorized the Federal Energy Regulatory Commission (FERC), an independent agency that regulates the interstate transmission of electricity, natural gas, and oil, to certify an "Electric Reliability Organization" (ERO) to create mandatory and enforceable reliability standards, subject to FERC review and approval. Following the 2003 blackout and subsequent federal establishment of the legislation Energy Policy Act of 2005, FERC designated NERC as the ERO with the responsibility to develop and enforce standards to ensure the reliability of the Bulk Power System. FERC certified NERC as the ERO for North America.

NERC began enforcing its Reliability Standard FAC-003 Transmission Vegetation Management Program on June 18, 2007. Because failure to address the vegetation clearance, compliance and monitoring requirements of FAC-003 can result in major power outages and injury to life or property, NERC can apply regulatory penalties for non-compliance, including mitigation and fines.

Accordingly, traditional methods of vegetation management have had to improve to meet the reliability standards required by NERC via FAC-003. Recent wildfire events in the Western Unites States have placed additional scrutiny on ROW vegetation management programs, as these events demonstrate the devastating loss of life and property that can occur if vegetation encroaches upon power lines.

TVA, like other energy companies, develops long-range vegetation management plans for its transmission system. This planning process includes considerations regarding how and when TVA would control the vegetation growing within its transmission line ROWs.

The purpose of TVA's transmission system vegetation management program is to develop a policy to strategically manage TVA's existing transmission line ROWs in a manner consistent with applicable laws, orders, standards, practices and guidance while providing reliable energy and protecting environmental resources to the extent possible. Failure to address vegetation clearance and management of brush, downed vegetation and small trees could result in wildfires, major power outages, and injury to life or property. The need for the proposed action includes:

- Enhance public safety through controlled vegetation management of TVA's transmission lines.
- Improve the effectiveness of TVA's vegetation management program by eliminating vegetation that interferes with the safe, efficient and reliable operation of the existing transmission system so as that TVA can continue to provide the public safe and reliable electric power in a cost-effective and environmentally sound manner.
- Comply with all current and future NERC Reliability Standards to maintain transmission lines in a safe and reliable operating condition, thereby minimizing TVA's potential for costly fines for NERC noncompliance.

In addition, TVA is currently subject to a court injunction issued a July 31, 2017 by the U.S. District Court for the Eastern District of Tennessee in the lawsuit, *Sherwood v. TVA*, No. 3-12-cv-156, which requires "TVA [to] maintain buffer zones on the edges of its ROW in a manner as described in its 1997 and 2008 Line Maintenance Manuals" until TVA prepares and publishes a thorough Environmental Impact Statement pursuant to the National Environmental Policy Act (NEPA) analyzing TVA's ROW vegetation management program. Thus, the successful completion of this PEIS will enable TVA to fulfill its legal obligations in this court action.

Cooperating Agencies
TVA has coordinated with other federal land management agencies in conjunction with this PEIS. In particular, the National Park Service (NPS) and the United States Forest Service (USFS) have agreed to serve as cooperating agencies. These agencies will participate in the following ways: assure that laws and regulations governing operation of their respective lands are appropriately considered as applicable to TVA; respond to requests for existing information and review of written material; provide TVA copies of pertinent planning documents, data, and resource information relating to management of resources in the study area; provide technical expertise and input on matters relating to their primary areas of responsibility; assist in the development of mitigation measures and monitoring plans; conduct appropriate technical and or administrative reviews of the preliminary draft and preliminary final PEIS; and provide written comments for use in subsequent revisions.

Methods Evaluated in the Programmatic EIS
Setting objectives, defining action thresholds, and selecting site-specific application of tools to control vegetation all require consideration as part of the vegetation management process. As such, TVA considered individual and various combinations of methods of general vegetation control to manage vegetation along transmission line ROWs and retained three methods:

- Manual removal
- Mechanical cutting and trimming
- Herbicide spraying and growth regulators

All practical “tools” (i.e., types of equipment) included in the “toolbox” (i.e., comprehensive set of methods identified above) for each component of TVA’s vegetation management program, which includes vegetation control, debris management, and restoration, are identified in this PEIS. These three methods were considered, and it was determined that the most suitable approach for management of TVA ROWs would be tailored to each site within the ROW so that the management objectives can be achieved for varying terrain and conditions over the entire system. Effective vegetation control along the transmission ROW typically requires the use of a combination of methods. Any approach that narrows the range of tools identified for use by TVA as part of its transmission ROW management would reduce TVA’s ability to optimize outcomes that enhance environmental stewardship and maximize long-term cost effectiveness.

In determining policy and direction for managing vegetation along its transmission line ROW, TVA examined its past and current vegetation management practices and considered standard practices utilized by other entities such as Bonneville Power Administration and the USFS, as well as research conducted by the Electric Power Research Institute (EPRI). TVA’s research revealed that Integrated Vegetation Management (IVM) is the industry standard. The goal of IVM is to provide an integrated and balanced approach of vegetation management that considers the overall long-term effect on public health and safety, reliability, environmental stewardship, and cost. Therefore, TVA determined IVM should continue to be a central component of its vegetation management strategy.

IVM allows TVA to apply a range of methods depending on the target vegetation type. TVA uses herbicides predominantly during routine floor vegetation management and a mix of manual and mechanical methods to remove trees. Noxious or invasive plant species are controlled predominantly by a mix of methods dominated by mechanical techniques and herbicides. By comparison, tall-growing, incompatible trees and shrubs are typically controlled using a more balanced application of all techniques (manual, mechanical, and herbicide).

Alternatives Evaluated in the PEIS

TVA is considering four alternatives to manage vegetation along its transmission system ROW:

- Alternative A: No Action.
- Alternative B: Cyclical-Based Control Strategy.
- Alternative C: Condition-Based Control Strategy (End-State: Meadow-Like).
- Alternative D: Condition-Based Control Strategy (End-State: Variable by Zone).

Each of these alternatives is context sensitive. Site-specific characteristics and the incorporation of TVA's office-level sensitive area review (O-SAR) process determine the selection of vegetation management methods employed. The O-SAR process identifies the need for site-specific field surveys and particular tool use when an area contains documented sensitive environmental resources or has the potential for the presence of such resources.

The scope of the potential alternatives is informed by the purpose and need of the proposed action, namely, the need to improve the effectiveness of TVA's vegetation management program by eliminating vegetation that interferes with the safe and reliable operation of the transmission system. Under all of the proposed alternatives, some vegetation control would be the same. For example, floor work (i.e., that which is focused on the maintained herbaceous community) would continue on an established cycle and, in general, would be controlled using a mixture of methods. To date, the proportion of methods to manage floor work has been approximately 90 percent herbicide, six percent mechanical, and four percent manual.

Each of the four alternatives under consideration includes routine assessment methods to establish a basis for vegetation control measures. Under the No Action Alternative (Alternative A), due to the *Sherwood v. TVA* litigation, TVA has stopped removing woody vegetation except for trees that are an immediate hazard. As a result, buffer zones within the existing ROW continue to contain vegetation incompatible with TVAs transmission system. The volume of non-compatible woody vegetation is also increasing within the previously-cleared ROWs due to the July 31, 2017 court injunction order. Therefore, to satisfy the need for the safe and reliable operation of the transmission facilities while improving the effectiveness of vegetation management, Alternatives B, C and D would have to include initial removal of woody vegetation of those buffer areas within the full extent of the ROW (leaving grasses, forbs, and some small shrubs). Following initial removal of woody vegetation, the full extent of the ROW would be maintained to a low height on a recurring cycle under Alternative B and to a meadow-like end-state under Alternative C (i.e., that which at maturity does not pose a risk of interference with electrical conductors). Under Alternative D the buffer zone would be managed to an end-state consisting of compatible vegetation that is variable by zone (compatible shrubs and trees in the border zone). Under both Alternatives C and D, compatible trees and shrubs would be allowed in areas actively maintained by others.

Summary of Impacts

Each aspect of TVA's vegetation management program (vegetation control, debris management, restoration) varies with respect to its impact on environmental resources. Table S-1 provides a summary of impacts associated with each of the vegetation management methods.

Table S-2 presents a summary of the impacts of each of the management alternatives carried forward for detailed analysis. Under all alternatives, direct impacts to herbaceous plant communities would continue as a result of the recurring impact on plants within the ROW. Such effects would include crushing, damaging, and accidental treatment or removal of both target and non-target vegetation. However, because this is part of an existing management program it would not result in widespread alteration of the overall plant community. Therefore, overall impacts to vegetation are considered to be moderate as the routine maintenance of vegetation would periodically impact plant communities across the broader transmission system, but they would not destabilize the general plant communities of the study area.

While there is a potential for long-term impacts to natural resources associated with the repeated disturbance within the ROW, such impacts would be minimized through sound planning and the incorporation of TVA's O-SAR process as a best management practice (BMP) and the incorporation of other established TVA transmission ROW Management BMPs and established transmission-related environmental protection practices (Appendix E).

Potential natural resource impacts of this repeated disturbance within the transmission ROW include the following:

- Limited disturbance and erosion of soils resulting from vegetation removal, traffic of maintenance equipment, and localized manual clearing activities.
- Small, localized and short-term alteration of water quality from runoff of residual herbicides and sedimentation through erosion from disturbed surfaces.
- Increased effects on wetlands from soil compaction, rutting, and long-term alteration of wetland type (forested to emergent) resulting in reduced functional value.
- Small, localized and short-term effects on aquatic biota.
- Expanded floor area managed in long-term as end-state consisting of low height condition that may be expected to have reduced wildlife value;
- Potential damage to listed or sensitive plant species and communities.
- Potential for generation of woody debris that may impede or alter flood flows.

Each of the above effects would be localized and short-term disturbances that are not expected to result in notable or destabilizing effects on any of the above resources. As such, impacts related to long-term vegetation management under all alternatives on the natural environment are minor.

Impacts associated with the initial woody vegetation removal of those buffer areas (except grasses, forbs, and some small shrubs) within the full extent of the ROW would only occur under Alternatives B, C, and D. This would result in long-term habitat loss and displacement of wildlife. However, because initial woody vegetation removal activities would be conducted within the buffer zone of the previously established ROW, the overall effect of these alternatives on vegetation is considered to be moderate as both the routine maintenance of vegetation and removal of the existing buffer zones would not destabilize the general plant communities or wildlife populations within the study area.

Impacts on factors related to the human environment (land use, socioeconomics, air, noise, cultural resources, solid/hazardous waste, public and worker safety, etc.) and on land management (residential, recreational, agricultural, commercial, industrial, NPS, USFS, City, County, and State) specific to all management alternatives, would occur as a result of the maintenance disturbance on the transmission ROW. Periodically recurring vegetation control of the ROW floor would be conducted in conjunction with other vegetation management actions within buffer zones and adjacent or outside the transmission ROW where danger trees may represent a risk to reliability and safety. The potential impacts of this repeated disturbance within the transmission ROW to elements of the human environment include the following:

- Periodic presence of work crews on private and public lands within project areas.
- Transient movement of equipment and work crews on the associated roadway network.
- Localized air, greenhouse gases (GHG) and noise emissions from equipment operated within the transmission ROW.
- Visual intrusion of workers and equipment and visual alteration.
- Disturbance of cultural resource sites.
- Periodic intrusions into the immediate viewshed of sacred sites.
- Disposal of debris and other wastes associated with increased equipment use.
- Need for access and local coordination efforts with affected landowners.
- Exposure of the public and workers to safety hazards associated with vegetation maintenance activities.

Each of the above effects would be localized and short-term disturbances that are not expected to result in notable or destabilizing effects on any of the above resources. Additionally, impacts to cultural, historic and traditional cultural properties would be minimized by ensuring compliance with Section 106 of the Natural Historic Preservation Act (NHPA). TVA has prepared a Programmatic Agreement (PA) under NHPA in coordination with State Historic Preservation Officers (SHPOs), the Advisory Council on Historic Preservation (ACHP) and federally recognized Indian tribes within the study area. For vegetation management activities not covered by the PA or in the event that TVA does not have an executed PA with a particular SHPO, TVA would follow the Section 106 process for specific undertakings. As such, impacts from any of the management alternatives on the elements of the human environment are minor.

A comparison summary of the environmental impacts of Alternatives A, B, C and D is shown in Table S-2.

Table S-1. Summary of Impacts Associated with Vegetation Management Methods

Resource	**Manual**	**Mechanical**	**Herbicides**	**Debris Management**	**Restoration**
Vegetation	Potential impact on non-target vegetation; may result in benefits to some herbaceous species due to improved light penetration. Tree removal may result in conversion of forest or tree-dominated communities to herbaceous communities.	May result in substantial impacts to non-target vegetation and potentially increase the spread of invasive species due to soil disturbance. Some methods may reduce adverse effects by minimizing soil disturbance. Repeated mowing may promote dense regrowth of woody stems that suppress herbaceous species.	Direct effects to targeted vegetation. Spot or localized spraying results in reduced impacts to non-target vegetation and may result in some positive effects on species composition. Broadcast and aerial application methods may have high potential for negative impacts to vegetation, including non-target vegetation.	Some methods may hinder or impede plant growth and restoration of treated areas.	Little potential to negatively affect transmission ROW vegetation because standard BMPs would dictate revegetation efforts to avoid the use of invasive weed species.
Wildlife	Lower potential for toxic inputs; less disturbing to soils; short-term noise and odor disturbance; disruptive to wildlife due to more frequent treatments; potential for localized direct injury to wildlife.	Promotes early-successional habitat favorable to wildlife; less disruptive to wildlife due to less frequent treatments; short-term disturbance of wildlife; habitat alteration impact to less mobile biota; short-term soil disturbance potential for localized direct injury to wildlife.	Use can create low-growing habitat beneficial to some wildlife; less disruptive to wildlife due to less frequent treatments; potential for herbicide toxicity to non-target wildlife, soil, and water.	Leaving debris can be beneficial by creating cover, nutrient recycling, and erosion control; leaving debris increases wildfire fuel load and can harbor tree diseases and pests; debris piles alter habitat; offsite debris removal involves mechanical equipment that increases wildlife	Minor temporary impacts associated with increased erosion and potential for fuel oil leaks or spills. Impacts minimized with standard BMPs. Overall long-term benefit to habitat.

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
				disturbance and erosion.	
Threatened and Endangered Species[1]	TVA uses the O-SAR process to avoid or minimize impacts to state and federally listed species that are known (or have potential) to occur on transmission ROWs by selecting context-sensitive methods that are least likely to negatively impact those species.	TVA uses the O-SAR process to avoid or minimize impacts to state and federally listed species that are known to occur on transmission ROWs by selecting context-sensitive methods that are least likely to negatively impact those species.	Similar to Vegetation, Wildlife, and Aquatic Ecology impacts. TVA uses the O-SAR process to avoid or minimize impacts to state and federally listed species that are known to occur on transmission ROWs by selecting context-sensitive methods that are least likely to negatively impact those species.	TVA uses the O-SAR process to avoid or minimize impacts to state and federally listed species that are known to occur on transmission ROWs by selecting context-sensitive methods that are least likely to negatively impact those species.	Minor temporary impacts associated with increased erosion and potential for fuel oil leaks or spills. Impacts minimized with standard BMPs and SMZs. Overall long-term benefit to habitat.
Surface Water	Temporary, minor impacts from potential sedimentation; less impact relative to mechanical control.	Temporary, minor impacts from potential fuel/lubricant leaks and spills and sedimentation from soil-disturbing heavy equipment. Minimized through use of BMPs.	Minor potential for herbicides to reach surface waters through leaching, drift, or runoff and potential for sedimentation from heavy equipment. No significant impact expected from proper implementation and application of herbicides.	Excess vegetation debris in surface water may alter flows; potential fuel/lubricant leaks and spills; sedimentation from soil-disturbing heavy equipment. Impacts expected to be temporary and minor through use of BMPs.	Minor, temporary impacts from the use of soil disturbing equipment. Overall long-term benefit to water quality due to reduced erosion and sedimentation.
Aquatic Ecology	Minor potential for sedimentation; minor chance of chainsaw	Minor potential for sedimentation and stream bank	Minor potential for sedimentation from equipment; minimized	Minor potential for sedimentation from soil disturbing	Minor, temporary impacts from the use of soil disturbing

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
	oil/fuel leaks/spills; likely no impacts to aquatic biota due to nature of work and standard use of BMPs.	destabilization from soil-disturbing equipment; minor amounts of cut debris reaching streams; minor chance of oil/fuel leaks/spills; minor potential for altered water quality and impact aquatic biota. Minimized through the use of BMPs.	through the use of BMPs. Potential for herbicides to reach waterways (rarely at toxic concentrations); potential acute and chronic impacts to aquatic biota. Potential impact minimized through prior planning, proper herbicide mixtures, and advanced technology to reduce or eliminate drift during application.	equipment; minor amounts of cut debris reaching streams; Minor impacts to aquatic biota. as TVA manages placement of debris to avoid placement proximate to streams or other aquatic environments. Minor positive impact as large woody debris can provide fish habitat; wood chips and mulch can reduce erosion.	equipment. Overall long-term benefit to the aquatic environment due to reduced erosion and sedimentation.
Wetlands	Little/no impact on non-target wetland areas. Tree removal may result in conversion of wetland type and reduction in wetland function; forested wetland conversion may be considered a jurisdictional activity by wetland regulatory agencies.	Minor potential for vehicular rutting and disturbance of wetland soils. Impact minimized with the use of BMPs such as matting, low ground pressure equipment, and dry season work. Tree removal may result in conversion of wetland type and reduction in wetland function; forested wetland conversion may be considered a	Impacts to non-target wetland areas due to runoff, leach, or drift of herbicides. Conversion of forest to emergent wetland may result in reduction of wetland function.	Debris left in wetlands may be considered a regulated fill by wetland regulatory agencies due to potential for obstructing flow, altering existing contours, changing water storage, and/or conversion to upland.	Positive benefit to wetland as restoration would prevent the spread of invasive weeds within the wetlands, promote the establishment of low-growing vegetation, and promote wildlife habitat.

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
		jurisdictional activity by wetland regulatory agencies.			
Floodplains	No impact.	No significant impact; greater impact relative to manual or selective herbicide. Impacts mitigated through the use of BMPs and measures taken to comply with EO 11988 and the National Flood Insurance Program.	No significant impact Impacts mitigated through the use of BMPs and measures taken to comply with EO 11988 and the National Flood Insurance Program.	Debris left in floodplains can impede the flow of water and create obstructions in the floodplain and floodway. Impacts mitigated through the use of BMPs and measures taken to comply with EO 11988 and the National Flood Insurance Program.	No impact.
Geology/Soils	No impact to geology or soils.	No impact to geology. Potential for localized soil disturbance and erosion.	No impact to geology or soils.	No impact on geology. Potential beneficial impact in erosion control.	No impact on geology. Potential beneficial impact in erosion control.
Groundwater	No impact.	Potential impact associated with contaminant release in proximity to groundwater recharge zones. Impact would be mitigated by best management practices and are anticipated to be minor.	Potential impact associated with contaminant release in proximity to groundwater recharge zones. Impact would be mitigated by best management practices and are anticipated to be minor.	Potential impact associated with contaminant release in proximity to groundwater recharge zones. Impact would be mitigated by best management practices and are anticipated to be minor.	Potential impact associated with contaminant release in proximity to groundwater recharge zones. Impact would be mitigated by best management practices and are anticipated to be minor.

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
Land Use and Land Ownership/ Management	No impact to land use, potential short-term disruption of character of lands. Vegetation management on state and federal lands must adhere to existing Land and Resource Management Plans, Special Use Permits, as well as programmatic or related agreements.	No impact to land use, potential short-term disruption of character of lands. Vegetation management on state and federal lands must adhere to existing Land and Resource Management Plans, Special Use Permits, as well as programmatic or related agreements.	No impact to land use, potential short-term disruption of character of lands. Vegetation management on state and federal lands must adhere to existing Land and Resource Management Plans, Special Use Permits, as well as programmatic or related agreements.	No impact to land use, potential short-term disruption of character of lands. Vegetation management on state and federal lands must adhere to existing Land and Resource Management Plans, Special Use Permits, as well as programmatic or related agreements.	No impact to land use. Vegetation management on state and federal lands must adhere to existing Land and Resource Management Plans, Special Use Permits, as well as programmatic or related agreements.
Prime Farmland	No impact.	Localized potential for disturbance or degradation of prime farmland soils from use of mechanized equipment that would be minimized using BMPs.	No impact.	No impact.	No impact.
Natural Areas, Parks, Recreation	Minor, short-term impacts from equipment noise and presence of work crews.	Minor, short-term impacts from equipment noise and work crews associated with trimming. Impacts from clearing would be greater as the character of vegetation could change.	Potential impacts from noise and odors from application of selective targeting herbicides. Minor beneficial impact associated with erosion protection, enhanced wildlife food and cover, and greater diversity. Greater minor, temporary impacts from aerial application in	Minor impacts from large debris left in place as it could interfere with recreation activities. Short-term impacts from burning due to presence of smoke and work crews.	Minor temporary impact associated with increased pedestrian traffic and noise. Long-term benefit due to enhancement of Natural Areas.

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
			indiscriminate treatment of vegetation.		
Cultural	No impact on subsurface cultural deposits when cutting methods are employed. Pulling methods have the potential to disturb cultural deposits depending on size of plant and root ball. Caution should be used when cutting or pulling near aboveground historic remains (i.e. foundations, cemeteries) and sacred sites.	If use of mechanical methods causes meaningful soil disturbance, subsurface cultural deposits could be affected. Impacts would be minimized through adherence to BMPs and Section 106 program alternatives, such as the PA, where applicable. Activities that would have the potential to effect historic properties would require Section 106 review on an individual basis.	No impact to subsurface cultural deposits.	No impact to subsurface deposits.	No impact to subsurface deposits.
Visual Resources	Pruned trees and shrubs, exposed stumps, and the resulting debris may seem unsightly to some viewers.	Can leave swaths of disturbed areas that can contrast with surrounding vegetation.	Areas of browned vegetation can be unsightly. However, the impact would be temporary as vegetation would eventually reestablish.	Felled logs and scattered branches can contrast with the surrounding landscape; stacking as windrows can reduce the unkempt look. Mulching and chipping can improve the visual landscape by covering bare earth with woodchips.	Minor, temporary visual discord due to the presence of additional personnel and equipment. Long-term improvement aesthetic condition.

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
Public and Worker Health & Safety	Minimal impact on public safety; minor potential for worker safety in conjunction with type and frequency of tool use and environmental conditions.	Minor potential for public safety issues; improved worker safety in proportion to treated area.	Low potential for public exposure to herbicides; selectively higher risk to workers based on herbicide active ingredient, tool use, and environmental conditions. Potential adverse effects mitigated and minimized by training, safety equipment, and adherence to labeling guidelines.	Debris left in place has potential implications on worker safety. Burning has potential minor localized effects on public and worker health and safety.	Additional workforce increases short-term safety risk. Long-term increase in worker safety through development of a plant community that is compatible to ROW management.
Solid and Hazardous Waste	Low impact. Minor generation of waste oil/fluids from maintenance of equipment.	Maintenance on equipment generates waste oils/fluids. Potential spills/releases of fuel/fluids. Generation of waste containers.	Potential accidental releases/spills. Generation of waste containers for herbicides.	Low impact related to use of mechanized equipment. Reduction in solid waste when debris is left to compost.	Low impact related to use of mechanized equipment.
Transportation	Little to no impact.	No impact with side-wall trimming (from air). Minor traffic volume generated by construction workforce.	No impact with aerial spraying of herbicides. Minor traffic volume generated by construction workforce.	Short-term increase in traffic volumes due to additional haul trucks needed for debris transport. No impact when debris is managed on site.	Minor traffic volume generated by construction workforce.
Air Quality and Climate Change	No impact to overall air quality; mobilization of work crews to and from project sites	No impact to overall air quality; mobilization of work crews to and from project sites represents minimal localized and	No impact to overall air quality; in addition to crew mobilization, minor impacts may be from mechanical methods	Chipping, mulching, etc., would have impacts similar to manual control methods; pile	No impact to overall air quality; in addition to crew transport-related impacts minimal

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
	represents a negligible increase in roadway traffic.	temporary emissions from combustion engines.	and airborne herbicide constituents.	burning would produce local smoke and particulate emissions; overall minor impacts to air quality would be temporary and local.	localized and temporary emissions from combustion engines.
Noise	Loud intermittent and short-term noise from use of chainsaws.	Loud intermittent and short-term increase in noise from transport of equipment and crews and use of chainsaws and mechanized equipment.	Limited and minor noise from crews on foot. Loud intermittent noise from aerial spraying.	Loud noise from transport of equipment and crews and use of heavy mulchers and chippers.	Intermittent and short-term increase in noise from transport of equipment and crews and use of chainsaw and mechanized equipment.
Socioeconomics and Environmental Justice	Minor short-term impact to local economies due to increased workforce.	Minor short-term impact to local economies due to increased workforce.	Minor short-term impact to local economies due to increased workforce.	Minor short-term impact to local economies due to increased workforce.	Minor short-term impact to local economies due to increased workforce.

Table S-2. Summary and Comparison of Management Alternatives by Resource Area

Alternative A: No Action	Alternative B: Cyclical- Based Control Strategy	Alternative C: Condition-Based Control Strategy; End-State: Meadow-Like	Alternative D: Condition-Based Control Strategy; End-State: Compatible Vegetation Variable by Zone
Cost			
Total Cost (NPV) to Maintain for 20 Years			
$205 million.	$169 million.	$180 million.	$223 million.
Long-Term Cost (NPV)(Years 9-20)			
$109 million.	$67 million.	$72 million.	$92 million.
Reliability			
Increased risk of non-compliance with reliability standards.	Enhances compliance with reliability standards – full ROW compatible.	Enhances compliance with reliability standards – full ROW compatible.	Enhances compliance with reliability standards – full ROW compatible.
Vegetation			
No change in baseline condition. Positive impact in the short-term as ROW buffer would not be removed and only trees that would present an immediate hazard to the reliability of the transmission system would be removed.	Moderate impact to vegetation associated with the direct loss of forest lands; floor maintained as low-growing herbaceous communities.	Impact to vegetation associated with the direct loss of forest lands. Impact would be moderate, yet less than Alternative B as floor vegetation would be managed to a meadow-like state.	Impact to vegetation associated with the direct loss of forest lands. Impact would be moderate, yet less than Alternatives B and C as the border zone would be managed to allow re-growth of compatible shrubs and trees.
Wildlife			
No change in baseline condition.	Short-term impact to wildlife as a result of initial vegetation removal.	Short-term impact to wildlife as a result of initial vegetation removal.	Short-term impact to wildlife as a result of initial vegetation removal.
Positive impact in the short-term as ROW buffer would not be removed and only trees that would present an immediate hazard to the reliability of the transmission system	Habitat alteration associated with initial vegetation removal is notably greater than under Alternative A and considered to be notable, but it should not destabilize associated resources. Therefore, impacts are considered	Long-term impact associated with habitat alteration would be moderate, yet less than Alternative B as floor would be managed to a meadow-like state, which would be of greater value to wildlife.	Long-term impact associated with habitat alteration would be moderate, yet less than Alternatives B and C as the border zone would be managed to allow re-growth of compatible shrubs and trees which would provide marginally improved habitat for wildlife.

Alternative A: No Action	Alternative B: Cyclical- Based Control Strategy	Alternative C: Condition-Based Control Strategy; End-State: Meadow-Like	Alternative D: Condition-Based Control Strategy; End-State: Compatible Vegetation Variable by Zone
would be removed.	to be moderate.		
Threatened and Endangered Species			
No change in baseline condition. Positive impact in the short-term as ROW buffer would not be removed and only trees that would present an immediate hazard to the reliability of the transmission system would be removed. Impact to threatened and endangered species would be avoided or minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures in the TVA's ESA consultations and applicable BMPs.	Potential short-term and long-term impacts to threatened and endangered species/ habitats as a result of initial vegetation removal. Impact to threatened and endangered species would be avoided or minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures in TVA's ESA consultations and applicable BMPs.	Potential short-term and long-term impacts to threatened and endangered species/ habitats as a result of initial vegetation removal. Impacts to threatened and endangered species would be avoided or minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures in TVA's ESA consultations and applicable BMPs.	Potential short-term and long-term impacts to threatened and endangered species/ habitats as a result of initial vegetation removal. Impacts to threatened and endangered species would be avoided or minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures in TVA's ESA consultations and applicable BMPs.
Surface Water			
No change in baseline condition.	Short-term impact associated with runoff and sedimentation during initial vegetation removal. Long-term impact related to runoff and sedimentation during cyclical vegetation management would be greater due to more total floor acreage than Alternative A.	Short-term impact associated with runoff and sedimentation during initial vegetation removal. Long-term impact related to runoff and sedimentation during cyclical vegetation management would be greater due to more total floor acreage than Alternative A. However, impacts	Short-term impact associated with runoff and sedimentation during initial vegetation removal. Long-term impact related to runoff and sedimentation during floor vegetation management would be less than Alternatives B and C due to smaller floor as vegetation within the buffer zone is

Alternative A: No Action	Alternative B: Cyclical- Based Control Strategy	Alternative C: Condition-Based Control Strategy; End-State: Meadow-Like	Alternative D: Condition-Based Control Strategy; End-State: Compatible Vegetation Variable by Zone
		would be less than Alternative B as once ROW is cleared, end-state ROW vegetation management may be less disruptive.	allowed to redevelop.
Aquatic Biology			
No change in baseline condition.	Short-term impact associated with loss of tree cover and runoff and sedimentation during initial vegetation removal. Long-term impact associated with increased risk of sedimentation and erosion as a result of cyclical vegetation management. Impact to aquatic biota would be avoided or minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures and BMPs. Therefore impact would be minor.	Short-term impact associated with loss of tree cover and runoff and sedimentation during initial vegetation removal. Long-term impact associated with increased risk of sedimentation during ROW vegetation management. However, impacts would be less than Alternative B as once cleared, end-state ROW vegetation management would be less disruptive. Impact to aquatic biota would be avoided or minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures and BMPs.	Short-term impact associated with loss of tree cover and runoff and sedimentation during initial vegetation removal. Long-term impact associated with increased risk of sedimentation during floor vegetation management; though, less than Alternatives B and C due to smaller floor as vegetation within the buffer zone is allowed to redevelop. Impact to aquatic biota would be avoided or minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures and BMPs.
Wetlands			
No change in baseline condition.	Short-term impact associated with loss of tree cover and runoff and sedimentation during initial vegetation removal. Long-term impact associated with modification of wetland type and function.	Short-term impact associated with loss of tree cover and runoff and sedimentation during initial vegetation removal. Long-term impact associated with modification of wetland type and function.	Short-term impact associated with loss of tree cover and runoff and sedimentation during initial vegetation removal. Long-term impact associated with modification of wetland type and function.

Alternative A: No Action	Alternative B: Cyclical- Based Control Strategy	Alternative C: Condition-Based Control Strategy; End-State: Meadow-Like	Alternative D: Condition-Based Control Strategy; End-State: Compatible Vegetation Variable by Zone
	Indirect impact resulting from sedimentation and erosion as a result of cyclical vegetation management. Impact minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs. Therefore impact would be minor.	Long-term indirect impacts associated with sedimentation during floor vegetation management. However, impacts would be less than Alternative B as once cleared, end-state ROW vegetation management would be less intensive. Impact minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs.	Long-term indirect impacts associated with sedimentation during floor vegetation management would be less than Alternatives B and C due to smaller floor as vegetation within the buffer zone is allowed to redevelop. Impact minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs.
Floodplains			
No change in baseline condition.	Potential for floodplain impacts due to vegetation removal and debris.	Potential for floodplain impacts due to vegetation removal and debris.	Potential for floodplain impacts due to vegetation removal and debris.
Geology, Groundwater and Soils			
No change in baseline condition.	Short-term impact associated with limited potential for soil disturbance and erosion during mechanized initial vegetation removal. Increased potential, albeit limited, for soil disturbance and erosion as a result of cyclical vegetation management of the ROW would be minor, yet greater than Alternative A due to more total floor acreage than Alternative A.	Short-term impact associated with limited potential for soil disturbance and erosion during initial vegetation removal. Increased potential, albeit limited, for soil disturbance and erosion in the long-term as a result of vegetation management of the ROW. However, impacts would be less than Alternative B as once cleared, end-state ROW vegetation management would be less intensive.	Short-term impact associated with limited potential for soil disturbance and erosion during initial vegetation removal. Increased potential, albeit limited, for soil disturbance and erosion in the long-term as a result of vegetation management of the ROW. However, impacts would be less than Alternatives B and C as once cleared, ROW vegetation management would be less intensive, and the floor area would be smaller as vegetation within the buffer zone is allowed to redevelop.
Land Use and Prime Farmland			
No impact.	Minor potential impact.	Minor potential impact.	Minor potential impact.

Alternative A: No Action	Alternative B: Cyclical- Based Control Strategy	Alternative C: Condition-Based Control Strategy; End-State: Meadow-Like	Alternative D: Condition-Based Control Strategy; End-State: Compatible Vegetation Variable by Zone
Land Ownership/Management			
No impact.	No impact.	No impact. However, TVA incurs an increased risk of landowners planting incompatible vegetation	No impact. However, TVA incurs an increased risk of landowners planting incompatible vegetation
Natural and Managed Areas			
No change in baseline condition.	Short-term impact associated with change in habitat and disruption as a result of initial vegetation removal. Increased impact during cyclical vegetation management relative to Alternative A due to more total floor acreage than Alternative A. Impact avoided or minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs. Therefore impact would be minor.	Short-term impact associated with change in habitat and disruption as a result of initial vegetation removal. Impact during ROW vegetation management would be less than Alternative B as once cleared, end-state ROW vegetation management would be less intensive. Impact avoided or minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs.	Short-term impact associated with change in habitat and disruption during initial vegetation removal. Impact during ROW vegetation management would be less than Alternatives B and C as once cleared, ROW vegetation management would be less intensive, and the floor area would be smaller as vegetation within the buffer zone is allowed to redevelop. Impact avoided or minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs.
Parks			
No change in baseline condition.	Short-term impact associated with disruption in use as a result of initial vegetation removal. Impact as a result of vegetation management would be the same as Alternative A.	Short-term impact associated with disruption in use as a result of initial vegetation removal. Impact as a result of vegetation management would be less than Alternative B as once cleared, end-state ROW vegetation management would be less intensive.	Short-term impact associated with disruption in use as a result of initial vegetation removal. Impact during ROW vegetation management would be less than Alternative B and C as once cleared, ROW vegetation management would be less intensive, and the floor area would be smaller as vegetation within the buffer zone is allowed to redevelop.

Alternative A: No Action	Alternative B: Cyclical- Based Control Strategy	Alternative C: Condition-Based Control Strategy; End-State: Meadow-Like	Alternative D: Condition-Based Control Strategy; End-State: Compatible Vegetation Variable by Zone
Cultural Resources			
No change in baseline condition.	Limited potential for impact to cultural resources during initial vegetation removal. In limited cases where impacts exist during ROW vegetation management, those impacts would be minimized through adherence to BMPs and Section 106 program alternatives, where applicable.	Limited potential for impact to cultural resources during initial vegetation removal. Provides flexibility in the improvement and management of visual quality of historic properties such as the Congressionally designated Trail of Tears National Historic Trail. In limited cases where impacts exist during ROW vegetation management, those impacts would be minimized through adherence to BMPs and Section 106 program alternatives, where applicable.	Limited potential for impact to cultural resources during initial vegetation removal. Provides flexibility in the improvement and management of visual quality of historic properties such as the Congressionally designated Trail of Tears National Historic Trail. In limited cases where impacts exist during ROW vegetation management, those impacts would be minimized through adherence to BMPs and Section 106 program alternatives, where applicable.
Visual Resources			
No change in baseline condition. Positive impact in the short-term as ROW buffer would not be removed and only trees that would present an immediate hazard to the reliability of the transmission system would be removed.	Potential for impact to the viewscape during initial vegetation removal. Increased short-term impacts during cyclical vegetation management relative to Alternative A due to more total floor acreage than Alternative A. Impacts avoided or minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs. Therefore impact would be minor.	Potential for impact to the viewscape during initial vegetation removal. Impact during ROW vegetation management would be less than Alternative B as once ROW is cleared, end-state ROW vegetation management would be less intensive, and the ROW would be managed to a meadow-like state.	Potential for impact to the viewscape during initial vegetation removal. Impact during ROW vegetation management would be less than Alternatives B and C as once ROW is cleared, ROW vegetation management would be less intensive, and the floor area would be smaller as vegetation within the buffer zone would be managed to allow re-growth of compatible shrubs and trees.

Alternative A: No Action	Alternative B: Cyclical- Based Control Strategy	Alternative C: Condition-Based Control Strategy; End-State: Meadow-Like	Alternative D: Condition-Based Control Strategy; End-State: Compatible Vegetation Variable by Zone
Health and Safety			
Reduced risk to workers solely by virtue of having fewer workers in the short-term as initial vegetation removal would not be conducted. Short- and long-term safety diminished for those who are working due to risks associated with manual processes required for individual tree removals. Property owner safety diminished due to tree trimming.	Minor increase in worker health and safety associated with initial vegetation removal. Minor impact associated with long-term increase in potential impacts to worker safety during cyclical vegetation management due to increase in man hours relative to Alternatives C and D. Enhanced property owner safety due to TVA controlled vegetation management.	Minor increase in worker health and safety associated with initial vegetation removal. Enhanced worker safety in the long-term by controlled vegetation management but safety enhancement is slightly less because some compatible trees would remain. Enhanced property owner safety due to TVA controlled vegetation management.	Minor increase in worker health and safety associated with initial vegetation removal. Enhanced worker safety in the long-term by controlled vegetation management but safety enhancement is slightly less because some compatible trees would remain. Worker safety reduced compared to Alternatives B and C due to higher concentration and increased duration of staff in the field (border zone only). Enhanced property owner safety due to TVA controlled vegetation management.
Solid and Hazardous Waste			
No change in baseline condition.	Increase in solid and hazardous wastes associated with initial vegetation removal. Minor impact during cyclical vegetation management relative to Alternative A due to more total floor acreage than Alternative A.	Increase in solid and hazardous wastes associated with initial vegetation removal. Impact during ROW vegetation management would be less than Alternative B as once cleared, end-state ROW vegetation management would be less intensive.	Increase in solid and hazardous wastes associated with initial vegetation removal. Impact during ROW vegetation management would be less than Alternatives B and C as once cleared, ROW vegetation management would be less intensive, and the floor area would be smaller as buffer areas would be managed to allow re-growth of compatible shrubs and trees.

Alternative A: No Action	Alternative B: Cyclical- Based Control Strategy	Alternative C: Condition-Based Control Strategy; End-State: Meadow-Like	Alternative D: Condition-Based Control Strategy; End-State: Compatible Vegetation Variable by Zone
Transportation			
No change in baseline condition.	Minor impact to transportation system as a result of additional vehicles and transportation of machinery needed to support initial vegetation removal. Impacts to transportation during cyclical vegetation management would be negligible.	Minor impact to transportation system as a result of additional vehicles and transportation of machinery needed to support initial vegetation removal. Impacts to transportation during end-state ROW vegetation management would be negligible.	Minor impact to transportation system as a result of additional vehicles and transportation of machinery needed to support initial vegetation removal. Impacts to transportation during end-state ROW vegetation management would be negligible.
Air Quality and Climate Change			
No change in baseline condition.	Potential for minor impacts during initial vegetation removal. Increased minor, short-term temporary impacts during cyclical vegetation management relative to Alternative A due to more total floor acreage than Alternative A. Long-term loss of carbon sequestration capacity due to loss of forested buffer. Would not impact regional climate change.	Potential for impacts during initial vegetation removal. Increased impacts during end-state ROW vegetation management would be less than Alternative B as ROW vegetation management would be less intensive. Long-term loss of carbon sequestration capacity due to loss of forested buffer.	Potential for impacts during initial vegetation removal. Increased impacts during end-state ROW vegetation management would be less than Alternatives B and C as ROW vegetation management would be less intensive and floor areas would be smaller. Long-term loss of carbon sequestration capacity due to loss of forested buffer.
Noise			
No change in baseline condition.	Increased minor short-term temporary impacts during cyclical vegetation management relative to Alternative A. Increased short-term temporary impacts during cyclical vegetation management relative to Alternative	Potential for minor impacts during initial vegetation removal. Increased impacts during end-state ROW vegetation management would be less than Alternative B as ROW vegetation management would be less intensive.	Potential for minor impacts during initial vegetation removal. Increased impacts during end-state ROW vegetation management would be less than Alternatives B and C as ROW vegetation management would be less intensive and floor areas would be

Alternative A: No Action	Alternative B: Cyclical- Based Control Strategy	Alternative C: Condition-Based Control Strategy; End-State: Meadow-Like	Alternative D: Condition-Based Control Strategy; End-State: Compatible Vegetation Variable by Zone
	A due to more total floor acreage than Alternative A.		smaller.
Socioeconomics and Environmental Justice			
No impact.	No impact.	No impact.	No impact.
Cumulative Effects			
Impact of land cover alteration associated with the development of new transmission ROW. Minor cumulative impact relative to context of the study area.	Cumulative effects to vegetation as a result of ongoing transmission corridor vegetation management and actions by others within the study area are expected to be the same as those under Alternative A.	Incremental benefits to habitat are negligible given the context of the study area.	Incremental benefits to habitat are negligible given the context of the study area.

TVA's Preferred Alternative

TVA's preferred alternative is Alternative C, which would implement a process of vegetation community conversion within the full extent of the actively-managed transmission ROW. This alternative is considered to provide the best balance in enhancing system reliability and safety, minimization of environmental impacts and striving for cost effectiveness.

Vegetation management under this alternative would be accomplished with an IVM approach to promote the establishment of a low-growing herbaceous plant community that is compatible with the safe and reliable operation of the transmission system. This alternative would entail the initial removal of vegetation to the full width of the existing ROW easement over the first eight years of the program. Removal would target trees and woody vegetation that either remained or have regrown within the transmission ROW since construction. Only three percent of the total ROW (8,094 of the total 238,196 acres of ROW) would require initial vegetation removal. All areas within the transmission ROW thereafter would be managed as floor. TVA would also use an approach that is condition based for identification and removal of incompatible vegetation and danger trees that would use Light Detection and Ranging (LIDAR) and other assessment techniques.

Routine vegetation maintenance would include identification and removal of vegetation within the transmission ROW that is incompatible with TVA's desired end-state condition. Within lands primarily managed by TVA, floor work would continue on an established cycle. The resulting end-state, consisting of a mix of herbaceous and low-growing shrub species, is more compatible and is expected to provide improved habitat value that over time is also expected to minimize intensity of maintaining the floor.

Under Alternative C there would be greater coordination and interaction with local landowners to identify compatible vegetation. TVA would work with local property owners to evaluate the compatibility of vegetation within or near the transmission ROW. Vegetation compatible with the safe and reliable operation of the transmission system may be allowed to remain within the ROW. Relative to the No Action Alternative, this alternative would enhance compliance with reliability standards.

Impacts associated with this alternative primarily include temporary short-term impacts during vegetation maintenance activities to most natural resources. Initial removal of buffer zones would result in notable but not destabilizing effects on forest resources and associated wildlife. Because vegetation removal activities would be conducted within the buffer zone of the previously established ROW, the overall effect of this alternative on vegetation is considered to be moderate as both the routine maintenance of vegetation and removal of the existing buffer zones would not destabilize the general plant communities within the study area. Long-term impacts of this management alternative are related to loss of forested land and associated wildlife habitat and carbon sequestration capacity as well as the impacts related to the repeated disturbance within the ROW.

The effects of Alternative C include both short-term and long-term impacts; however, sound planning and the incorporation of TVA's O-SAR process and other BMP measures would avoid and minimize long-term impacts. Alternative C provides benefits in terms of habitat quality and management intensity based on differences in the end-state. Because habitat alteration associated with initial vegetation removal is considered to be notable but not destabilizing of the associated resources, impacts to wildlife, forested land cover and related factors remain moderate under this alternative.

Impacts on factors related to the human environment (land use, socioeconomics, air, noise, cultural resources, solid/hazardous waste, public and worker safety, etc.) are generally considered to be localized and temporary. TVA would not allow homeowners to maintain incompatible vegetation within and along the transmission ROW. This alternative also keeps incompatible vegetation away from transmission lines, reducing the likelihood of devastating, and possibly fatal, wildfires. Consequently, this alternative reduces the risk to homeowners' safety.

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Acronyms, Abbreviations, and Glossary of Terms Used

acre	A unit measure of land area equal to 43,560 square feet.
access road	A dirt, gravel, or paved road that is either temporary or permanent, and is used to access the right-of-way and transmission line structures for construction, maintenance, or decommissioning activities.
ADEM	Alabama Department of Environmental Management
ANSI	American National Standard Institute
ATV	All-Terrain Vehicle
BA	Biological Assessment
BMP	Best Management Practices
border zone	The border zone is the area located between the outside edge of the ROW and the wire zone. The width of this area varies based upon ROW width, voltage, structure type, and structure height.
BPA	Bonneville Power Administration
buffer zone	A portion of the border zone on some transmission ROWs that has not been subjected to routine maintenance .
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
circuit	A section of conductors (three conductors per circuit) capable of carrying electricity to various points.
CO	Carbon Monoxide
CO_2	Carbon Dioxide
compatible vegetation	Compatible vegetation is that which will never grow sufficiently close to a conductor so as to violate the minimum clearance distances.
conductors	Cables that carry electrical current
CWA	Clean Water Act
danger tree	Tree located off the ROW that, under maximum sag and blowout conditions, would strike a transmission line structure or come within an unsafe distance of a transmission line if it were to fall toward the line. For most transmission lines, this distance is five feet, but for higher voltage lines, the distance is generally 10 feet.
dB	Decibel
dBA	A-weighted decibel
EA	Environmental Assessment
easement	A legal agreement that gives TVA the right to use property for a purpose such as a right-of-way for constructing, maintaining, and operating a transmission line.
EIS	Environmental Impact Statement
endangered species	A species in danger of extinction throughout all or a significant part of its range.
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act

ephemeral stream	Watercourses or ditches that only have water flowing after a rain event; also called a wet-weather conveyance.
EPRI	Electric Power Research Institute
ERO	Electric Reliability Organization
ESA	Endangered Species Act
extant	In existence; still existing; not destroyed or lost
feller-buncher	A piece of heavy equipment that grasps a tree while cutting it, which can then lift the tree and place it in a suitable location for disposal; this equipment is used to prevent trees from falling into sensitive areas, such as a wetland.
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FGDC	Federal Geographic Data Committee
GHG	Greenhouse Gas
groundwater	Water located beneath the ground surface in the soil pore spaces or in the pores and crevices of rock formations.
hazard	Vegetation that is a risk to the reliability of the transmission system and/or safety of the public. An *immediate hazard* is any vegetation that upon inspection potentially presents a jeopardy or risk to the public safety or the transmission system reliability during the period from the date of inspection or evaluation until the next scheduled Preventative Maintenance tree maintenance activity.
HQ	Hazard Quotient
HUD	U.S. Department of Housing and Urban Development
Hz	Hertz
incompatible vegetation	Incompatible vegetation is that which has the potential to grow sufficiently close to a conductor so as to violate the minimum clearance distances.
IPaC	Information, planning and assessment database (USFWS)
IVM	Integrated Vegetation Management
kV	Symbol for kilovolt (1kV equals 1,000 volts)
Ldn	Day-Night Sound Level
LIDAR	Light Detection and Ranging
load	That portion of the entire electric power in a network consumed within a given area; also synonymous with “demand” in a given area.
LPC	Local Power Company
$\mu g/m^3$	Micrograms per cubic meter
MOA	Memorandum of Agreement
MOS	Margin of Safety
MOU	Memorandum of Understanding
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
NESC	National Electric Safety Code

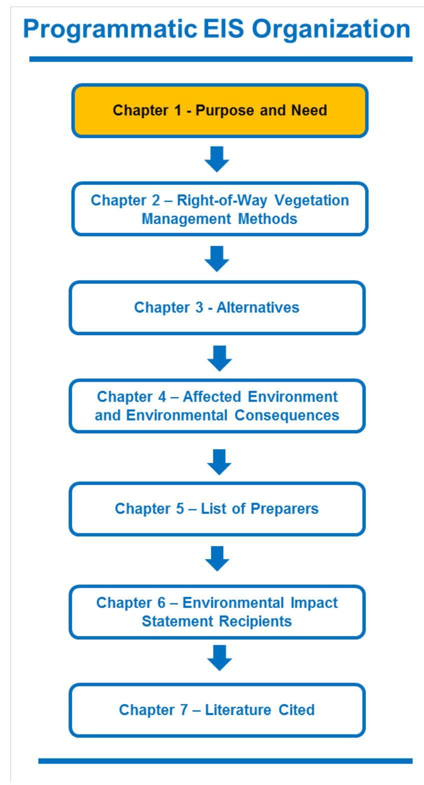
NF	National Forest
NHPA	National Historic Preservation Act
NLAA	Not Likely to Adversely Affect
NLCD	National Land Cover Database
NOI	Notice of Intent
NO_2	Nitrogen Dioxide
NPDES	National Pollutant Discharge Elimination
NPS	National Park Service
NRHP	National Register of Historic Places
NRI	Nationwide Rivers Inventory
NPV	Net Present Value
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
NWSG	Native Warm Season Grasses
O-SAR	Office-Level Sensitive Area Review
O_3	Trioxygen (Ozone)
OSHA	Occupational Safety and Health Act
outage	An interruption of the electric power supply to a user
PA	Programmatic Agreement
Pb	Lead
PCB	Polychlorinated Biphenyls
PEIS	Programmatic Environmental Impact Statement
PM	Particulate Matter
ppb	Parts Per Billion
ppm	Parts Per Million
PSA	Power Service Area
PSD	Prevention of Significant Deterioration
RCRA	Resource Conservation and Recovery Act
riparian	Related to or located on the banks of a river or stream
ROW	Right-of-way, a corridor containing a transmission line
runoff	That portion of total precipitation that eventually enters a stream or river
SHPO	State Historic Preservation Officer
SO_2	Sulfur Dioxide
SMZ	Streamside Management Zones
SMWO	Small, Minority Owned, and Woman Owned
structure	A pole or tower that supports a transmission line
substation	A facility connected to a transmission line used to reduce voltage so that electric power may be delivered to a local power distributor or user.
TCP	Traditional Cultural Properties
threatened species	A species likely to become endangered within the foreseeable future

TMDL	Total maximum daily load
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDA	U.S. Department of Agriculture
USET	United South and Eastern Tribes, Inc.
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
wetland	A marsh, swamp, or other area of land where the soil near the surface is saturated or covered with water, especially one that forms a habitat for wildlife.
wire zone	The wire zone includes the area directly under the lines
WSDOT	Washington State Department of Transportation

CHAPTER 1 – PURPOSE AND NEED FOR ACTION

The Tennessee Valley Authority (TVA) has prepared this Programmatic Environmental Impact Statement (PEIS) to address potential environmental, social, and economic impacts associated with the proposed management of vegetation within its transmission rights-of-way (ROW). Accordingly, the analysis of impacts in the PEIS adopts a regional perspective and presents impacts in a comparative manner. Following the completion of the PEIS and Record of Decision, individual transmission line segments that undergo vegetation maintenance practices would tier from the PEIS and receive more site-specific review and analysis.

The Final PEIS is organized as follows:



- Chapter 1 provides background information related to TVA's transmission system and vegetation management practices. It identifies the purpose and need for the action, and the scope of the project.
- Chapter 2 introduces three categories of general vegetation control methods TVA is considering for managing vegetation. It includes a description of equipment used under each method and the method's advantages, disadvantages and costs. Methods deemed impractical and eliminated from further consideration are identified for each category, as appropriate.
- Chapter 3 describes action alternatives TVA is considering to manage vegetation along its transmission system ROW, identifies action alternatives considered but dismissed from further evaluation, and presents a summary comparison of impacts for each action alternative. TVA's preferred alternative is also identified in Chapter 3.
- Chapter 4 provides a description of the potentially affected environmental resources of the study area and the general impacts of vegetation control. Impacts specific to the methods of vegetation control (identified in Chapter 2) are identified and a summary comparison of impacts is presented. Impacts related to each of the management alternatives under consideration are also identified in Chapter 4. A summary comparison of the impacts of each management alternative is included in Chapter 3.
- Chapter 5 lists the names, education, and experience of the persons who helped to prepare the PEIS. Also included are the subject areas for which each person was responsible.
- Chapter 6 identifies agencies, organizations, governments and individuals that received copies of the PEIS or notices of its availability with instructions on how to access the PEIS on the project Web Page.
- Chapter 7 lists literature cited to support the analyses in the document.

1.1 Introduction and Background

1.1.1 Transmission Versus Distribution

TVA provides electricity to its customers by the transmission of energy typically ranging from 46,000 to 500,000 volts (46 to 500 kilovolts [kV]). High voltage allows energy to be transmitted over long distances with maximum efficiency. The energy is delivered to more than 50 directly served, large industrial customers and to 154 local power companies (LPC). These LPCs typically utilize voltages in the range of 4 to 69 kV to connect with end-use customers (e.g., residential homes).

1.1.1.1 The Difference Between Transmission Lines and Distribution Lines

The TVA transmission network consists of a range of high-voltage lines that extend from generation sources to primary substations (Figure 1-1). A primary substation is the main connection point used by LPCs to “take” power from TVA and “distribute” energy to low-voltage substations in their service area. Transmission lines are also used for interconnection points with neighboring large utilities to allow interchange of power. This interchange of power provides stability to the power grid during peak energy times.

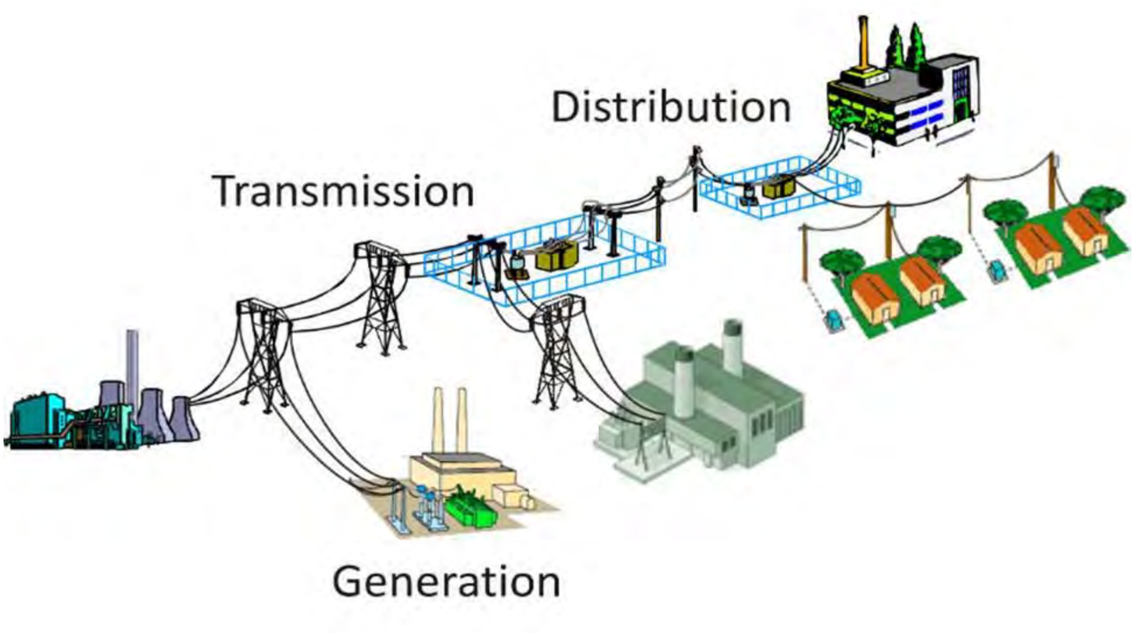


Figure 1-1. Electricity Generation, Transmission and Distribution

Distribution lines should not be confused with transmission lines since they differ in their overall function and purpose. Distribution lines are low-voltage lines that normally are owned by LPCs and deliver electricity from substations to the end-user, whether residential or business (see Figure 1-1). The lines cover shorter distances and are separated into circuits supplying energy to different areas. Distribution lines usually consist of overhead and underground circuits from the substations to the various end-users.

Reliability is extremely important because interruptions can cause widespread and extended outages. For example, one high-voltage transmission line can support a primary substation, but if an interruption occurs on this transmission line, all other substations that depend on the primary substation also will be interrupted. The other secondary substations distribute power to homes, businesses, hospitals, and safety devices, such as traffic lights. Therefore, the loss of one primary substation can affect thousands of people.

Vegetation that is not managed properly contributes to unnecessary interruptions. On distribution lines, safe working clearance distances can be more easily maintained due to the lower voltages and corresponding electrical arc potential. On higher voltage transmission lines, conductive objects, such as trees and vegetation, pose a greater threat to interrupting the power system because the higher energy levels enable the electricity to arc over greater distances to the object and then to the ground.

1.1.2 Description of the TVA Electric Transmission System

TVA's transmission system serves nearly ten million residents in a more than 82,000-square-mile area that spans portions of seven states identified as the TVA Power Service Area (PSA) (Figure 1-2). As of April 2019, electricity generated on the TVA system is from three nuclear plants, six coal-fired plants, nine simple-cycle combustion turbine plants, seven combined-cycle combustion turbine plants, 29 hydroelectric dams, a pumped-storage facility, a methane-gas co-firing facility, a diesel-fired facility, non-TVA owned facilities under power purchase agreements, and various small solar photovoltaic facilities. The electricity generated by these resources is transmitted along high-voltage transmission lines to TVA business customers (e.g., industries, federal installations, LPCs).

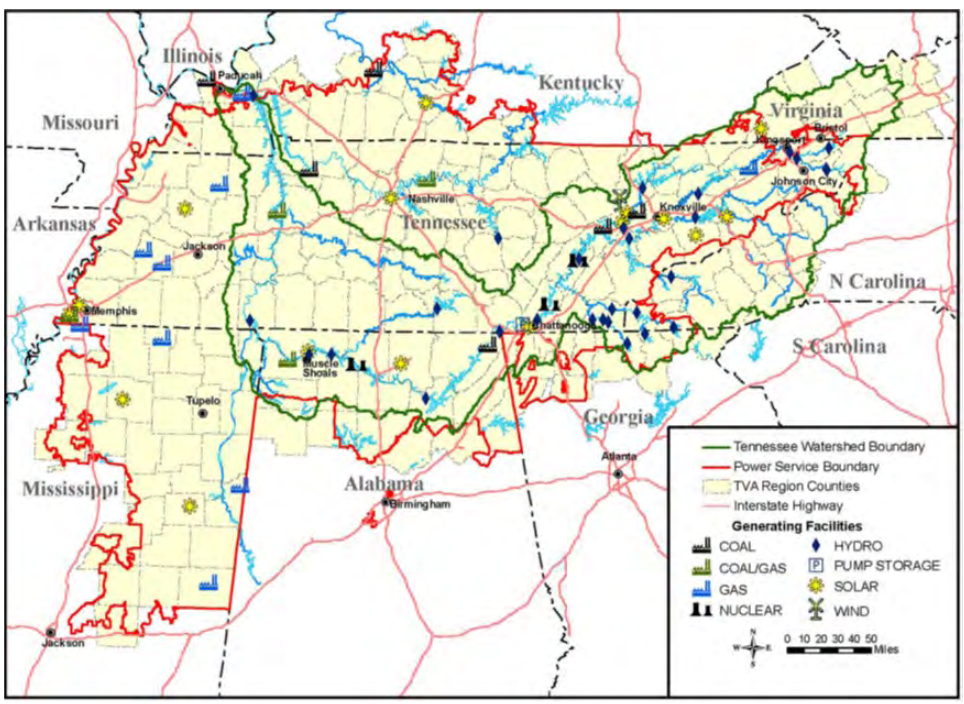


Figure 1-2. TVA Power Service Area[1]

[1] As of April 1, 2018, Allen Fossil Plant and Johnsonville Fossil Plant no longer produce coal-generated electricity.

For vegetation management purposes, the TVA study area is divided into six regions consisting of 12 sectors (Figure 1-3). This more than 82,000-square-mile area defines the study area for this PEIS as this area is inclusive of all areas where TVA maintains ROWs or could acquire new ROW in the future and subsequently build transmission line on the newly acquired ROW. TVA develops a separate plan to maintain transmission line ROWs within each sector.

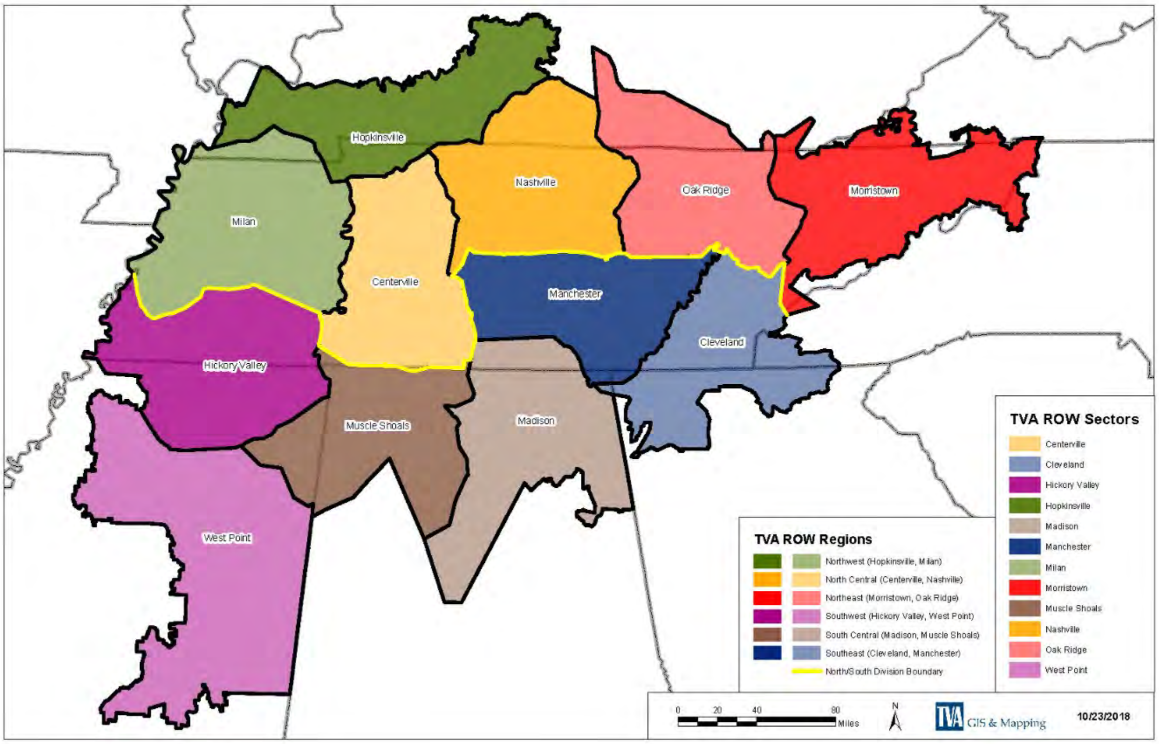


Figure 1-3. TVA's Programmatic Environmental Impact Statement Study Area

TVA's vegetation management program along its transmission ROW consists of the following basic components:

- *Floor work* – Vegetation maintenance activities which target previously cleared or maintained areas along the transmission ROWs. Typically, floor activities consist of mechanical control (e.g., brush hogging, which is also known as bush hogging and will be referred to as brush hogging in this document) and herbicide application.
- *Tree work* – Vegetation maintenance activities which focus on tree removal trimming. Typically, tree activities consist of manual control (e.g., chainsaw) and mechanical control (e.g., equipment mounted saws and other devices).
- *Inspections* – Periodic review of transmission ROW condition to determine maintenance needs, and any need to adjust the cycle of scheduled work due to emergent conditions.
- *Planning and Support* – The transmission ROW manager develops plans to maintain his or her respective ROWs in a cost-effective, efficient, and environmentally responsible manner to minimize vegetation-related interruptions.

- *Communication* – Notification of, communication to and education for the property owner.
- *Reliability and Compliance* – Vegetation management activities maximize reliability of the transmission system. Vegetation maintenance activities also must be compliant where applicable with the North American Electric Reliability Corporation (NERC) Reliability Standard FAC-003.

1.1.3 Vegetation Management for Safety and Reliability

The vegetation management most people are familiar with is done by LPCs on their low-voltage distribution lines that provide power to the end-user. LPCs often employ tree-topping and side-trimming practices to keep trees away from conductors to prevent interruptions. Often tree limbs are trimmed on only one side of a tree, are trimmed to leave flat tops versus a normal branching pattern, or trimmed with “tunnels” for lines as shown in Figure 1-4. These types of vegetation maintenance practices are safe for low-voltage distribution lines that service homes and businesses, but are neither safe nor reliable for vegetation management of the high-voltage transmission lines such as TVA maintains because electricity can arc from the power line to the vegetation and then to the ground as described below.

Figure 1-4. Example of Tree Topping Conducted by Local Power Companies

In stark contrast to low-voltage LPC lines, a fault (an abnormal electric current) on a TVA high-voltage line can result in surges in ground current connecting with underground utility services such as cable and water. These surges can lead to home fires, the electrocution of individuals, and forest fires. It is not necessary to touch a transmission conductor wire to be electrocuted. A tree contacting a wire or a downed high-voltage wire will seek a path to complete the circuit until the electricity is grounded (Figure 1-5).

Figure 1-5. Trees in Contact With a High Voltage Wire

Homeowners often do not realize the danger posed by a tree that is too close to a high-voltage line. To illustrate by analogy: household appliances can arc or spark when the prongs of a plug are "close to" but not in contact with the socket. In the case of a 120-volt household appliance, "close to" means a fraction of an inch. In the case of a 500 kV transmission line, "close to" means approximately 10 feet away, because the force of the energy is that much greater. To compound the situation, power lines expand with heat and will sag closer to the ground during warmer weather and/or times of high transmission load. Likewise, lines can swing horizontally in the wind, making it more difficult to judge the actual proximity of trees to the side of transmission lines.

While vegetation management is essential to protecting the reliability of the transmission system, public safety near high-voltage transmission lines is of paramount importance.

1.1.4 TVA's Transmission System Rights-of-Way

TVA's transmission system consists of a network of more than 16,000 miles of electric transmission lines and about 500 power substations all contained within approximately 238,000 acres of utility ROW. The ROW width for a single line varies from approximately 75 feet to 200 feet, increasing with the voltage of the line. ROW containing multiple lines can be wider depending on the number of lines and voltage. As summarized in Table 1-1, TVA's transmission ROW can be classified into three broad categories based on the need for routine vegetation maintenance. TVA has vegetation management rights for the entirety of the 238,000 acres of active transmission ROW; however, TVA actively maintains only approximately 46 percent or 110,752 acres. This is because approximately 51 percent of the transmission ROW is used as cropland, golf courses, orchards or similar uses that integrate compatible vegetation, which is primarily maintained by the landowner. Compatible vegetation is that which will never grow sufficiently close to a conductor so as to violate the minimum clearance distances. While the floor of the transmission ROW is often maintained by others in these areas, TVA conducts routine inspection and vegetation management of ditch banks, fence rows, towers, and other features. A relatively small amount of the TVA transmission system ROW (4,720 acres) does not require routine vegetation management by anyone. These areas include transmission ROW that spans open water or deep valleys where vegetation growing at lower elevations does not threaten the transmission line.

> **What is "compatible" and "incompatible" vegetation?**
>
> Compatible Vegetation: Vegetation will never grow sufficiently close to a conductor so as to violate the minimum clearance distances. Example: low-growing shrubs and herbaceous plants.
>
> Incompatible Vegetation: Vegetation that has the potential to violate minimum clearance distances. Example: young woody trees.

Danger trees are managed on lands along and adjacent to the TVA transmission ROW. A danger tree is a tree, located off the ROW that, under maximum sag and blowout conditions, would strike a transmission line structure or come within an unsafe distance of a transmission line if it were to fall toward the line. For most transmission lines, this distance is five feet, but for higher voltage lines the distance is generally 10 feet. Danger trees that are or have the potential to be an immediate hazard to the safety and

> **What are "Danger" Trees?**
>
> Danger trees are trees located off the ROW that are tall enough to fall within an unsafe distance of transmission lines under maximum sag and blowout conditions. For most transmission lines, this distance is five feet, but for higher voltage lines, the distance is generally 10 feet.

reliability of TVA's transmission line system must be removed. Any reference to danger tree removal includes all trees that fit this definition.

Most of TVA's transmission system is located on private lands. TVA typically acquires perpetual rights through purchased easements which typically provide TVA the legal rights to maintain or repair transmission lines. Many of TVA's purchased transmission ROW easements provide TVA the perpetual right to keep the ROW clear of structures, trees, brush, stored personal property, as well as fire hazards. They also provide TVA the right to clear any trees located beyond the limits of the purchased easement that qualify as danger trees. There are some variations in TVA purchased easements, but in all cases, TVA's rights are defined by the language of the easement associated with the particular tract and applicable law.

Table 1-1. Summary of Routine Vegetation Maintenance Rights and Extent Within TVA Transmission Rights-of-Way

Rights and Extent of Vegetation Maintenance	ROW (acres)[1]	Percent of ROW
Lands Primarily Maintained by Others	122,724	51.5%
Lands Subject to Limited Maintenance	4,720	2.0%
Lands Actively Maintained by TVA	110,752	46.5%
Total	**238,196**	**100%**

[1] Active transmission ROW

1.1.5 Transmission Line Rights-of-Way Vegetation Management Practices

The study area supports a variety of vegetation including trees, brush and herbaceous plants. Transmission ROW vegetation management is necessary to ensure that the source of safe and reliable electric power to TVA's end-users is not interrupted by trees or other vegetation growing under or near the transmission lines. To protect public safety and improve power reliability, TVA maintains different areas within a transmission ROW (Figure 1-6):

- *Wire Zone* – Generally, the wire zone includes the area directly under the lines.
- *Border Zone* – The border zones are located between the outside edge of the ROW and the wire zone. The width of this area varies based upon ROW width, voltage, structure type, and structure height.
- *Buffer Zone* – A portion of the Border Zone on some transmission ROW that has *not* been subjected to routine maintenance.

To reduce the risk of trees or branches falling onto lines, or lines sagging or swaying into trees, incompatible vegetation in the wire and border zones should be removed. Additionally, trees planted within border zones should not have any portion of their canopies growing under the lines. Figure 1-7 illustrates incompatible vegetation in the border zone.

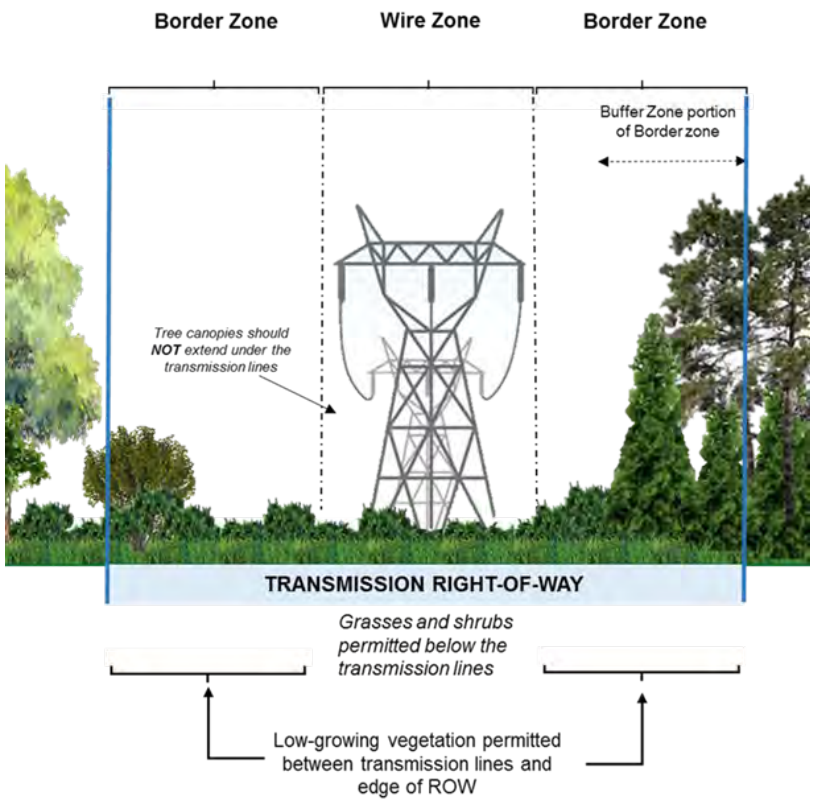


Figure 1-6. Transmission Line Rights-of-Way Zones

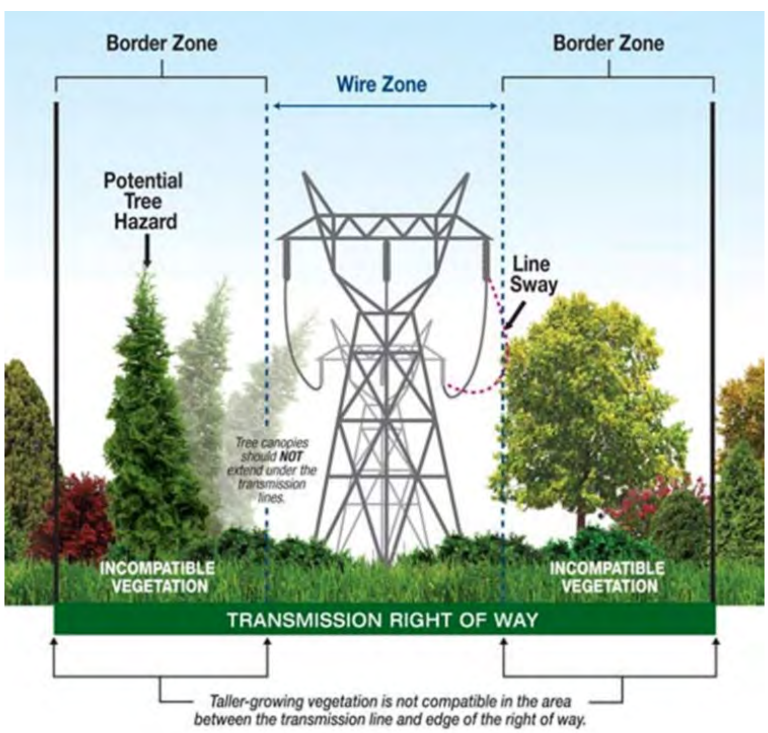


Figure 1-7. Incompatible Vegetation for Transmission Line Rights-of-Way

1.1.6 Past Vegetation Management Practices

Historically, although TVA performed vegetation management consistent with its 1997 and 2008 Line Maintenance Manuals, it did not engage in system-wide maintenance planning. Rather, TVA employees in charge of individual ROW sectors had discretion to determine which vegetation within the ROW in their sector would be cleared. Decisions were based on a variety of factors, including how great a threat the vegetation presented to the transmission lines, budget constraints, and agreements with landowners (TVA 2008). The industry-wide reliability standard enacted in 2007 (see Section 1.3.1) states that transmission systems, like the TVA system, must maintain adequate transmission line clearances as required by the National Electric Safety Code (NESC) in order to be able to survive single-failure events while continuing to serve customer needs with adequate voltage. As such, between 2011 and 2014, the floor work maintenance cycle on transmission ROWs associated with transmission lines carrying 230 kV or higher was shortened from a three-year cycle to a two-year cycle. In addition, floor vegetation maintenance work incorporated a greater percentage of herbicide use to expedite adequate clearance. Although the NERC reliability standards did not require removing trees from the transmission ROW, the penalties assessed by NERC for allowing even one tree to encroach within a specified distance of a conductor can be up to $1 million for each day that the encroachment is deemed to exist, and NERC can also mandate costly mitigation plans. Therefore, in response to the financial risk of non-compliance, TVA increased the vegetation management budget to allow for reclaiming non-maintained areas within the width of the transmission ROWs.

1.1.7 Present Vegetation Management Practice

TVA's current vegetation management practices are identified in a July 31, 2017 injunction order from the U.S. District Court (*Sherwood et al. v. TVA*). This injunction requires "TVA [to] maintain buffer zones on the edges of its ROW in a manner as described in its 1997 and 2008 Line Maintenance Manuals" until TVA prepares and publishes a thorough Environmental Impact Statement (EIS) pursuant to the National Environmental Policy Act (NEPA) analyzing TVA's ROW vegetation management program.

1.2 Purpose and Need

Energy companies such as TVA typically are interconnected to bordering energy companies, thus creating a larger interconnected transmission grid or network. Generated power can flow in both directions across these interconnections. An interconnected grid yields benefits by allowing the buying and selling of power between energy companies and support during emergency power situations. Sometimes this means that power has to be transported across an energy company's local grid to get to another energy company's service area.

Transmission Reliability is Critical:

In August 2003, a single tree contacted a transmission line in Ohio that initiated a series of events that triggered transmission line failures and blackouts from Ontario, Canada to the northeast United States that affected 55 million people and resulted in an economic impact estimated at $6 billion.

While the interconnectedness of the grid brings many benefits, it also means that an interruption, especially a sustained outage caused by vegetation, can have impacts larger than the area served by the specific provider where the outage occurs. For example, in August 2003, when a single tree contacted a transmission line in Ohio, the effect was not limited to the Ohio transmission line, but it initiated a series of cascading events that triggered transmission line failures and blackouts from Ontario, Canada, to the northeastern

United States. The blackouts that ensued affected 55 million people and resulted in an economic impact estimated at $6 billion. In response to these widespread outages, Congress enacted the Energy Policy Act of 2005 (Public Law 109-58), which authorized the Federal Energy Regulatory Commission (FERC), an independent agency that regulates the interstate transmission of electricity, natural gas, and oil, to certify an “Electric Reliability Organization” (ERO) to create mandatory and enforceable reliability standards, subject to FERC review and approval.

Following the 2003 blackout and subsequent federal establishment of the Energy Policy Act of 2005, FERC designated NERC as the ERO with the responsibility to develop and enforce standards to ensure the reliability of the Bulk Power System. NERC is a not-for-profit international regulatory authority whose mission is to assure the effective and efficient reduction of risks to the reliability and security of the electric grid. NERC develops and enforces Reliability Standards; annually assesses seasonal and long-term reliability; monitors the bulk power system through system awareness; and educates, trains, and certifies industry personnel. NERC’s area of responsibility spans the continental United States, Canada, and the northern portion of Baja California, Mexico. NERC's jurisdiction includes users, owners, and operators of the Bulk Power System, which serves more than 334 million people.

NERC began enforcing its Reliability Standard FAC-003 Transmission Vegetation Management Program on June 18, 2007. Because failure to address the vegetation clearance, compliance and monitoring requirements of FAC-003 can result in major power outages and injury to life or property, NERC can apply regulatory penalties for non-compliance, including mitigation and fines.

Accordingly, traditional methods of vegetation management have had to improve to meet the reliability standards required by NERC via Reliability Standard FAC-003. Recent wildfire events in the Western United States have placed additional scrutiny on ROW vegetation management programs, as these events demonstrate the devastating loss of life and property that can occur if ROW are not properly maintained. TVA, like other energy companies, now develops long-range vegetation management plans for its transmission system, which include considerations for how and when TVA controls the vegetation growing on its transmission line ROWs.

The purpose of TVA’s transmission system vegetation management program is to strategically manage TVA’s existing transmission line ROW consistent with applicable laws, orders, standards, practices and guidance while providing reliable energy and protecting environmental resources. The need for the proposed action includes:

- Enhance public safety through controlled vegetation management of TVA's transmission lines.
- Improve the effectiveness of TVA's vegetation management program to eliminate vegetation that interferes with the operation of the existing transmission system so that TVA can continue to provide safe and reliable electric power in a cost-effective and environmentally sound manner.
- Comply with all current and future NERC Reliability Standards to maintain transmission lines in a safe and reliable operating condition, thereby minimizing TVA's potential for costly fines for NERC noncompliance.

This PEIS studied potential environmental impacts of updating TVA's vegetation management practices to achieve the stated purpose and need.

1.2.1 National Environmental Policy Act and Tiering

TVA uses a structured and standardized environmental review process to assess potential impacts of methods to manage vegetation within its transmission line ROWs and to evaluate and compare alternative management options. The environmental review process provides opportunities for public review and comment and ensures that TVA's evaluation of methods and alternative management options reflects a full range of stakeholder input.

This EIS has been completed at a programmatic level to encompass transmission ROW vegetation management across TVA's transmission system. Following the Record of Decision, any decisions regarding proposed vegetation management actions for individual transmission line segments will tier from the Final PEIS. To facilitate "tiering", the PEIS establishes the process TVA considers when making decisions regarding vegetation management, identifies potential environmental impacts associated with vegetation management tools, and establishes mitigation measures that minimize environmental impacts. Future site-specific assessments would integrate findings and conclusions of this analysis. This process is illustrated in Figure 1-8.

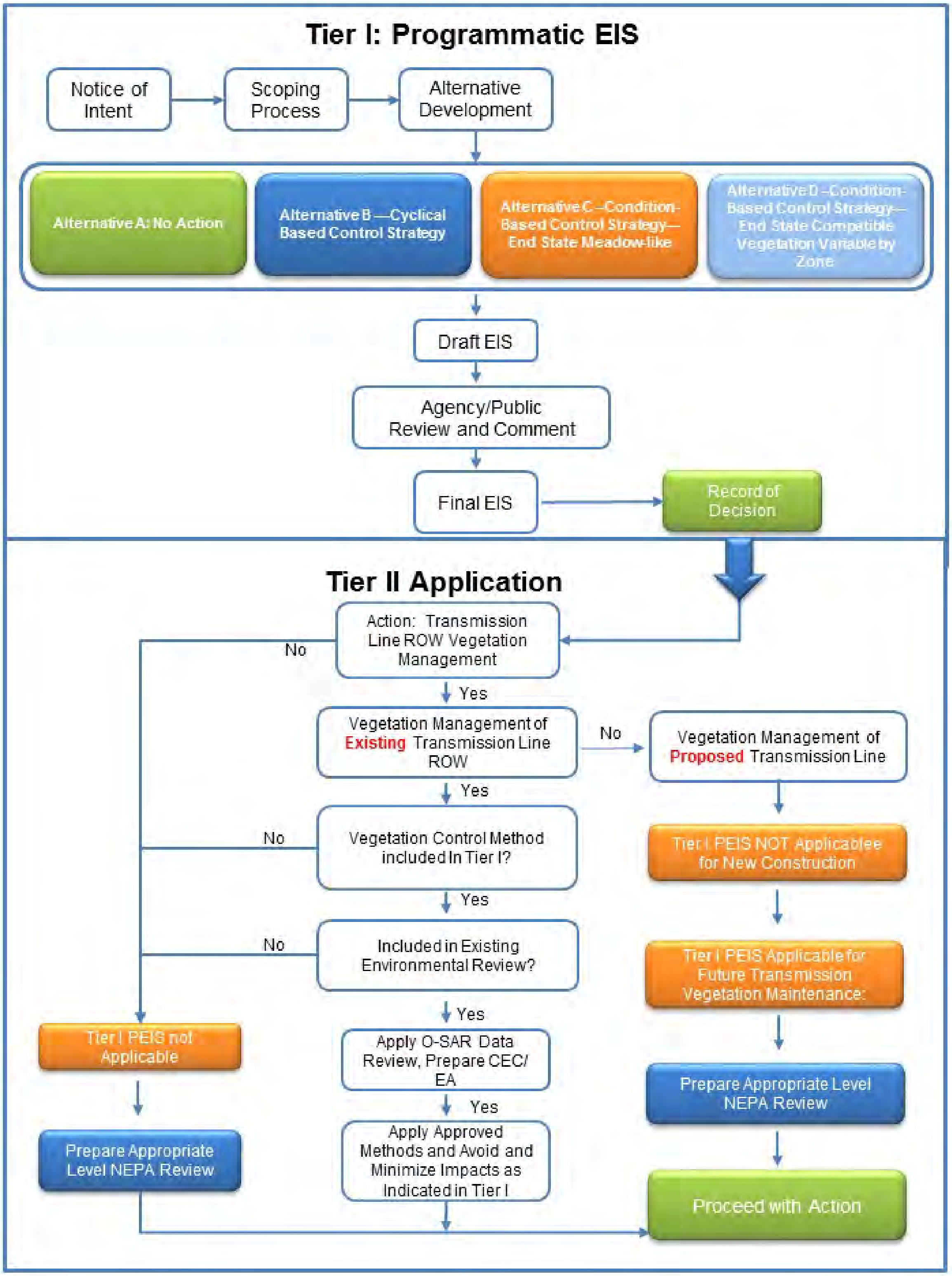


Figure 1-8. Tiering Process

1.2.2 Emphasis on Integrated Vegetation Management

FERC and NERC both recognize the American National Standard Institute (ANSI) Tree, Shrub and Other Woody Plant Maintenance-Standard Practices for electric utility ROW as a best management practice (BMP) (ANSI 2012). The concept of Integrated Vegetation Management (IVM) is the basis of this standard and is defined as:

> A system of managing plant communities in which compatible and incompatible vegetation is identified, action thresholds are considered, control methods are evaluated, and selected control(s) are implemented to achieve a specific objective. Choice of control methods is based on effectiveness, environmental impact, site characteristics, safety, security, and economics.

TVA's IVM process consists of six elements (Figure 1-9).

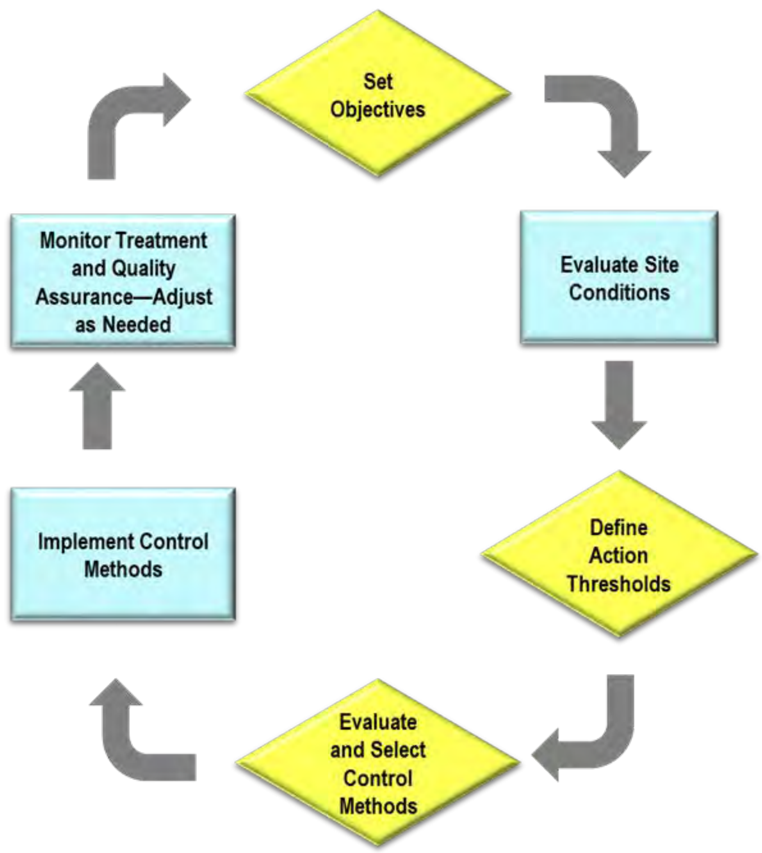


Figure 1-9. TVA Integrated Vegetation Management Process

The goal of IVM is to provide an integrated and balanced approach of vegetation management that considers the overall long-term effect on public health and safety, reliability of electric transmission, environmental stewardship, and cost. As vegetation growth is dynamic, the planning and implementation process is iterative and continuous; this allows flexibility to adjust plans as needed. Setting objectives, defining action thresholds and selecting site-specific application of tools to control vegetation are all considered in the IVM process. TVA believes that the IVM process provides the greatest flexibility for decisions regarding transmission ROW management; thus, all of the alternatives it considers in this PEIS are based on the IVM concept. While each alternative is founded on the IVM concept, the management alternatives described in Chapter 3 differ on the objective sought (i.e., the vegetative end-state), the manner in which vegetation is controlled on lands maintained by others, the long-term cost effectiveness, and the extent to which IVM is implemented to achieve the desired end-state. As described in Chapter 3, tools are selected based upon a thorough consideration of the end-state and form of the plant communities that are subject to control and an integrated application of TVA's office-level sensitive area review (O-SAR) process. The O-SAR process prescribes the need for site-specific field surveys and particular tool use based on the documented or potential presence of sensitive environmental resources. Chapter 3 further describes the process for selecting from various vegetation management methods based on end-state goals, existing plant communities, and integrating results of TVA's O-SAR process.

1.3 Decision to be Made

TVA must decide how to strategically manage vegetation along its transmission line ROWs by developing a policy consistent with applicable laws, orders, standards, practices and guidance while providing reliable energy and protecting environmental resources to the extent possible. TVA's decision will consider factors such as environmental impacts, economic issues, availability of resources, and the need to continue to provide safe and reliable electric power.

1.4 Related Environmental Reviews

TVA has routinely included consideration of vegetation management as part of its analyses of transmission project development. While NEPA reviews for new transmission line projects encompass the analysis of environmental impacts of construction and establishment of the proposed transmission lines, these environmental reviews have also considered issues related to vegetation management activities and have assessed the environmental effects of various methods and tools as part of the analysis. These prior NEPA reviews have included both environmental assessments (EA) and EIS documents from 1971 through 2018. A total of 107 studies were conducted between the period from 1971 and 2018. This PEIS more broadly represents a comprehensive analysis of management activities and potential environmental impacts associated with TVA's vegetation management program across all sectors within the study area.

1.5 Public and Agency Involvement

Scoping, which is integral to the process for implementing NEPA, is a procedure that solicits public input to the NEPA process to ensure: (1) issues are identified early and properly studied; (2) issues of little significance do not consume substantial time and effort; (3) the NEPA document is thorough and balanced; and (4) delays caused by an inadequate review are avoided. TVA's NEPA procedures require that the scoping process commence soon after a decision has been reached to prepare a NEPA review in order to provide an early and open process for determining the scope and identifying significant issues related to a proposed action.

1.5.1 Notice of Intent

On January 23, 2017, a Notice of Intent (NOI) to prepare an EIS to address the management of vegetation on its transmission system was published in the federal register (TVA 2017d). The NOI initiated scoping for the proposal.

1.5.2 Scoping

In addition to publishing an NOI in the Federal Register, TVA notified the public of the initiation of the planning process in a variety of ways. TVA published information about the review and planning effort on TVA's project Web site[2], notified the media, and sent notices to numerous individuals, organizations, and intergovernmental partners with information about the review.

TVA established a project Web site as the primary platform for public outreach. The project Web site is intended to serve as the primary hub for distributing information to the public. Visitors to the page can navigate from the project Web site to other web sites for additional information pertaining to TVA's transmission system and current vegetation management. During the scoping period, the Web site directed the public to submit scoping comments via email, mail, or an online comment form accessed from the project Web site.

The public scoping period, initiated with the publication of the NOI in January 2017, concluded on April 1, 2017. TVA prepared a Scoping Report to summarize its outreach efforts and the input that was received from the public and other agencies during the scoping period. The report was used to assist TVA in determining the scope of the project, alternatives to consider and significant issues to be addressed during the PEIS NEPA process. TVA received 19 comment letters from two federal agencies (National Park Service [NPS] and the U.S. Fish and Wildlife Service [USFWS]), five state agencies (Tennessee Department of Environment and Conservation, Tennessee Division of Water Resources, Virginia Department of Health, Virginia Department of Environmental Quality, Virginia Division of Natural Heritage), two organizations (Sierra Club and University of the South), and nine members of the public including the attorney representing the plaintiffs in the *Sherwood v. TVA* lawsuit. The NPS requested to be a cooperating agency on the development of the PEIS and on Section 106 consultation. The NPS also suggested that TVA enter into a Memorandum of Agreement (MOA) with the NPS to better identify site-specific measures to be taken within NPS lands.

Written scoping comments were reviewed to identify particular issues raised by each commenter and were tabulated and grouped into two general categories: control method or transmission ROW management and issues to be addressed.

In total, 53 comments were included in the tabulation. Fifteen comments related to use of herbicides and mechanical controls, and five comments were submitted regarding the use of border to border management. The remaining 33 comments identified issues to be addressed in the Programmatic EIS. These comments were considered in the formulation of alternatives and the identification of resources evaluated in the draft PEIS.

1.5.3 Review of Draft Programmatic Environmental Impact Statement

After drafting the PEIS, TVA's public and agency involvement process included a public notice and a 45-day public review. To solicit public input, the availability of the Draft PEIS was announced in regional and local newspapers. A news release was issued to the media and posted to TVA's project Web site[2] and hard copies were made available by request. TVA's agency involvement included circulation of the Draft PEIS to local, state, and federal agencies and federally recognized Tribes as part of the review. A list of agencies and tribes

[2]Project Web site: https://www.tva.gov/Environment/Environmental-Stewardship/Environmental-Reviews/Transmission-System-Vegetation-Management-Program

notified of the availability of the Draft PEIS is provided in Chapter 6. The NPS and the USFS served as cooperating agencies in this review.

During the public comment period on the Draft PEIS, TVA conducted seven public meetings across the Valley. Notification of the public meetings was published in local newspapers and on TVA's project Web site.

TVA accepted comments submitted through mail, email, an online comment form on the public Web site, by telephone, and at the public meetings. Appendix A contains all of TVA's responses to public comments. TVA received 150 comment submissions from members of the public, organizations and state and federal agencies. Comment submissions were carefully reviewed and compiled into main topics which received general responses. More specific public comments, local group comments, and agency comments received individual responses. The most frequently mentioned topics included comments regarding keeping the "old" vegetation management policy, project purpose and need, private property concerns, project costs and use of herbicides. Additional comments regarding climate change, compatible vegetation, best management practices, and expressing preference for a particular alternative were also received. Many comments were referencing an opinion piece originally published in the Knoxville Sentinel titled: "TVA again wants to hack down 16,000 miles of trees, and you can help stop it" from September 14th, 2018, by V. Sherwood. TVA has provided multiple responses in Appendix A to the incorrect information contained in the published article, which also addresses many of the other concerns expressed by the public.

In response to comments received by TVA from the public, agencies and other interested parties, TVA has revised text within the Final PEIS and has included a response to comments in Appendix A. Agency comments on the Draft PEIS are included in Appendix B. Public comments on the Draft PEIS are included in Appendix C. TVA will not make a final decision any earlier than 30 days after the Notice of Availability of the Final PEIS is published in the Federal Register.

1.6 Scope of the Programmatic Environmental Impact Statement

The geographic scope of this programmatic analysis includes the more than 82,000-square mile area that spans portions of seven states identified as the study area (see Figure 1-2). TVA prepared this PEIS in compliance with NEPA, regulations promulgated by the Council on Environmental Quality (CEQ) and TVA's procedures for implementing NEPA.

TVA has determined that the resources listed below are potentially impacted by the alternatives considered. These resources were identified based on internal scoping as well as comments received during the public scoping period.

- Air Quality
- Climate Change
- Surface Water Resources
- Geology
- Groundwater/ Hydrogeology
- Vegetation
- Wildlife
- Aquatic Ecology
- Threatened and Endangered Species
- Wetlands
- Floodplains
- Natural Areas
- Parks and Recreation
- Socioeconomics and Environmental Justice
- Transportation
- Visual Resources
- Cultural and Historic Resources
- Noise
- Solid Waste and Hazardous Waste
- Public Health and Safety

TVA's action would satisfy the requirements of Executive Order (EO) 11988 (Floodplain Management), EO 11990 (Protection of Wetlands), EO 12372 (Intergovernmental Review), EO 12898 (Environmental Justice), EO 13112 as amended by 13751(Invasive Species) and applicable laws including the Farmland Protection Policy Act, the National Historic Preservation Act of 1966 (NHPA), Endangered Species Act of 1973 (ESA), as amended, Clean Water Act (CWA), and Clean Air Act (CAA).

1.7 Necessary Federal Permits or Licenses

No federal permits are required to implement the proposed management of vegetation on TVA transmission ROWs. Identification of specific permit requirements are one of the steps in the process TVA uses to manage vegetation on its transmission ROW as outlined in Section 3.1. When specific actions are proposed on TVA transmission ROW, additional environmental reviews for these actions would be undertaken as necessary to address potential project-specific impacts.

1.8 Programmatic Agreements

Pursuant to Section 7 of the ESA, and in consultation with the USFWS, TVA prepared a programmatic Biological Assessment (BA) that evaluated impacts of a suite of TVA routine actions on federally listed bats present in the TVA PSA. This consultation was completed in April 2018. TVA also has consulted with the USFWS on routine vegetation management activities carried out on TVA transmission ROWs for all other threatened and endangered species. This consultation was completed in May 2019.

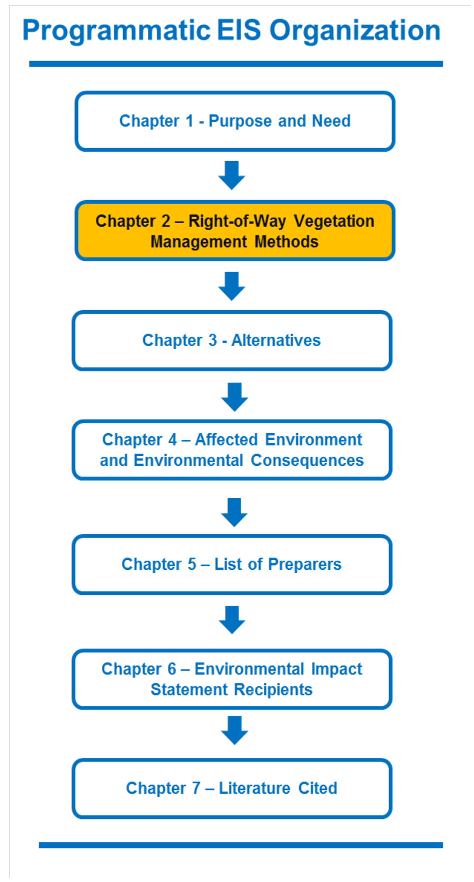
TVA has prepared a Programmatic Agreement (PA) with the Advisory Council on Historic Preservation; the State Historic Preservation Offices (SHPO) of Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee and Virginia; and all federally recognized Indian tribes with an interest in the region, pursuant to Section 106 of the NHPA, for existing TVA operation and maintenance activities, including vegetation management.

Further, TVA has coordinated with other federal land management agencies in conjunction with this PEIS. In particular, the NPS and the USFS have agreed to serve as cooperating agencies. These agencies participated in the following ways: assured that laws and regulations governing operation of their respective lands are appropriately considered as applicable to TVA; responded to requests for existing information and review of written material; provided TVA copies of pertinent planning documents, data, and resource information relating to management of resources in the study area; provided technical expertise and input on matters relating to their primary areas of responsibility; assisted in the development of mitigation measures and monitoring plans; conducted appropriate technical and/or administrative reviews of the preliminary draft and preliminary final EISs; and provided written comments for use in subsequent revisions.

Agency correspondence is included in Appendix B, and Agreements and consultations with each agency, as appropriate, are included in Appendix D.

CHAPTER 2 – RIGHT-OF-WAY VEGETATION MANAGEMENT METHODS

This chapter introduces all practical "tools" (i.e., types of equipment) included in the "toolbox" (i.e., comprehensive set of methods of vegetation maintenance) for each component of TVA's vegetation management program: vegetation control, debris management, and restoration. It includes a description of each tool and its advantages, disadvantages, and costs. Tools deemed impractical and therefore eliminated from further consideration are identified for each element of vegetation management, as appropriate. Impacts associated with each component of TVA's vegetation management program are evaluated in Chapter 4.



2.1 Vegetation Control

TVA is considering three methods of general vegetation control that can be used alone or in combination to manage vegetation within the transmission line ROW including:

- Manual removal
- Mechanical cutting and trimming
- Herbicide and growth regulator application

Vegetation control methods are summarized below, and characteristics of each method are provided in Table 2-1. All tools within the toolbox would be available under any of the vegetation management alternatives considered by TVA. Vegetation management alternatives are discussed in Chapter 3.

Table 2-1. Transmission Line ROW Vegetation Control Methods

Description	Advantages	Disadvantages
Manual Removal – Hand Work (Pulling or Cutting)		
Chainsaw, machete, brush hooks, axes, bush blades		
Hand work is effective for selective vegetation removal. May be necessary in select areas where mechanical or chemical methods cannot be used. Most effective for minor projects or sensitive areas such as wetlands, steep slopes, or where restrictions are imposed on other viable methods.	Selective – only targeted vegetation is removed. Lighter footprint – less ground disturbance, which mitigates potential impacts to sensitive cultural or biological areas. Can be employed under most field conditions.	Prohibitively expensive for large areas. Labor intensive, less safe to workers, and more intrusive than some herbicide treatments. Typically, most effective for areas of low density vegetation. Can create an environment where resprouting occurs, which increases the woody stem count. Resprouting leads to increased safety concerns and higher costs due to the need for increased long-term vegetation management. Not effective for invasive weeds and can facilitate the expansion of invasive plant communities. Chainsaw use may be restricted at certain times in areas with protected animal species
Mechanical Cutting and Trimming		
Clearing – Bulldozer, track-hoe, skid steer, shears (e.g., feller-buncher), mulcher/chipper, Hydro-ax (including various other attachments), tracked equipment such as Compact Track Loader		
Clearing of trees and shrubs where previous vegetation maintenance has been infrequent and woody plants have encroached into ROW or removal of vegetation in areas where trees were never cleared. Can also be used to safely remove off-ROW danger trees.	Efficient and lowest cost method of clearing, especially for areas of dense vegetation. Machinery can also be used to mitigate certain hazard exposures due to working near energized transmission lines. Can fell, lift, and stack trees; mulch trees; or selectively cut trees depending on the machine and attachments. Mechanical equipment that can mulch or chip eliminates removal of large debris, hastens decomposition, adds organic matter to the soil (keeps nutrients in place), and reduces erosion potential.	Used on large, accessible areas. May not be appropriate for sensitive areas (e.g., archeological sites). Cannot be used on steep slopes (>30%). Negative environmental impacts include non-selective removal of vegetation, ground agitation, noise, and possible oil leaks and spills. Not effective against invasive weeds, as the machines scatter seeds and leave roots. Shatters stumps and supporting near-surface root crowns. Resprouting from shattered stumps and root crowns can produce multi-stem dense stands, which can result in a monoculture (single species vegetation cover). Potential seasonal restrictions for sensitive species (e.g., federally listed bat species and ground-nesting birds).

Description	Advantages	Disadvantages
Mowing – Mower or brush hog		
Mowing of herbaceous plants and seedlings to maintain vegetation within the floor area of the ROW. Typically performed on a short-term basis (cycle is 3 years or less). Removes and grinds brush and fells small trees.	Effective at grinding brush and felling small trees. Grinding and scattering improves aesthetics, facilitates debris decomposition, and reduces fire hazards. Mowing reduces debris size (creates mulch), hastens decomposition, and adds organic matter to the soil (keeps nutrients in place). Appropriate timing can affect plant community development by selecting for low-growing plants.	Same as clearing.
Side-Wall Trimming (from air) – Helicopter tree saw		
Trimming trees immediately adjacent to the ROW to prevent encroachment within the ROW.	Can prune trees quickly and efficiently.	Requires repeated treatments that may not keep up with fast growing species and leads to ongoing vegetation management cost.
Side-Wall Trimming (from ground) – Hydro-ax, Jarraff & Kershaw line trimmers, aerial lifts		
Trimming trees immediately adjacent to the ROW to prevent encroachment.	Efficient and safer than other trimming methods.	Same as side-wall trimming from air.

Description	Advantages	Disadvantages
Herbicide Spraying and Growth Regulators		
Spot, Localized, Ground-based Broadcast, and Aerial Broadcast Spraying – Backpack sprayers, wick applicators, boom sprayers, misters, high-pressure spray gun		
Individually treats selected species or groups of species within a limited area.	Species-specific, low-volume applications of herbicides using a variety of techniques and timing show definite improvement of ROW plant diversity. Low-volume select application creates diminished need for herbicides over time. Provides better erosion protection, more wildlife food and cover plants, and often provides increases in flowering plants and shrubs that enhance pollinator habitat. Herbicides can be liquid, granular, or powder and can be applied aerially (broadcast) or by ground, giving this method some application flexibility. Involves less ground disturbance when applied at a distance, which minimizes damage to soils, archaeological resources, and nesting and tunneling wildlife. Retains ground cover with associated food species and insect communities.	Applicators must be trained, follow applicable state guidelines for licensure and charter requirements. Applicators must also follow manufacturer instructions and U.S. Environmental Protection Agency (EPA) guidelines. Application can require written permissions or permits. Multiple, specific restrictions on applications around waterbodies, agricultural areas, urban areas, federal and state parks and forests, and other sensitive areas. Herbicides must be prevented from reaching streams whether by direct application or through runoff (unless labeled for aquatic use). Timing of application is seasonally dependent (e.g., foliar applications made during the growing season).
Spot, Localized, Ground-based Broadcast, and Aerial Broadcast Spraying – Aerial Sprayers		
Aerial application of herbicide from a fixed wing or rotary aircraft.	Cost-effective because it can be used without disturbing the ROW. Can be cost effective and efficient for large, remote, or difficult-to-access sites.	Requires preflight walking or flying inspection 72 hours prior to application (or as specific state statutes require). Aerial application of herbicides requires specific weather conditions (e.g., wind speed, fog, temperatures). Risks associated with flying. Temporary decreases in diversity of native plants and degraded habitat for sensitive species. Aerial applications require buffers around sensitive resources. Threat to off-target vegetation from drift of herbicides.

Description	Advantages	Disadvantages
Resprout or Growth Control – Backpack sprayers, wick applicators		
Stump spray following cutting to control re-growth. Hack and squirt involves making small cuts in the trunk of target trees and squirting herbicide into the cut. Growth regulators are designed to reduce growth rates of some fast-growing species.	Stump spraying kills unwanted woody plants by preventing re-growth or sucker growth. Growth regulators are helpful to slow growth and avoid removal where tree removals or vegetation conversions are prohibited or impractical (e.g., urban forests).	Effectiveness varies by season (works best when plants are taking up nutrients for the winter). Growth regulators are not economical on a large scale.

2.1.1 Manual Removal

Manual control methods are those that control vegetation using hand-operated tools (ANSI 2012). This type of equipment includes chainsaws, machetes, brush hooks, axes, and brush blades, among others. TVA would select manual vegetation control methods where the use of mechanical or chemical methods is prohibited due to safety, land use, proximity to environmental resources, terrain, budget, weather, project timeline, project scope, or other resource constraints. Manual vegetation control is most effective for selective vegetation removal, small-scale projects, areas with difficult terrain, or areas near sensitive environmental resources that prohibit the use of other types of vegetation control. Example scenarios where manual methods would be employed in the transmission ROW include, but are not limited to: removal of larger trees that could be a hazard to the transmission system, and danger trees outside the ROW, limited vegetation removal, residential or agricultural lands, steep hillsides, and proximity to sensitive environmental resources such as wetlands, archeological sites, streamside management zones, cave openings, and protected plant species.

What Factors Influence Cost of Manual Methods?

Costs of implementing manual vegetation control vary. For example, tall, dense vegetation is inherently more expensive to control. Other factors such as the remoteness of work and length of the work period also contribute to higher costs associated with this method.

2.1.1.1 Description

Manual control methods include pulling or cutting with hand tools.

- *Pulling* – physically pulling vegetation from the soil. Hand-pulling and hoeing are most appropriate for landscaping near sensitive environmental resources.
- *Cutting* – maintaining vegetation using hand shears, clippers, chainsaws, brush saws, and axes to cut vegetation. Cutting with chainsaws is the manual method most commonly used by TVA to manage vegetation in the transmission ROW. Chainsaws are most often used when cutting down larger trees within the ROW or danger trees outside of the ROW.

2.1.1.2 Advantages

Manual vegetation control methods can precisely and selectively remove vegetation (i.e., individual stems or limbs), can be used in variable habitats, and have a lighter footprint. Because manual techniques can be highly selective, this approach is ideal for sensitive environmental areas such as wetlands, stream banks, and areas supporting other sensitive land uses. Additionally, reduced ground disturbance limits the potential impacts to sensitive environmental and cultural areas.

Manual methods allow for vegetation control work to be conducted under most field conditions. For example, manual techniques are ideal for very steep, rough terrain and can be used in poor weather conditions, which can limit the use of mechanical equipment due to safety implications and environmental impacts.

2.1.1.3 Disadvantages

Manual vegetation control methods are labor intensive and can be more expensive on a per unit area than other methods. Vegetation control using hand-operated tools is difficult and less effective to carry out where the vegetation is dense. Manual methods are not effective for invasive weeds (especially if used without follow-up herbicide treatments) and, in some cases, the use of manual methods can facilitate the expansion of invasive plants (e.g., seed spread by mowing and other machines). Additionally, manual controls are only effective in the short-term for many deciduous trees. Depending on the species, many trees can resprout from a single cut stem, resulting in multiple stems that require greater maintenance effort in the future. Depending on the species, these new stems could grow rapidly and be structurally weaker than the original single stem, which would create more debris and increases project costs.

Manual vegetation control methods can also be noisy and less safe than other tools used to control vegetation. Chainsaw noise can disturb wildlife and may even be restricted in areas with sensitive or rare animal species. Worker health and safety issues associated with this method center on the potential safety hazards for workers who carry and use chainsaws and other hand-operated tools.

2.1.1.4 Costs

Costs for manual vegetation control methods range from approximately $125 to $800 per acre (Table 2-2). Costs vary due to site-specific conditions such as vegetation type, vegetation density, location along the transmission ROW, and tool limitations.

Table 2-2. Costs of Manual Vegetation Control Methods

Application Method	Cost Per Acre
Manual Methods	$125 - $800

2.1.2 Mechanical Cutting and Trimming

Mechanical control methods are defined by the ANSI as vegetation control using equipment-mounted saws, mowers, grinders, and other devices (ANSI 2012). Mechanical methods include clearing, mowing, and side-wall trimming using large machinery. Mechanical vegetation control methods would be used where project scope, work area safety, terrain, budget, proximity to the public, and environmental constraints would allow. Some equipment can be fitted with rubberized tracks or wide tires to reduce ground pressure for wetlands and other ground-sensitive areas. TVA most likely would implement mechanical vegetation control methods for initial woody vegetation removal in the transmission ROW, managing the floor area where herbicides are prohibited or inappropriate, trimming trees adjacent to the transmission ROW, removing danger trees and where large-scale debris management requires mechanical equipment.

What is a feller-buncher?

A feller-buncher is a type of harvester used in logging. It is a motorized vehicle with an attachment that can rapidly gather and cut one or more trees before felling them. Feller-bunchers can be wheeled (such as shown in the picture) or tracked (often used by TVA). Tracked feller-bunchers have been recognized by the U.S. Army Corps of Engineers as “non-mechanized”.

2.1.2.1 Description

1. *Clearing* **–** using, for example, tools such as bulldozers, track-hoes, skid steers, shears (e.g., feller-buncher), mulcher/chippers, or Hydro-axes (including various other attachments) to clear trees and shrubs where previous vegetation maintenance has been infrequent and woody plants have encroached into the transmission ROW. This includes reclaiming non-maintained areas within the width of the ROW and removal of danger trees outside the ROW.

2. *Mowing* – using a mower or brush hog to cut herbaceous plants and seedlings to maintain vegetation within the floor area of the transmission ROW. This approach is effective at removing and grinding brush and felling small trees. Typically used on a short-term basis (cycle is 3 years or less).

Hydro-Ax

3. *Side-Wall Trimming (Aerial or Ground)* – using a helicopter mounted tree saw, Hydro-ax, Jarraff & Kershaw line trimmers, or aerial lifts as examples. Side-wall trimming is effective for trimming trees immediately adjacent to the ROW.

Among the mechanical methods identified above, mowers are the tool most often used on TVA transmission ROWs for routine vegetation maintenance.

2.1.2.2 Advantages

Mechanical methods are the most efficient and lowest cost method of vegetation removal, especially for areas of dense vegetation where herbicide application is difficult or impractical. This approach is effective for completely removing thick stands of vegetation in large, accessible areas more quickly than manual cutting. Mechanical methods generally achieve 90 to 100 percent stem count removal of both compatible and incompatible vegetation on the first treatment.

Some mechanical equipment also can mulch or lop and scatter vegetation debris as the equipment moves through an area, thereby facilitating debris decomposition. Mechanical methods can fell, lift, stack, or mulch trees, and some mechanical methods can be effective at targeted removal of select trees. Mechanized equipment also can be used to mitigate certain hazards presented by working close to energized transmission lines. For example, as compared to other methods, side-wall trimming is a particularly safe and efficient method for routine pruning of the trees along the edge of the border zone.

Helicopter-mounted Tree Saw

2.1.2.3 Disadvantages

Mechanical mowers not only cut taller saplings and seedlings on the transmission ROW, but also shatter the stump and the associated near-surface root crown. The tendency of resistant species to resprout from root crowns and shattered stumps can produce dense, multi-stem stands in the transmission ROW. Repeated use of mowers for short cycle vegetation removal may result in dense thickets of a single species, or monocultures, dominated by these resprouted stems and may actually suppress more desirable herbaceous species. Mechanical methods are not effective for invasive weeds as machines scatter seeds and leave roots.

TVA has observed that stems adapted to frequent mowing cycles can produce regrowth at a rate of 5 to 10 feet in height each year. In years with high rainfall, annual growth can reach 12 to 15 feet in height. These dense, monoculture stands can become nearly impenetrable even for large tractors. Left untreated, the dominance of monocultures reduces overall ecosystem benefits for wildlife that would be realized with a more diverse plant community.

Jarraff Line Trimmer

Although mechanical methods generally achieve 90 to 100 percent stem count removal of both compatible and incompatible vegetation on the first treatment, if compatible vegetation is not established, the treated area is susceptible to colonization by a range of plant species that may or may not be desirable in the long-term. As with manual methods, mechanical vegetation control often can have limited effectiveness in the short-term. For example, as illustrated by Figure 2-1, use of mechanical means often is followed by rapid regrowth within the transmission ROW, thereby limiting the duration of control effectiveness.

Mechanical vegetation control is effective in removing vegetation on both a small and large scale, but it would not necessarily eliminate targeted stems. Similar to manual vegetation control, regrowth would occur unless the stump of the targeted stem also was removed using additional mechanical or chemical control.

Kershaw Line Trimmer

Mechanical equipment is typically restricted to large, accessible areas such as the floor area of the transmission ROW. Mechanical equipment cannot be used on steep slopes (greater than 30 percent) or in other conditions incompatible with equipment use (e.g. extremely wet weather or where work occurs on sandy river levees and terraces). Additionally, landscape features (e.g., ravines) can limit access and make this control method less efficient, thereby increasing costs and creating a safety hazard.

Noise, exhaust and dust from machinery can disturb wildlife and may even be restricted in during certain times of the year to protect sensitive species such as federally listed bat species and ground nesting birds. There is also the possibility of accidental releases associated with the use of mechanical equipment.

a. *Transmission ROW showing active mowing*

b. *Transmission ROW 2 to 3 years after mowing*

Figure 2-1. Example of Rapid Regrowth in a Transmission Line Right-of-Way Managed by Mowing

2.1.2.4 Costs

Costs for mechanical vegetation control methods typically range from approximately $125 to $300 per acre, or higher in certain conditions, e.g. high stem count and/or constrained access (Table 2-3). Costs vary due to site specific conditions such as vegetation type, vegetation density, location along the transmission ROW, and equipment restrictions.

Table 2-3. Costs of Mechanical Vegetation Control Methods

Application Method	Cost Per Acre
Mechanical Methods	$125 - $300

2.1.3 Herbicides and Growth Inhibitors

Herbicides kill or damage plants by inhibiting or disrupting basic plant processes. TVA previously has worked with universities (e.g., Mississippi State University, University of Tennessee, Purdue University, and others), chemical manufacturers, other utilities, U.S. Department of Transportation, USFWS, and USFS personnel to explore options for vegetation control. Research, demonstrations, and other transmission ROW programs show a high degree of effectiveness in ROW vegetation treated with selective low-volume herbicides using a variety of application techniques and timing. Herbicides can be applied in a variety of ways; however, all herbicides would be applied under the supervision of a licensed applicator in accordance with applicable state and federal laws and regulations. Additionally, only TVA-approved herbicides registered with the U.S. Environmental Protection Agency (EPA) or those approved by another government agency (e.g., NPS or USFS), as appropriate, are used and applied in accordance with manufacturers' label directions. Table 2-4 identifies herbicides TVA currently uses for transmission ROW vegetation control. Table 2-5 identifies pre-emergent herbicides TVA currently uses on bare ground areas in transmission ROWs. These lists may change over time as new herbicides are developed and registered with EPA, or new information on presently approved herbicides becomes available.

Table 2-4. Herbicides Currently Used on TVA Rights-of-Way

Trade Name	Active Ingredient
Accord/Accord XRT II	Glyphosate/Liquid
Arsenal	Imazapyr/Liquid/Granule
Chopper	Imazapyr/RTU
Clearstand	Imazapyr/Metsulfuron Methyl/Liquid
Escort	Metsulfuron Methyl/Dry Flowable
Garlon	Triclopyr/Liquid
Garlon 3A	Triclopyr/Liquid
Habitat	Imazapyr/Liquid
Krenite S	Fosamine Ammonium
Milestone VM	Aminopyralid/Liquid
Pathfinder II	Triclopyr/RTU
Rodeo	Glyphosate/Liquid
Roundup	Glyphosate/Liquid
Roundup Pro	Glyphosate
Streamline	Aminocyclopyrachlor/Metsulfuron Methyl/Liquid
Transline	Clopyralid/Liquid
Viewpoint	Imazapyr/Aminocyclopyrachlor/Metsulfuron Methyl/Liquid

Table 2-5. Pre-Emergent Herbicides Currently used for Bare Ground Areas on TVA Rights-of-Way

Trade Name	Active Ingredients
Arsenal 5G	Imazapyr/Granule
Sahara	Diuron/Imazapyr
SpraKil SK-26	Tebuthiuron/Diuron/Granules
SpraKil S-5	Tebuthiuron/Granules
Topsite	Diuron/Imazapyr

Growth regulators (or inhibitors) slow the growth and limit the size of trees and shrubs in lieu of immediate removal. Table 2-6 identifies growth regulators that TVA may use on tall-growing trees and shrubs under special circumstances that restrict complete removal (but would otherwise require trimming on a regular cycle).

Table 2-6. Growth Regulators Currently Used on TVA Rights-of-Way

Trade Name	Active Ingredients
Profile 2SC	TGR-paclobutrazol
TGR	Flurprimidol

These identified herbicides and growth regulators are all included in the overall vegetation control tool box. Planning steps (see Chapter 3) are used by TVA to determine which herbicides, if any, would be appropriate for site-specific use (e.g., some National Forests have a limited list of acceptable herbicides). In all cases, TVA applies each herbicide in accordance with the EPA-registered label instructions and in accordance with appropriate BMPs and standard protocols and procedures.

Environmental Constraint:
Pollinator Sensitivity

BMP Employed: Landowners who have beehives located on or near a TVA right-of-way are concerned about the impact of herbicide application to their colonies. TVA works with landowners to schedule herbicide application during times when the bees will be less active and not foraging on the ROW.

The application method for herbicides is determined after considering the impacts on public and personnel safety, environmental conditions, and the site characteristics of the area to be treated. Herbicide applications are grouped into four categories:

- Spot
- Localized
- Ground-based broadcast (manual and mechanical)
- Aerial broadcast

Each category can use a variety of tools and application techniques to achieve vegetation control.

2.1.3.1 Description

2.1.3.1.1 Spot Herbicide Application

Spot applications treat individual plants with the least amount of herbicide compared to localized ground-based broadcast or aerial broadcast). TVA generally treats fence rows, towers and other features in the transmission ROW using spot applications by such methods as:

- *Stump treatments* – Herbicide is applied by hand (squirt bottle) or backpack to freshly cut stumps of trees (excluding conifers) and shrubs to prevent resprouting and regrowth.
- *Hack and squirt (injection and notch treatments)* – Herbicide is injected into the tree around the base using tubular injectors (e.g., lances); or herbicide is squirted or sprayed into frills, notches, or cups chopped around the base of individual trees or shrubs. These very selective treatments are used to target specific trees or shrubs.

2.1.3.1.2 Localized Herbicide Application

Localized herbicide applications treat individual or small groupings of plants. This application method normally is used only in areas of low to medium target-plant density. Localized herbicide applications include, but are not limited to:

- *Basal treatments* – Herbicides are applied by hand via squirt bottle or by backpack to the base of the plant (directly to the bark or stem) from the ground up to knee height. These treatments can be completed during the dormant season or growing season.
- *Low-volume foliar treatment* – Herbicides primarily are applied by workers using backpack sprayers and applicator (see inset). An all-terrain vehicle (ATV) or tractor with a spray-gun attachment also can be used. Herbicide is applied to the foliage of individual or clumps of plants according to the label directions during the growing season. Herbicides are mixed with water and surfactants typically are added to increase environmental safety and herbicide effectiveness. Thickening agents also can be added to control drift, when necessary. Dyes often are added to easily identify areas that have been previously treated.
- *Localized granular application* – Granular or pellet forms of herbicide are hand-applied to the soil surface beneath the drip lines of an individual plant or as close to a tree trunk or stem base as possible. Herbicide is

Illustration of selective application of low-volume foliar herbicides using backpack applicators.

What are "Surfactants"?

Surfactant is short for "surface-acting agent." These chemical compounds reduce the surface tension of water, thereby increasing penetration, coverage, and overall effectiveness of the selected herbicide on the target vegetation.

applied when there is enough moisture to dissolve and carry the herbicide to the root zone.

- *Bare-ground treatments* – Applications made via backpack sprayer, ATV, tractor with a spray-gun, or hand disbursed. This approach treats the ground to keep any vegetation from growing rather than treating the vegetation itself. The herbicide used can be in liquid or granular formulations. This technique commonly would be used in an electric yard (substation) and around wood transmission poles within the transmission ROW.

2.1.3.1.3 Ground-based Broadcast Herbicide Application

Ground-based (manual and mechanical) broadcast herbicide applications treat an entire area, rather than individual plants or small groupings of plants. Ground-based broadcast applications are used to treat transmission ROWs that are heavily vegetated, and also are used to treat invasive weeds. Ground-based broadcast applications also are suited to initially manage areas of dense vegetation, with subsequent use of other methods in the future. Application techniques for this group include:

- *High-volume foliar treatments* – Herbicide is applied by truck, ATV, or tractor with a spray-gun, broadcast nozzle, or boom. A hydraulic sprayer is mounted on a rubber-tired tractor, truck, or tracked-type tractor to spray foliage and stems of target vegetation with the prescribed mixture of water, surfactant, dye, and herbicide. The herbicide mixture is pumped through hoses to either a hand-held nozzle or a boom. When using a hand-held nozzle, a worker activates the nozzle and directs the spray to the target vegetation. With a boom application, a fixed nozzle or set of nozzles is used to spray a set width as the tractor passes over an area.
- *Cut-stubble treatment* – Herbicide is applied from a mobile boom over large swaths of freshly mechanically-cut areas to prevent resprout or regrowth of vegetation. This is the broadcast style of localized stump treatment described in Section 2.1.3.1.2 above.
- *Broadcast granular treatment* – Granular forms of herbicide are dispersed by hand, belly grinder (a front-held container that disperses seeds by turning a hand crank), truck, or tractor. The herbicide is dispersed over a relatively large area, such as in an electric yard (substation) or around the tower legs of a transmission structure.
- *Broadcast bare-ground treatments* – Herbicide is dispersed by ATV or tractor with a spray-gun, by trucks with mounted booms, or can be hand disbursed. This application treats the ground to keep vegetation from growing, but it covers a wider area than other broadcast application methods. Generally, this application technique is used in electric yards (substations) and other areas that need to be kept completely clear of vegetation for safety purposes (i.e., prevention of worker electrocution due to vegetation creating a difference in the electrical potential).

Broadcast herbicide treatments are more appropriate for densely vegetated areas that are accessible by truck or in electric yards (substations) where total vegetation control is desirable.

2.1.3.1.4 Aerial Broadcast Herbicide Application

Aerial broadcast herbicide applications are used to treat large areas that typically are populated with dense vegetation needing control (e.g., invasive weeds), steep slopes that increase risk to worker safety, or inadequate road access including access roads to transmission ROWs with a steep grade. Approaches for this method include:

- *Fixed-wing aircraft* – Herbicide application is accomplished with a boom system mounted to the undercarriage and near the trailing edge of airplane wings. Fixed-wing aircraft fly above the transmission-line conductors to treat the target transmission ROW.
- *Helicopter* – Booms are attached to a helicopter to deliver herbicide to the target area. The helicopter may fly above or below transmission line conductors to treat the transmission ROW.

Aerial broadcast applications are conducted during the growing season. TVA only would use non-petroleum-based surfactants. Herbicide drift is controlled by immediate shut-off devices, close monitoring of weather conditions, and the use of adjuvants to maintain herbicide droplet size (bigger droplets fall straight down). If wind speeds are greater than what is recommended by the label instructions and restrictions, no spraying would be allowed.

New advancements in helicopter aerial herbicide application include on-board Global Positioning Systems with predetermined computerized buffer zones. Portable weather stations are used to monitor changing weather conditions (e.g., wind speeds, humidity, and temperature) to aid in the management of aerial applications. Specially designed booms provide accurate herbicide applications with minimal herbicide drift.

Aerial herbicide applications are appropriate in remote areas that are difficult to access by foot or ATV or where worker safety can be impacted. Accessible landing sites, however, are required near the area to be treated (e.g., an airport for fixed wing aircraft or a suitable landing area for helicopters) to rendezvous with herbicide supply trucks. Aerial herbicide treatments also are well-suited for areas with tall, dense vegetation that is otherwise inaccessible and where the foliage is too high for broadcast or backpack sprayers.

2.1.3.2 Advantages

Herbicide treatments are effective in controlling vegetation because of their flexibility and selectivity to promote the growth of desirable vegetation. The multitude of herbicide products (e.g., granular and liquid) and delivery methods (e.g., spot, localized, and ground-based broadcast) allow for site-specific targeting of vegetation under various field conditions. The herbicide type, amount, and delivery system all can be tailored to the site-specific vegetation control needs. Herbicides can be selective, so as to only affect the target vegetation, or non-selective so as to affect all the vegetation in its path. Spot and localized herbicide treatments, for example, work well in treating deciduous tree stumps to prevent resprout and regrowth in the transmission ROW. Selective treatment of vegetation at a distance allows for less ground disturbance, which minimizes inadvertent damage to sensitive areas or compatible (non-targeted) vegetation. Dyes added to the herbicide mix provide a means to assess application efficiency on target vegetation. Additionally, growth regulators similar to those referenced in Table 2-6 are helpful where tree removal or other types of vegetation management is prohibited or impractical in the short-term (e.g., urban forests).

Spot and localized herbicide treatments result in better erosion protection, more wildlife food and cover plants, and often yield an increase in flowering plants and shrubs, which enhances available pollinator habitat. Spot and localized herbicide treatment retain ground cover, which helps reduce erosion issues in the transmission ROW. Ground cover provides habitat, which helps retain the biological communities associated with those habitats. Techniques such as hack and squirt can create additional wildlife habitat in dead, standing vegetation.

How Do Costs of Herbicide Control Methods Differ?

- Costs of **spot and localized** herbicide treatments are the lowest of all vegetation control methods.
- Cost of ground-based **broadcast** herbicide treatments are relatively higher than other herbicide application techniques, but lower than mechanical methods due to the rate at which herbicide can be applied.
- Cost of **aerial** broadcast herbicide treatment is still lower than other vegetation control methods despite requiring an aircraft, as aerial spraying of large areas can be completed quickly.

Vegetation control using herbicides can be more cost effective and efficient for large, remote, or difficult-to-access sites. Stump spraying kills unwanted woody plants by preventing regrowth or resprouting (sucker growth). As such, herbicides are effective for a longer period of time than mechanical vegetation removal. Additionally, low-volume select application can promote a sustainable, low-maintenance environment that requires less herbicide use over time. Herbicide use minimizes the need for debris management, which mitigates the need for heavy mechanical equipment while providing additional savings.

Site specificity and application flexibility maximize herbicide effectiveness and limit negative side effects. Additionally, the amount of active ingredient in each herbicide used is minimal. The duration between repeat treatments is 3 to 5 years. NEPA reviews by the USFS (e.g., 1989a, 1989b, 2002a, and 2002b) found limited environmental impact of select herbicides beyond control of the target vegetation.

2.1.3.3 Disadvantages

Herbicides applied to the TVA transmission ROW have the potential to impact non-target vegetation, water sources, or fish and wildlife through inadvertent application, excess surface runoff, spray drift, and leaching through the soil profile. Restrictions on herbicide applications around waterbodies, agricultural areas, urban areas, public lands, and other sensitive areas limit use of these methods. Risks of non-target exposure with herbicide use are low when herbicides are used according to the label recommendations and applied by trained applicators.

Herbicide treatments require that applicators be trained, follow applicable state guidelines for licensure and charter requirements, and follow manufacturer instructions and EPA guidelines. Herbicide applications may require written permission or permits on various public lands. Health and safety issues are possible from exposure to the active and even inert herbicide ingredients. Workers handling herbicides are required to take precautions to ensure their safety and to minimize exposure. The flight involved in aerial application of herbicides carries additional risk. Additionally, aerial application requires preflight walking or flying inspection of the transmission ROW 72 hours prior to application (or as specific state statutes require), can only be conducted during specified weather conditions, and cannot be used inside buffers surrounding sensitive resources.

Effectiveness of an herbicide application can take from several days to two months following treatment. Variations are dependent on vegetation type, herbicide type and concentration, application method, and various environmental conditions (e.g., precipitation and temperature). The potential disadvantage of long response times to treatment can be somewhat mitigated through the use of dyes that identify application areas more effectively. Additionally, timing of application is seasonally dependent. Foliar applications, for example, should be made during the growing season and stump applications are best just prior to the dormant season, when plants are taking up nutrients for the winter. Though vegetation control using herbicides can be more cost effective and efficient for various scenarios, growth regulators are limited in application and are not economical on a large scale.

2.1.3.4 Costs

Costs of herbicide vegetation control methods are shown in Table 2-7. The costs of spot and localized herbicide treatments ($60 to $160 per acre) are the lowest of all other vegetation control methods considered. Spot and localized herbicide treatments are particularly efficient because they use less equipment and diminish the need for management of vegetation debris. By comparison, the relatively higher cost of ground-based broadcast herbicide treatments ($110 to $250 per acre) reflect the use of heavy equipment (e.g., trucks) and the difficulty of reaching sites by access roads. Costs for this approach are still less than mechanical vegetation control costs because broadcast herbicide applications are applied more efficiently and typically require no management of debris. The costs of aerial broadcast herbicide treatments ($70 to $200 per acre) are low on a per unit area due to greater coverage of a single application.

Table 2-7. Costs of Herbicide Applications

Application Method	Cost Per Acre
Spot	$60 - $160
Localized	$60 - $160
Ground-based Broadcast	$110 - $250
Aerial Broadcast	$70 - $200

2.2 Debris Management

Managing vegetation includes the treatment or disposal of vegetative debris generated by the various vegetation control methods. Basic methods to manage vegetative debris are summarized below and presented in Table 2-8, and the advantages and disadvantages of each method are also outlined in Table 2-8.

2.2.1 Manual Methods

2.2.1.1 Description

Cut and leave (Left in place) – Uses chainsaws or other manual tools to cut down woody vegetation that is then left in place. This method frequently is used in steep areas where access is constrained or around sensitive wetlands or streams where tree removal would cause excessive ground disturbance. In specific areas, this approach requires approval from the appropriate regulatory agency. Benefits of this approach include: eliminating debris removal costs, providing wildlife cover, recycling nutrients back into the soil, and minor erosion control. Disadvantages are related to visual impacts from felled debris that can look unkempt, reduce access to the transmission ROW, and the potential for the cut vegetation to harbor invasive pests. Buildup of debris also can act as fuel for wildfires.

Cut and leave (Lopping and scattering) – Uses chainsaws or other manual tools to cut down woody vegetation and then trim the cut branches and trunks into 4- to 8-foot lengths. These woody sections then would be scattered throughout the transmission ROW, laid flat, and left to decompose. Excess debris, however, can reduce access to the transmission ROW, harbor invasive pests, and can create fuel for wildfires. Thus, larger limbs and debris that would constrain future maintenance activities are typically pushed to the edges of the ROW. Debris can be left as wildlife habitat, erosion control, or crushed by driving over it with machinery to speed decomposition to reduce the potential for wildfires. Decomposing debris also provides recycled nutrients on site that benefit revegetation. Costs are reduced, but not eliminated, for lop and scatter debris management. This approach can be difficult and unsafe due to terrain and time consuming due to remote locations with limited access.

2.2.2 Mechanical Methods

2.2.2.1 Description

Chip in place – Cut trees and brush would be manually or mechanically (e.g., with a winch or excavator) fed into a chipper. The chips then would be blown onto the transmission ROW where the vegetation maintenance is being conducted. Tree trunks too large to be handled by the chipper would be de-limbed and placed in windrows (conical ridge or long, narrow accumulation of material) along the edge of the transmission ROW or scattered as the situation dictates. The chips and trunks left on the transmission ROW decompose naturally, which benefits wildlife, recycles nutrients, and reduces erosion potential. This approach eliminates offsite hauling costs, but it requires access for the chipping equipment. This method typically is used in rural areas.

Tracked Chipping Machine

Mulch in place – A mulcher, which is a tracked or wheeled vehicle with a power mulching head, is used to grind up vegetation consisting mainly of woody stems. Mulching creates wood chips 4 to 24 inches long, larger than the material produced by a chipper, which are scattered and left in place. Debris is left to decompose naturally, which benefits wildlife, recycles nutrients, and reduces erosion potential. Mulching eliminates the need to handle and collect debris; however, larger debris may create access problems in certain high-traffic areas. Mulching is the least appropriate method for vegetation removal in the transmission ROW because it can damage non-target vegetation and is less effective at controlling invasive weeds. This method is used routinely in unmaintained rural and semi-suburban areas with challenging terrain. It only rarely is used in sensitive areas and high-density residential areas.

Wheeled Mulching Machine

Offsite debris disposal (Haul) – Mechanical loading of the tree trunks, limbs, and other brush into a large trailer that is hauled offsite or to a designated onsite location where the material naturally can decompose. This method frequently is used in high-density residential areas that do not have adequate areas or space to set up a mechanical chipper. The method allows for the expeditious removal of the entire tree from a high-traffic site. Removal of excess debris reduces wildfire potential and enhances worker safety. This method, like other mechanical methods, inadvertently may spread invasive species by distributing seeds off the transmission ROW during transport. Additionally, repeated truck trips can create rutting, soil compaction, and increase erosion. This method is expensive due to hauling costs and potential debris disposal costs.

Offsite debris disposal (Chip and haul) – Woody vegetation debris is manually or mechanically fed into a chipper with a winch or excavator, which grinds the debris into smaller chips. These wood chips are blown directly into a trailer for subsequent disposal at an offsite location. Chipping reduces the number of truck trips needed to haul debris offsite. Trunks too large to be handled by the chipper are placed as windrows along the edge of the transmission ROW or scattered throughout the ROW as the situation dictates. As with the offsite haul method, this method reduces wildfire potential and enhances worker safety, but it may inadvertently spread invasive species, requires repeated truck trips that can impact the soil, and could present access problems for trucks and chippers in isolated locations. However, chipping reduces the number of truck trips needed to haul debris offsite. This method is expensive due to hauling costs and potential debris disposal costs.

Table 2-8. Transmission ROW Debris Management Methods

DESCRIPTIONS	ADVANTAGES	DISADVANTAGES
MANUAL METHODS		
Cut & Leave (Left in Place) – Chainsaws or other manual tools		
Trees may be cut and left in place in specified areas with approval from the appropriate regulatory agency. These areas may include sensitive wetlands or streams where tree removal would cause excessive ground disturbance or very rugged terrain where windrowed trees are used as sediment barriers along the edge of the ROW. TVA prefers to leave vegetation in place in areas where removal is a significant risk to worker safety	Eliminates offsite hauling costs. Can provide wildlife habitat under coarse-woody debris (depending on the species of interest). Can provide nutrient recycling (i.e., organic soil matter). Can provide erosion control. Good for sensitive areas or very rugged terrain.	Requires prior approval from appropriate regulatory agency. Potential public backlash because of the initial aesthetics of felled logs and brush debris. Reduced access for subsequent vegetation maintenance activities. Cut vegetation might visually intrude on public or private landowner uses. Can create fuel for wildfires. Can harbor tree pests (e.g., emerald ash borer) and disease.
Cut & Leave (Lopping & Scattering) – Ground crews, chainsaws, brush rakes, skidders		
Branches of trees are cut (lopped) and trunks are cut into 4- to 8-foot lengths. Limbs and trunks are then scattered throughout the ROW, laid flat, and left to decompose. Debris can then be "crushed" by driving over with machinery (which can speed decomposition).	Eliminates offsite hauling costs. Some mechanical equipment also can mulch or lop and scatter vegetation debris as the equipment moves through an area. Can provide wildlife habitat (depending on the species of interest). Can provide erosion control and nutrient recycling.	Can be difficult, time consuming, and less safe. Cut vegetation might visually intrude in lands traditionally used by others. Can create more fuel for wildfires. Can harbor tree pests (e.g., emerald ash borer), disease, and spread invasive species (e.g., scatter seed). Limited use for certain tree species. For example, pine needles can reduce grass re-growth and there is a risk of poisoning to grazing livestock from pine needles and the wilted leaves of wild cherry. Not appropriate for sensitive areas.

DESCRIPTIONS	ADVANTAGES	DISADVANTAGES
MECHANICAL METHODS		
Chipping in Place – Chippers, skidders, grapples, rakes		
Mechanical brush disposal cuts brush into chips (less than 4-inch diameter). Chips are then spread over the ROW. Trunks too large to chip are de-limbed then placed as windrows at the edge or scattered along the ROW, as the situation requires.	Eliminates offsite hauling costs. Can provide erosion control and nutrient recycling (i.e., organic soil matter). Spread-out wood chips and mulch can create a visually appealing park-like look. Windrows can capture snow/precipitation and hold more moisture and provide some shade protection for seedling establishment. Potential benefits to wildlife and nutrient cycling.	Non-target plants can be damaged when debris is dispersed. Chipper equipment can have limited access. More labor intensive than mulching. Windrows allow tree saplings to sprout in places where mechanical equipment cannot reach during future vegetation control.
Mulching in Place – Roller-choppers, mulchers, mowers		
Mulching falls between chip and lop-and-scatter methods. Debris is cut into 4-inch to 2-foot lengths and scattered in the ROW to decompose. Best when terrain or conditions do not allow use of mechanical chipping equipment.	Same as Chipping in Place.	Not effective against invasive weeds (spread seed and leave roots). Not appropriate for sensitive areas. Non-target plants can be damaged when mulching. Results in more coarse debris than chipping.
Offsite Debris Disposal (Hauling) – Loaders; truck and trailers		
Cut trees and brush are collected into piles and loaded onto trailers or debris trucks, regardless of debris size. Debris is then hauled by trucks to offsite locations.	Removing all debris can create a more visually appealing look. Creates safer conditions in the ROW for workers and the public. Reduces the fuel available for wildfires.	Trucks can have limited access. Rutting can damage non-target plants and compact soils from repeated truck-trips. May inadvertently spread invasive species by distributing seeds off the ROW. More labor intensive and expensive than Cut and Leave methods. Potential disposal costs at offsite locations.
Offsite Debris Disposal (Chip and Haul) – Chippers; truck and trailers		
Brush is chipped and blown directly into a trailer. Trunks too large to chip are de-limbed then placed onto	Removing all debris can create a more visually appealing look.	Same as above.

DESCRIPTIONS	ADVANTAGES	DISADVANTAGES
trailers. All debris is then hauled by trucks to offsite locations.	Creates safer conditions in the ROW for workers and the public. Reduces the fuel available for wildfires. Chipping increases the amount of debris that can be loaded onto a single trailer, reducing number of truck-trips needed.	
BURNING METHODS		
Burning (Pile) – Ground crews, chainsaws, skidders, brush rakes, drip torches		
Debris is moved off the ROW and burned in small piles.	Reduces or eliminates hauling and debris processing costs. Reduces wildfire potential of remaining slash. Reduces transmission of insects and disease.	Reduces air quality, visibility, and public health due to the smoke created by burning woody biomass. Conditions can alter the effectiveness of this method and fire can spread if not managed properly. Workers conducting the burning can experience minor to severe burns, smoke irritation, and inhalation of toxic agents or particulates that can have acute effects. Burning is a hazard in the ROW and near substations where smoke can induce flashovers from electrified facilities. Will typically sterilize an area of the soil, making it susceptible to weeds. The soil in and around the burn should be stirred to re-inoculate the soil with beneficial micro-flora and fauna.

DESCRIPTIONS	ADVANTAGES	DISADVANTAGES
Burning (Container) – Air current incineration systems (e.g., Air Current Destructor, Air Curtain Burner, Trench Burner)		
The main operating principle of air curtain incineration systems is high velocity air (curtain) that is blown across and into the upper portion of the combustion chamber. The high volume of air causes over-oxygenation of the fire, and secondly the high velocity airflow over the combustion chamber traps particulates (smoke). These types of burners can efficiently dispose of large quantities of forest waste products at very high temperatures with very little air emissions.	Produces lower smoke emissions compared to pile or broadcast burning. Burns a greater variety of materials (new and old) and turns 95 to 98% of debris into ash. Reduces fire risk and outbreak of insect problems. Operates with fewer restrictions on weather and burn conditions. Residents in urban interface areas are more willing to accept use and remove wood waste and slash fuel hazards around their homes if offered free disposal. The fire is contained and easily and quickly extinguished, if necessary.	Still produces smoke emissions and heat, which may make this option untenable in the ROW. May not be as cost competitive in areas where broadcast and pile burning are acceptable. Requires use of motors to add forced-air into the system, which has risks (e.g., fuel spills, emissions, noise). Requires purchase of the system, which is an expensive upfront capital cost.
OTHER METHODS		
Landowner Use – Shears (e.g., feller-buncher), forwarders, skidders, chainsaws		
Wood that is large enough for firewood or sale by the owner can be cut to lengths upon request and left for the owner's use.	Benefits local landowners and can improve relations overall. Reduces need to remove large timber from the ROW.	Generally, only an option during initial ROW clearing and has limited application for existing ROW vegetation management. Requires prior communication and coordination with local landowners.

2.2.3 Other Methods for Debris Management

2.2.3.1 Burning

Although uncommon, burning may be used as a debris management technique and may utilize the following:

- *Pile burning* – Ground crews, chainsaws, skidders, and brush rakes are used to move vegetation debris off of the ROW to burn in small piles. Pile burning eliminates the need to dispose of vegetation debris via more expensive methods. Burned debris returns nutrients back into the soil but sterilizes the area of soil at the burn site. This area needs to be treated post-burn to reduce weed establishment. There are obvious worker safety concerns associated with working with fire including the potential for burns and smoke inhalation. There also is potential for the fire to spread offsite. Additionally, smoke emissions can reduce air quality and visibility and can act as a conductor of electricity, making this method untenable under active transmission lines.
- *Container burning* – Using air current incineration systems (e.g., Air Current Destructor, Air Curtain Burner, Trench Burner), high velocity air (curtain) is blown across and into the upper portion of the combustion chamber causing over-oxygenation of the fire and higher temperatures. The high velocity airflow over the combustion chamber traps smoke, which reduces emissions. These systems efficiently dispose of large quantities of vegetation debris. However, because smoke emissions can act as a conductor of electricity, this method is not possible under active transmission lines. These systems also use engines, which have the potential to leak or spill oil and fuel.

2.2.3.2 Landowner Use

At the requests of landowners, vegetation debris may be left for landowners' personal use under appropriate circumstances. For example, felled trees can be cut to lengths for firewood. Landowner use can reduce the costs needed to remove large debris. This method is more frequently used during initial clearing and is less applicable to routine vegetation management.

2.2.4 Herbicide Debris Management

Herbicide application typically creates dead standing vegetation along the ROW. This debris is left in place to decompose unless safety or environmental concerns determine otherwise. For example, if treated vegetation is large enough to fall into a roadway or public place it would be considered for removal using one or more of the debris management methods previously described.

2.2.5 Costs

Costs of debris management are dependent on both method and stem count as summarized in Table 2-9.

Table 2-9. Costs Associated with Debris Management Methods (Dollars per Acre)

Type of Disposal	Stem Count[1] High	Stem Count[1] Medium	Stem Count[1] Low	Typical Equipment
Mulch In Place	$2,000-$2,300	$1,800-$2,300	$1,100-$2,000	Tracked or Wheeled Mulcher
Chip In Place	$1,600-$2,000	$1,400-$1,800	$1,000-$1,600	Tracked or Pull Behind Whole Tree Chipper
Offsite Disposal (Chip and Haul)	$2,400-$3,000	$2,200-$2,700	$1,200-$2,700	Chipper and Chip Truck
Offsite Disposal (Haul)	$1,200-$2,500	$1,000-$2,200	$900-$2,000	Truck and Loader
Cut and Leave	$900-$1,200	$600-$900	$400-$600	Chainsaws

[1]Stem count estimates based on trees greater than 6 inches diameter at breast height.
High Stem Count = 350-400 per acre;
Medium Stem Count = 100-350 per acre; and
Low Stem Count = less than 100 per acre.

2.3 Restoration

In some cases, TVA restores the transmission ROW through reseeding. Generally, these restorative measures are implemented to:

1. Minimize soil erosion.
2. Prevent the establishment of invasive weeds.
3. Promote the establishment of low-growing vegetation.
4. Promote wildlife habitat.
5. Mitigate visual impacts.

Restoration methods are summarized below and presented in Table 2-10.

2.3.1 Restoration Methods

2.3.1.1 Descriptions

Reseeding – Non-invasive seeds of grasses, legumes, and forbs are purchased and planted in disturbed soils by drilling or broadcasting the seeds. Broadcasting can be done by hand, by belly-grinder, from a truck or tractor-mounted broadcast seeder, using a truck-mounted hydro-seeder, or via aerial application from a helicopter. Drill seeding typically involves a tractor-drawn machine that drills small holes or slits in the ground and then deposits seeds into the holes.

Table 2-10. Transmission ROW Restoration Methods

DESCRIPTIONS	ADVANTAGES	DISADVANTAGES
RESTORATION METHODS		
Reseeding – Ground crews, belly-grinder, tractor seeder, aerial seeder, hydro-seeder		
Seeds of grasses, legumes, and forbs are purchased and dispersed by drilling or by broadcasting the seeds. Broadcasting can be done by hand (throwing seed onto the ground), by belly-grinder (a front-held container that disperses seeds by turning a hand crank), from a truck or from tractor-mounted seeders, hydro-seeders, and via aerial application from a helicopter. Seed also may be planted using no-till drills.	Helps control erosion. Helps establish low-growing vegetation and prevent the establishment of invasive weeds. Improves and promotes wildlife habitat. Mitigated visual impacts of clearing vegetation. Good on steep slopes or erodible soils with little potential for natural revegetation. Appropriate on access roads, around tower legs, potentially on other portions of a ROW, and at non-electric facilities in landscaping.	Must be done with adapted, good quality seed (with no invasive weed seeds present). Native seeds may not be available in necessary quantities or at a reasonable cost. Ground must be prepared (soil amendments and fertilizers if necessary) and seeding rates and drill spacing are variable. Variable survival rates. Germination rates and plant establishment can be slower for native prairie forbs. Seed germination for all species requires that soils be kept moist. Seeding should include mulching to achieve adequate erosion control.

2.3.1.2 Advantages

Reseeding facilitates restoration to a compatible vegetative community in the transmission ROW. Both methods help control erosion and prevent the establishment of noxious and/or invasive weeds. Additionally, restoration improves and promotes wildlife habitat and mitigates visual impacts of clearing vegetation. Steep slopes or erodible soils with little potential for natural revegetation are areas that could require restoration if disturbed. It also may be appropriate on access roads, at stream crossings, around transmission structure tower legs and other portions of disturbed transmission ROW.

2.3.1.3 Disadvantages

Reseeding must be done with good-quality plant material (with no invasive weed seeds present) and under the right conditions. Often the ground must be prepared with soil amendments and fertilizers, if necessary, prior to seeding. Additionally, seeding rates are variable and require experienced oversight. Seasonal timing also is critical to restoration success and must be carefully planned within the context of the maintenance/construction schedule. Despite all the preparation, seed will have variable survival rates. Moreover, germination rates and plant establishment can be slower for some species. Seed germination for all species requires that soils be kept moist. Therefore, seeding costs should include mulching to maintain moisture and achieve adequate erosion control.

2.3.1.4 Costs

Costs for permanent reseeding and restoration in the ROW vary from $1,764 to $2,200 per acre using standard revegetation practices. In some situations, reseeding with native warm season grasses (NWSG) could provide cost savings through reduced long-term vegetation management (Turk 2015). Total costs of reseeding with NWSG (i.e., equipment, materials, and inspections) are high—estimated at $2,092 per acre (Turk 2015). However, over a 12-year period the cost savings to the vegetation management program was estimated at $1,200 per acre. Cost savings were due to NWSG better suppressing the growth of woody plant species in the ROW.

2.4 Methods Considered for Use by TVA

Of the individual and various combinations of methods TVA considered to manage vegetation along transmission line ROWs, two were eliminated. Specifically, biological controls (i.e., insects or pathogens and livestock grazing) and prescribed fire were eliminated from further consideration for TVA’s vegetation management program. TVA retained three methods (manual, mechanical, and herbicides) and considered the methods both individually and in combination.

2.4.1 Individual Methods Eliminated

The use of insects or pathogens would involve the introduction and management of specific natural enemies of select invasive weeds to control weed spread directly and indirectly through stress and reduced competitiveness. The release of biological agents requires close coordination with experts. Additionally, the process is slow and has variable effectiveness. TVA also considered the risk of unintentional consequences (e.g., feeding on non-target plants, spread of disease, and altering populations of native fauna) and impacts to property owners. Ultimately, biological control is unlikely to eradicate invasive weeds because the biological agent is dependent on the host weed, and population dynamics limit overall success. For these reasons, the use of biological agents was eliminated from further consideration.

Grazing by livestock often has desirable effects in controlling vegetation in agricultural lands. However, the use of this technique by TVA as a means to control vegetation within the transmission ROW is not practicable. Grazing uses domestic livestock (e.g., sheep or goats) to graze the ROW to promote grasses and reduce the establishment of woody plants. The logistics related to the care and transport of animals over the extent of TVA's transmission ROW make this method untenable. In addition, grazing does not effectively control mature brush and tall trees, which would further reduce cost effectiveness. For these reasons, the use of livestock grazing was eliminated from further consideration.

Like most utilities, TVA prohibits burning on the transmission ROW for vegetation control for safety and power reliability reasons. Prescribed fire involves closely managed burning at periodic intervals to maintain low-growing vegetation. Although this method effectively controls woody vegetation and promotes regrowth of grasses and forbs, prescribed burning under transmission lines is dangerous. A fire burning under a transmission line can arc from the conductor to the ground. Heat from the fire can also damage conductors, burn wood poles, and damage steel-structures. Ultimately, prescribed fire is difficult to manage in a narrow transmission ROW and the potential for fire escape is too great. For these reasons, prescribed fire was eliminated from further consideration.

2.4.2 Selection of Vegetation Control Methods Retained

The vegetation control methods or tools considered in this PEIS and their appropriate uses for various transmission ROW conditions are identified on Table 2-11.

Of the vegetation control methods available for transmission ROW vegetation maintenance (e.g., manual, mechanical, and herbicide/growth regulators), the most suitable approach would be the one that best achieves the management objectives at each site within the transmission ROW. The site-specific selection of control methods (individually or in combination) are based on a range of factors including an understanding of environmental resources and their sensitivities, knowledge of specific site characteristics, safety, economics, and current land use issues. Effective vegetation control along the transmission ROW typically requires the use of a combination of methods. TVA recognizes that each tool has inherent advantages and disadvantages as summarized in Tables 2-1, 2-8, and 2-11.

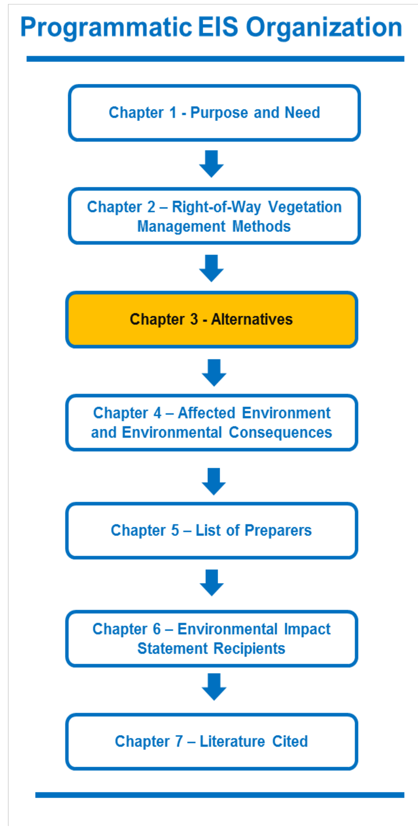
As discussed in Section 1.2.2, setting objectives, defining action thresholds and selecting site-specific application of tools to control vegetation all require consideration as part of the IVM process. Use of all the methods identified above (manual, mechanical, and herbicide/growth regulators) is appropriate and necessary to ensure flexibility of application, increased environmental sensitivity, and cost effectiveness for each site-specific application. Any approach that narrows the range of tools identified for use by TVA as part of its transmission ROW management would reduce TVA's ability to optimize outcomes that enhance environmental stewardship and maximize long-term cost effectiveness.

Table 2-11. Methods Appropriate for Use on TVA Transmission ROWs

Vegetation Control Method	Agricultural Areas	Forested Areas	Grassland and Shrub	Residential Areas	Danger Trees Outside the ROW
Manual	Usually not many trees requiring control.	Manual methods appropriate for tree removal.	Usually not many trees requiring control. Would address invasive weeds in very limited cases. Root systems would not be controlled; seeds have the potential to spread.	Would address invasive weeds in very limited cases. Weed roots would not be controlled; seeds have the potential to spread.	Manual methods are appropriate for selective removal of danger trees.
Mechanical	Usually not many trees requiring control.	Appropriate for dense stands of vegetation and for removal of buffers.	Appropriate for clearing brush on access roads, or around towers.	Same as for Manual (above).	Appropriate; however, mechanical methods tend to be non-selective and used for smaller tree heights.
Herbicide	Appropriate for target vegetation control. Agricultural landowner often uses herbicide methods for localized treatments of weeds.	Appropriate for target vegetation control (including invasive weeds), and stump treatments of deciduous trees.	Appropriate for general application and for invasive weed control.	Appropriate for controlling invasive weeds, selected application.	Growth regulator may be appropriate to stunt growth of potential danger trees.

CHAPTER 3 – ALTERNATIVES

The alternatives TVA is considering for the management of vegetation along the transmission ROW are presented in this chapter. In developing the alternatives, TVA considered its existing practices, as well as the need to address future management along the transmission ROW. Alternatives eliminated from further consideration and the preferred management alternative also are identified in this chapter. Environmental impacts associated with each management alternative that was carried forward for further analysis (including TVA's preferred alternative) are evaluated in Chapter 4.



3.1 Process of Managing Vegetation Within TVA Transmission Line ROWs

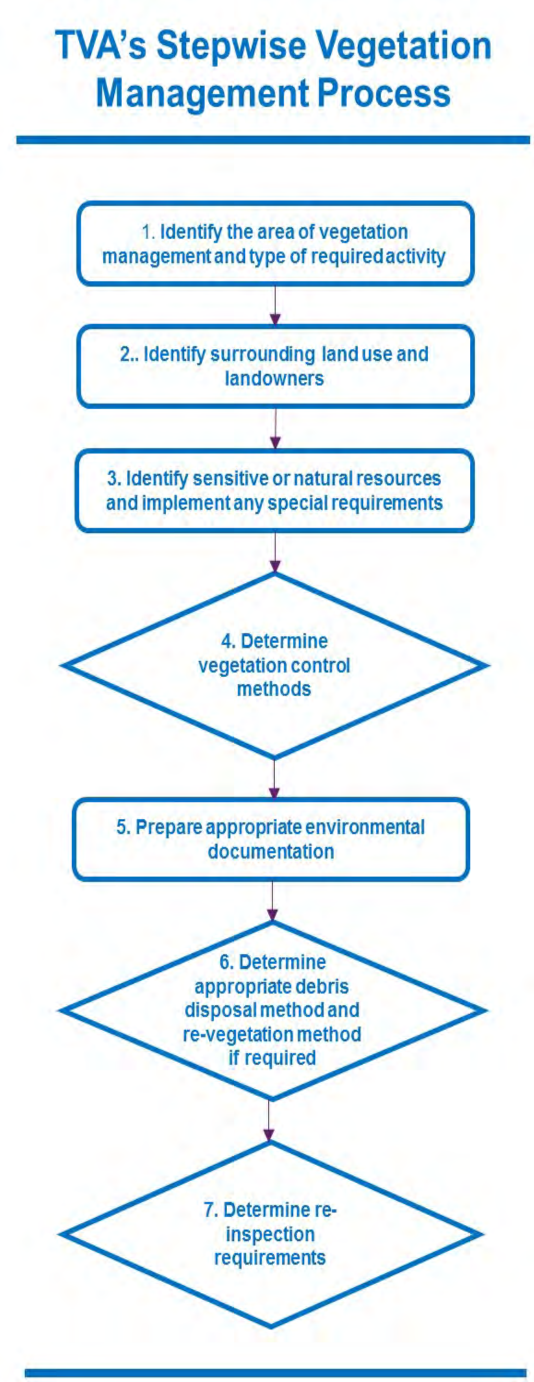
3.1.1 Vegetation Management Framework

Each year TVA assesses vegetation conditions on and along its transmission ROW to identify vegetation that potentially could interfere with the safe, efficient and reliable operation of the existing transmission system, and public safety. TVA also must comply with the NERC Reliability Standard (FAC-003) where applicable. Maintaining adequate clearance between transmission line conductors and tall growing vegetation is essential to reliability, safety, and compliance with applicable regulatory standards. As noted in Chapter 1, TVA's transmission system vegetation management responsibilities encompass approximately 238,000 acres of transmission ROW.

The framework for TVA's vegetation management program within its transmission system consists of the following basic components:

- Inspections
- Planning and Support
- Floor work
- Tree work
- Communication
- Reliability and Compliance

Floor work on TVA's transmission system is routine and focused on periodic, repeated application of vegetation control measures. Floor work is used to maintain plant communities in an herbaceous or low-growing condition to prevent future incompatibility with transmission facilities, thereby promoting reliability and regulatory compliance. Vegetation management of lands primarily maintained by others includes cropland, golf courses, orchards, lawns, and other developed landscapes. Within these areas of the transmission ROW, floor work primarily is performed by landowners maintaining landscapes in residential and developed lands and by routine agricultural practices (e.g., cultivated fields, haylands, pastures, orchards, etc.). Even within lands maintained by others, TVA retains rights for vegetation management within its transmission line easements. Landowners cannot engage in activities that violate the easement terms or create an unreasonable interference to TVA operations. TVA typically manages vegetation along fence rows, tower structures, ditch banks and other features, as resources allow. Floor work is conducted using a range of tools and methods as described in Chapter 2. Floor activities typically consist of herbicide application with lesser amounts of mechanical and manual control methods.



Tree work throughout TVA's transmission system (including lands primarily managed by others) focuses on removal of incompatible trees to maintain the safety and integrity of the transmission system. Tree work includes removal of trees that may become a risk to the reliability of the transmission system within the transmission ROW easement and removal of danger trees outside of the transmission ROW easement. Typically, trees are controlled through manual methods (e.g., chainsaw) and mechanical controls (e.g., equipment-mounted saws, mowers). Tree work throughout TVA's transmission system is directed by inspections and assessments that identify incompatible woody vegetation and guide control measures.

As part of the process, TVA develops a vegetation removal plan specific to each transmission line project area based on local terrain conditions, species composition, growth form, and vegetative density. TVA has developed a stepwise process incorporated under all of the proposed vegetation management alternatives to ensure that vegetation management proactively protects environmental resources, considers land use and land ownership, and enhances health and safety. This process applies to planned vegetation maintenance activities and is not applicable to addressing emergency needs.

Under this approach TVA ensures the following steps are implemented:

1. **Identify the area of vegetation maintenance and type of required activity to ensure safety and reliability.**
    a. *Floor work* – Identify the types of vegetation that require control (invasive weeds, tall-growing vegetation).

b. *Tree Work* – Tree removal of incompatible vegetation that would represent a current or future hazard to the transmission system.

2. Identify surrounding land use (i.e., urban, forested, agriculture, pasture, etc.) and landowners.

a. Address ROW vegetation maintenance within special use lands associated with NPS, USFS, tribal lands, or other special use/conservation lands in accordance with any existing agreements or regulations.
b. Follow current TVA process for notifying property owners.
c. Evaluate surrounding land uses to determine constraints on vegetation control. Incorporate appropriate BMPs as described in *A Guide for Environmental Protection and Best Management Practices for Tennessee Valley Authority Construction and Maintenance Activities Revision 3-2017* (TVA 2017a). The manual can be accessed [here.]

3. Identify sensitive or natural resources within an area of activity and implement any special requirements associated with performing work in those areas.

a. Review and interpret O-SAR data (see Section 3.1.2 below).
b. Identify appropriate mitigation measures as outlined in TVA's guide for environmental and best management practices (TVA 2017a) for the following resources:
   - Streamside Management Zones (SMZ).
   - Wetlands.
   - Other sensitive resources which can include, but are not limited to, caves, federal and state-listed threatened, endangered or special status species (plants and animals), public water supplies, groundwater, critical or unique wildlife or habitat (e.g., trout streams, designated critical habitat, wading-bird nesting areas, heronries, sinkholes), and cultural resource features.
c. Evaluate work area for safety factors in relation to TVA personnel and the general public.
d. Identify areas with steep or unstable slopes (usually greater than 30 percent). Certain types of mechanical equipment may not be feasible in these areas.
e. Ensure TVA personnel and contractors are properly trained for specific techniques required for special requirements.

4. Determine vegetation control methods.

a. Consider Steps 1 through 3.

b. Consider safety.

c. Consider cost.

Environmental Constraint:
Streamside Management Zones

BMP Employed: When removing vegetation within an SMZ, TVA uses buffers of a minimum 50 feet on each side of the bank. Buffer width is predetermined based on waterway, primary use, topography, physical barriers, and resource sensitivity. Removal of vegetation within an SMZ is limited to only tall-growing, incompatible species, preserving the low-growing vegetation to minimize disturbance. Stumps must be left in place and all debris from vegetation removal must be removed from within the SMZ.

d. Incorporate appropriate BMPs and guidance as described in TVA's guide for environmental and BMPs (TVA 2017a or most current revision) and current TVA Vegetation Management Guidelines as described in Appendix E.

5. Prepare appropriate environmental documentation.

a. Determine if the work is within the parameters of the PEIS.

1. If yes, determine if work is covered under an existing Categorical Exclusion or EA.
2. If not, conduct further environmental review if anticipated impacts are substantially different from those evaluated in the PEIS
3. Monitor to determine whether follow-up treatments or mitigation measures are necessary.

6. Determine appropriate debris management method and re-vegetation method if required.

1. Determine whether reseeding is necessary or appropriate under the circumstances.
2. Determine appropriate debris management method considering Steps 1 through 3 above.

7. Determine re-inspection requirements.

1. Determine steps needed to evaluate whether vegetation treatments and/or mitigation measures are working properly and to ensure that other resources are not being adversely affected.
2. Monitor to determine whether follow-up treatments or mitigation measures are necessary

3.1.2 TVA's Integrated Sensitive Area Review Process

The types of sensitive resources occurring in or near the transmission ROW vary widely and include threatened and endangered plant and animal species, caves, heron/osprey rookeries, natural areas, and wetlands. To protect sensitive resources on transmission line ROWs, TVA developed the O-SAR process as an integral component of all of its vegetation management practices including TVA's Stepwise Vegetation Management process. The O-SAR process is used to address routine vegetation maintenance activities. Sensitive area class definitions for vegetation management activities are provided in Appendix F. As part of the O-SAR process, qualified biologists perform reviews of the entire transmission system every 3 years. These desktop reviews use computer-based mapping programs and a wide array of digital data, in lieu of field surveys, to ascertain where sensitive resources may occur on TVA transmission ROWs. Field verified data is added to the O-SAR data, if and when it becomes available. Sensitive resources identified as part of the review process are grouped into five general categories (Table 3-1). The more common widely available data sets used in office-level reviews include aerial photography, U.S. Geological Survey (USGS) topographic maps, National Wetland Inventory (NWI) data, EPA Level 4 ecoregion maps, and Natural Resource Conservation Service soils maps. TVA's approach is unique in that it uses specific data as part of the O-SAR review that includes both transmission line/structure locations coupled with TVA's extensive Regional Natural Heritage database.

This is a “living[3]” database that contains over 30,000 occurrence records for protected plants, animals, caves, heronries, eagle nests, and natural areas for the entire TVA study area.

Table 3-1. Elements of TVA’s Office-Level Sensitive Area Review Database

Sensitive Resource Categories	Data Descriptions
Plants	Locations (documented or potential) of federally or state-listed plant species or unique plant communities.
Aquatic Animals	Locations (documented or potential) of federally or state-listed aquatic animal species.
Terrestrial Animals	Locations (documented or potential) of federally or state-listed terrestrial animal species, bald eagle nests, caves, heron rookeries, osprey nests, Indiana/northern long-eared bat habitat, and other unique resources.
Natural Areas	Locations of federal, state, local, or non-profit lands managed for ecological and/or recreational purposes. A few examples include National Parks, Federally Designated Critical Habitat, Tennessee Designated Natural Areas, state Wildlife Management Areas, and land trust properties.
Wetlands	Includes NWI wetlands; potential wetlands identified by TVA using topographic features, water bodies, soils boundaries, and proximity to NWI; and field verified wetlands delineated during TVA field surveys of transmission ROW.

In the first phase of the O-SAR review process, data are added to the O-SAR database primarily when TVA biologists conduct desktop reviews of each transmission line every three years in conjunction with planned vegetation maintenance activities. If during the review, data indicates a sensitive resource may be present, a polygon that defines the area of interest is created within the O-SAR database and overlaid on the segment of transmission line ROW under review. Sensitive areas may be defined based on information available on the various computer-based mapping sources described above. These also may be added to the O-SAR database because landscape features (i.e. slope, soils, exposed bedrock) and proximity to previously documented resources could indicate that other sensitive resources may be present within or near the ROW easement.

As an example, TVA staff performed an O-SAR review of a 161 kV transmission line situated in the Inner Nashville Basin Physiographic Region in central Tennessee, a region known for its diversity of plant and animal life. This review resulted in the addition of multiple polygons to the O-SAR database along a 14-structure span of the ROW. Figure 3-1 illustrates the compilation of sensitive area information within this example location. In this case, the TVA botanist added a polygon for federally and state-listed plants because of the numerous documented occurrences of rare plants in the vicinity. Additionally, aerial photos indicated that limestone outcrops were common in the transmission ROW and surrounding areas, which suggested the ROW might harbor the rare species previously documented within the vicinity. Polygons also were added for the federally listed Indiana bat and

[3] TVA adds records based on field survey findings, and TVA’s Regional Natural Heritage database is periodically synced with both the USFWS federal listing of threatened and endangered species and state Natural Heritage programs.

northern long-eared bat because trees growing along the transmission ROW edges likely provide roosting habitat for both species. This section of the ROW also crosses a natural area. Wetland features were added based upon the proximity of NWI wetlands and the individual assessment by the TVA wetland scientist. In this manner, the entire transmission line project was assessed for potential occurrence of sensitive resources. Similar assessments are made routinely in conjunction with all transmission vegetation maintenance activities within the PEIS study area.

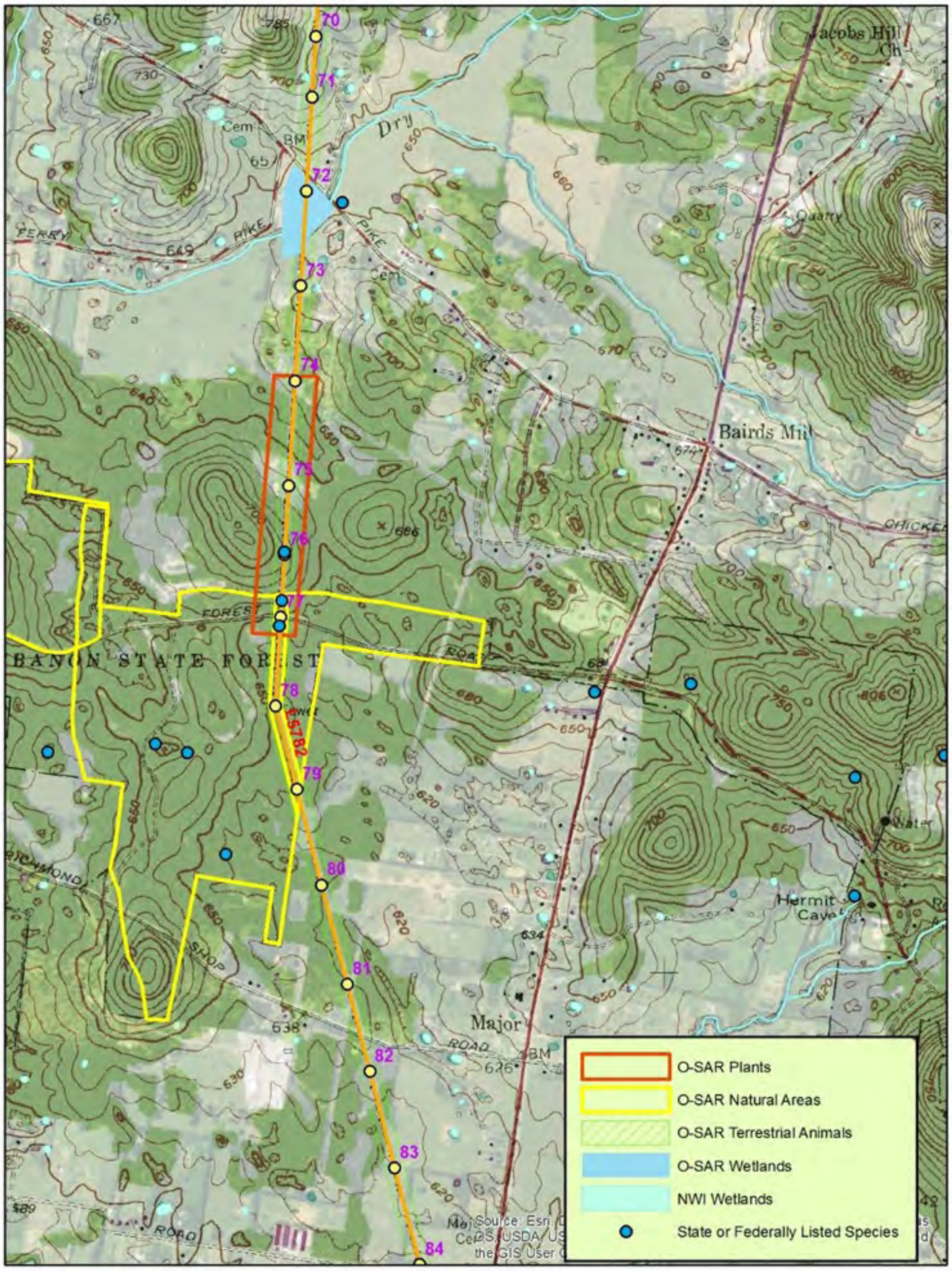


Figure 3-1. An Example of a Section of Transmission Line Within the TVA Transmission System

In the second phase of the O-SAR review process, specific guidance governing transmission ROW vegetation management is appended to every identified sensitive resource polygon (Figure 3-2). This guidance results in the assignment of a "Class" level for each polygon that is accompanied by specific guidance provided to TVA transmission ROW personnel to support further vegetation management planning efforts. The guidance may be informational or prescriptive and result in limitations of particular control measures, requirements for notification to TVA biologists, or the need for site-specific field surveys to be performed by TVA biologists prior to work activities. This guidance constitutes an important aspect of the implementation of BMPs to minimize environmental impact. The guidance is particularly important to clearly define what vegetation maintenance activities are permissible within sensitive areas, taking into account the specific sensitive resources that occur or might occur on a given section of transmission ROW. The guidance also seeks to give certainty and flexibility to TVA transmission ROW personnel, who develop vegetation control activities over large areas under schedule and budget constraints. On lands managed by NPS and USFS, additional reviews by appropriate agency staff is required prior to the implementation of vegetation management practices. Among other things, the need for additional review will be determined by TVA's respective property rights and/or any effective agreements. For instance, NPS parcels on ROW may not have any chance of T&E plants or animals, but herbicide use is still not allowed because of specific guidance per the land manager.

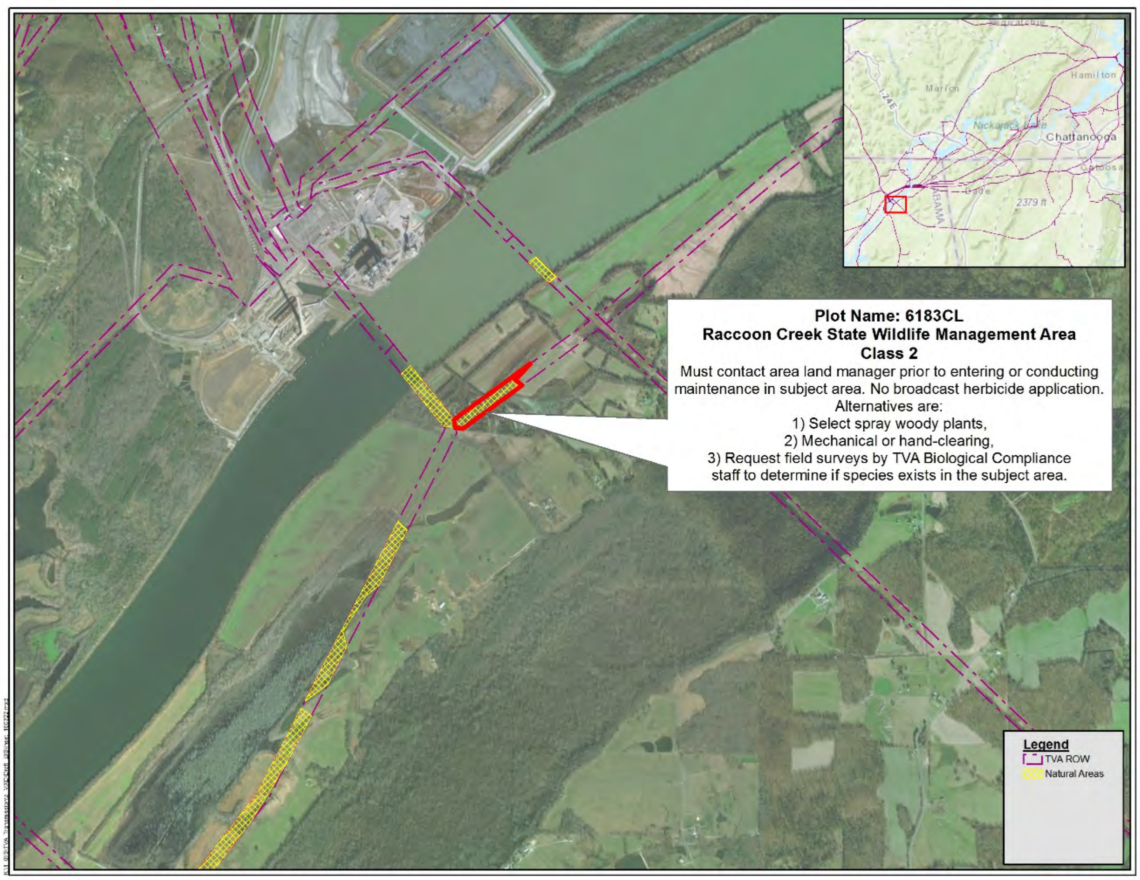


Figure 3-2. Representation of Office-Level Sensitive Area Review Database

Resources are assigned to various classes from those that need less special treatment to those that include more sensitive species that require greater precautions. The sections below illustrate the various classes into which plants, aquatic and terrestrial animals, natural areas and wetlands are categorized.

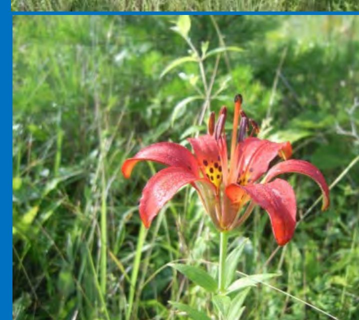
3.1.2.1 Plants

Class 1: Allows for selective herbicide application and mechanical/hand-clearing of vegetation without site-specific coordination with the TVA botanist, regardless of season. Broadcast herbicides are not permitted. This level of guidance is applied to protect rare species and habitats and is applied when federally or state-listed plants, or uniquely diverse plant communities, are somewhat likely to occur within a given section of transmission ROW based on the professional judgment of the TVA botanist. Broadcast herbicide use is prohibited under this guidance because it is considered to be the most detrimental vegetation maintenance tool to rare plants and diverse, herbaceous plant habitats dominated by native plant species. Also, selective application of herbicide to woody plant species often promotes herbaceous habitat and is considered an appropriate tool for the large portions of the TVA transmission system that have not been field surveyed and could contain federally or state-listed plant species.

Class 2: Management of sensitive plant areas assigned as Class 2 requires active coordination between TVA operations personnel and the TVA botanist. The guidance provided does not prescribe or prohibit any specific tool because each Class 2 area is handled on a case by case basis depending on the site, plant species in question and the timing/type of vegetation clearing proposed. This guidance is applied to sensitive areas where federally or state-listed (rank of S1 or S2) species are known to (or are highly likely to) occur. Often, areas covered under this classification are areas of regional conservation significance and contain unique species and habitat that are better represented within the early successional habitats perpetuated within the transmission ROW. Before scheduled vegetation maintenance, particularly herbicide application, TVA botanists regularly perform field surveys to flag the exact location of federally or state-listed plant species within the transmission ROW (see inset). The herbicide applicator can then be directed to avoid spraying where plants occur while still treating the remainder of the ROW. In some cases, the decision is made to forgo herbicide application (in favor of mowing) or change the timing/method of application to avoid impacts to the species.

Environmental Constraint: Sensitive Botanical Resources

BMP Employed: In an effort to realize the benefits of selective herbicide application and reduce the risk to sensitive plant species, plant populations are delineated with flagging tape so that the sites are plainly visible. In areas where threatened and endangered species occur, herbicide contractors selectively treat all woody species outside of flagged zones and hand clear the few trees that occur within those zones.



Delineating populations of the state-endangered wood lily (*Lilium philadelphicum*).

3.1.2.2 Aquatic Animals

Class 1: This level allows for selective herbicide application and mechanical/hand-clearing of vegetation without site-specific coordination with the TVA aquatic biologist, regardless of season. Broadcast herbicide is not permitted. This class is applied to an Aquatics polygon when federally or state-listed aquatic animals are known or likely to occur within water-bodies crossed by a given section of transmission ROW based on the professional judgment of the TVA aquatic biologist. Broadcast herbicide is prohibited under this class because it is considered to have the highest potential to enter waterways and affect sensitive species. Only herbicides registered with EPA specifically labeled for use in aquatic areas are utilized for selective application in close proximity to water features. Overspray or direct spray into waterbodies is not allowed.

Class 2: This classification is applied to sensitive areas where federally listed species are known or highly likely to occur. Often, areas covered under this classification are federally Designated Critical Habitat Units and contain unique species and habitats. Management of vegetation in Class 2 sensitive aquatic areas requires active coordination between TVA operations personnel and the TVA aquatic biologist. Each Class 2 area is handled on a case by case basis depending on the resource and the timing/type of vegetation clearing proposed.

3.1.2.3 Terrestrial Animals

Class BALDEAGLE, HERONOSPREY, HERONRY, and OSPREY: Vegetation management of sensitive areas in this class places seasonal restrictions on mowing and herbicide application within 660 feet of previously documented bald eagle nests and outside appropriate buffers determined for heronries and osprey nests by state guidelines to be outlined in TVA's Avian Protection Plan. Vegetation maintenance activities can proceed unencumbered outside of the nesting season.

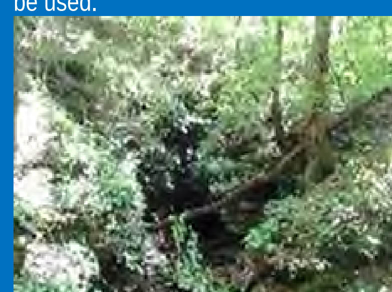
Class CAVE: Herbicide application, including both broadcast and selective methods, are prohibited within 200 feet of known cave entrances (see case study inset). Hand-clearing or mowing is used to control woody vegetation within these areas.

Class IBAT, IBATNLEBAT, and NLEBAT: Vegetation management of sensitive areas in this class places a seasonal restriction on tree cutting to protect summer roosting habitat for Indiana and northern long-eared bat. Tree cutting must take place during a given period of time, which varies by state. Surveys are required when cutting is needed outside of the prescribed window. Herbicide application is not restricted.

Class SPECIAL: Sensitive areas within this class are included to protect other federally and state-listed terrestrial animal species that are known or likely to occur on a transmission ROW. Vegetation management of these areas requires active coordination between the TVA operations personnel and the terrestrial zoologist.

Environmental Constraint:
Caves

BMP Employed: When working near a cave, TVA imposes a buffer of 200 feet around the cave opening. Inside this buffer no herbicide application can take place, and heavy equipment must not be used.



3.1.2.4 Natural Areas

Class 1: Use of broadcast herbicide on natural areas assigned to this class is prohibited. Mowing, selective herbicide application and hand-clearing are permitted. The land manager (e.g., manager of public lands such as a state park) of natural areas in this class would have had to indicate that TVA does not need to initiate contact before conducting vegetation maintenance activities within the transmission ROW for an area to be put in this class.

Class 2: Same as Class 1, except TVA must contact the natural area land manager at least three weeks before conducting vegetation maintenance activities on the transmission ROW.

Class 3: This guidance is used when transmission line ROWs crossing natural areas also possess known sensitive, rare, or protected biological resources, and vegetation management must be conducted following specific restrictions to avoid impacts to the sensitive species or habitats present. This classification requires active coordination between the TVA operations personnel and the TVA natural areas manager or biologist.

3.1.2.5 Wetlands

Class 1: Any area(s) defined as a potential wetland or as a field-verified wetland adheres to TVA guidance as defined in "Wetlands ROW Re-clearing and Pole Replacement Guidelines" (Appendix G). The document references vegetation clearing BMPs designed to prevent erosion, ensures only EPA-registered herbicides approved for used in aquatic environments are utilized, and describes generally how to minimize impacts to wetland habitats.

3.1.3 Programmatic Agreements and Consultations

TVA's formulation of vegetation management alternatives also integrates the content of PAs and consultations developed and executed in coordination with other federal and state agencies. TVA uses these program-level, regulatory-based determinations to avoid or minimize adverse effects of TVA actions.

As described in Chapter 1, and in accordance with Section 7 of the ESA, TVA consulted with the USFWS to assess, on a programmatic basis, the impact of 10 overarching TVA routine actions on four federally listed bat species (gray bat, Indiana bat, northern long-eared bat, Virginia big-eared bat) and their habitats. As part of this effort, TVA prepared a programmatic BA, which was submitted to USFWS on June 18, 2017. Within the BA, TVA analyzed the effects of 96 routine activities associated with the 10 routine actions. One of the routine actions was maintenance of existing electric transmission assets, which included vegetation management activities along transmission line ROWs.

TVA determined that 21 of the 96 activities will have no effect on Indiana bat or northern long-eared bat; 72 activities may affect, but are not likely to adversely affect these two species; and three activities are likely to adversely affect these two species. Potential adverse effects to Indiana bat and northern long-eared bat could result from tree removal (two of three activities) or prescribed fire (one of three activities). Of these, tree removal is identified as an activity that can occur during vegetation maintenance activities. The use of prescribed fire is limited to portions of TVA Reservoir Lands and would not be used during vegetation maintenance activities. TVA also determined that 21 activities covered under the programmatic BA will have no effect on gray bat or Virginia big-eared bat, and 75 activities may affect, but are not likely to adversely affect these two species.

As a component of the BA, TVA committed to implementing conservation measures to avoid and minimize impacts associated with routine actions, as well as to continue conducting conservation measures that may benefit or promote the recovery of the Indiana bat, northern long-eared bat, gray bat, and Virginia big-eared bat.

In response to TVA's programmatic BA on bats and routine actions, the USFWS prepared a programmatic Biological Opinion, concurring with TVA's "effects determinations" and proposed conservation measures. This programmatic consultation was completed in April 2018, and it will be carried out over a 20-year term. Documentation of this consultation including the Biological Opinion is included Appendix D.

TVA also consulted with the USFWS to assess the impacts of routine activities associated with TVA's transmission ROW vegetation management program on all species listed under the ESA (other than the four federally listed bat species addressed in the programmatic consultation) with potential to occur in the study area. This consultation was completed and the USFWS issued a Biological Opinion in May 2019 concurring with TVA's effects determinations. The Biological Opinion is included in Appendix D. BMPs and conservation measures developed in conjunction with this consultation to avoid and minimize effects to sensitive species will be integrated into TVA's transmission ROW vegetation management procedures.

In addition, TVA is finalizing a PA with the Advisory Council on Historic Preservation; the SHPOs of Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee and Virginia; and all federally recognized Indian tribes with an interest in the region pursuant to Section 106 of the NHPA, for existing TVA operation and maintenance activities, including vegetation management.

3.2 Right-of-Way Vegetation Management Alternatives

3.2.1 Management Alternatives Considered But Eliminated

The following alternatives were considered but eliminated from detailed analysis by TVA.

3.2.1.1 Application of a Single Vegetation Control Method

TVA considered various approaches that consisted of the use of a single method to manage vegetation along the transmission ROW. Under this alternative TVA would limit vegetation control to only manual, mechanical or herbicide methods across the transmission ROW system. For example, under this alternative TVA would utilize only mechanical vegetation control methods (e.g., mowing) to maintain vegetation within its transmission ROW, or use only herbicides (broadcast, spot application, etc.). However, TVA found that the application of a single method would not be practicable for the following reasons:

- *Limited applicability* – The TVA study area is a diverse geographic area that supports a wide range of plant communities within a heterogeneous physical environment. Plant communities include both natural environments and managed landscapes that occur in developed areas, cultivated lands and other environments. Because these plant communities are diverse and include a wide range of species and growth forms, the use of many different vegetation control methods are required to ensure effective control across the broader transmission ROW and within site specific locations (e.g. fence lines, transmission line tower footings/poles).

Furthermore, the site-specific vegetation conditions require the use of selective application of tools, such as chainsaws, that may otherwise be inappropriate for wide-scale use.

In addition, the physical environment within the TVA study area consists of varied topography including level or nearly level lands, rolling terrain, and mountainous areas with deep ravines Therefore, while the use of a single method, such as mowing, may be appropriate and usable on level or gently sloping terrain, that method would be inappropriate for use on other terrain, such as valleys and ravines with steep slopes.

- *Reduced reliability* – Use of single methods ultimately would reduce TVA's ability to effectively maintain the floor, identify and remove incompatible vegetation, and proactively develop a transmission system that has enhanced reliability. Failure to address vegetation clearance and maintenance of brush, downed vegetation and small trees could result in wildfires, major power outages, and injury to life or property.
- *Increased environmental impact* – As described in Chapter 2, each of the tools and methods under consideration differ in their effectiveness and environmental impacts. Under this alternative the exclusive use of a single method such as mechanical control by mowing would increase the potential for disturbance of soils, potential incidence of releases or spills of fuels and oils, air and noise emissions and other factors. Additionally, exclusive use of such techniques would promote resprouting from the stumps and root crowns that often produces a multi-stem dense stand resulting in a monoculture that diminishes the environmental quality of the plant community. Similarly, the exclusive use of herbicides may result in excessive application within sensitive environments (SMZs, cave entrances, residential areas, etc.) that would increase environmental impacts.
- *Reduced worker safety* – Use of single method approaches such as mowing would require TVA to use inappropriate tools and methods in situations that compromise worker safety. For example, workers that attempt to use mowing as a means to control vegetation on steep slopes and ravines would be exposed to high risk of accident and injury. Such an approach is in direct conflict with TVA's commitment to enhance safety and reduce risks in the workplace.
- *Increased cost* – Use of a single methodology such as mowing would actually increase the cost of TVA's transmission vegetation management program. For example, use of mowing as an exclusive vegetation control technique would encourage stump/root crown resprouting and the incidence of noxious/invasive vegetation. Because such vegetation has a high rate of re-growth, transmission ROWs treated in such a manner would require increased frequency of treatment that would increase overall project costs.

Therefore, adoption of a management alternative that prohibits or limits the use of the retained methods to a single or selected combination of methods would reduce the ability to efficiently and effectively control vegetation along the transmission ROW and would not be responsive to the purpose and need of this program. This alternative was therefore eliminated from detailed consideration.

3.2.1.2 Landowner Maintenance of Trees on Lands Primarily Maintained by Others

As described in Section 1.1.4, TVA has vegetation management rights for the entirety of the transmission ROW. However, approximately 51 percent of the transmission ROW is used as cropland, golf courses, orchards or similar uses, which are primarily maintained by the landowner. While the floor of the ROW is often maintained by others in these areas, TVA is ultimately responsible for system reliability and conducts routine inspection and vegetation management of ditch banks, fence rows, towers, and other features if they are not maintained by the owner. Under this alternative, TVA would rely upon agreements with landowners to maintain vegetation. Maintenance of the floor in such settings (lawns, cultivated fields, pastures, etc.) would continue to be the responsibility of the landowner. In addition, landowners would be responsible to trim or control woody vegetation growing along fence rows, tower/pole footings, and other features and would be responsible to trim or remove trees that present a hazard to the reliability of the transmission system.

This alternative is critically flawed as it would defer TVA's rights for vegetation maintenance to landowners, while the ultimate responsibility for the reliability of the transmission system always remains with TVA. In cases where landowners fail to conduct the required maintenance, the transmission ROW inevitably would have an increased frequency of incompatible vegetation and danger trees. What is more, it is not efficient nor cost-effective for TVA to track varying agreements with landowners across its vast transmission system. There also is a high-probability of error and/or oversight in tracking such agreements. These conditions would reduce system reliability and ultimately expose TVA to the potential for non-compliance with applicable NERC reliability standards. Therefore, because of the high potential for non-compliance, reduced system reliability and increased financial risk, TVA has eliminated this alternative from further consideration.

3.2.1.3 Elimination of Trees and Shrubs on Lands Primarily Maintained by Others, Regardless of Compatibility

Under this alternative, TVA would assert its overall system management authority across lands primarily maintained by others and preclude the presence of any trees and shrubs established by landowners, whether or not compatible with the transmission system. While some trees and shrubs established by landowners may be inherently lower growing (see Appendix H), in an abundance of caution TVA would remove any existing trees and shrubs from the transmission ROW within such lands. This alternative has the advantage of providing for continuity in vegetation management across the entire TVA study area and would not differentiate between lands primarily maintained by others and those primarily maintained by TVA.

However, as a result of this alternative TVA would also remove any trees that are inherently low growing and may be of particular value or importance to landowners (e.g., aesthetic/ landscaping value, orchards). Furthermore, this alternative would reduce TVA's opportunity for cooperative landowner engagement as part of its transmission vegetation management program. Therefore, because TVA values cooperative relationships with local landowners and because the removal of inherently compatible trees and shrubs is not essential for ensuring system reliability or safety, TVA has eliminated this alternative from further consideration.

3.2.2 Management Alternatives Retained for Detailed Analysis

TVA initially considered vegetation management strategies that ranged from the management of only danger trees to the full removal of vegetation from the entire transmission ROW.

In determining policy and direction for managing vegetation along its transmission line ROW, TVA examined its past and current vegetation maintenance practices and considered standard practices utilized by other entities such as Bonneville Power Administration (BPA) and the USFS, as well as research conducted by the Electric Power Research Institute (EPRI). TVA's research revealed that IVM is the industry standard. It provides maximum flexibility to address site-specific environmental conditions, maintains safety and reliability, and is cost effective. Therefore, TVA determined that IVM should be a central component of its vegetation management strategy.

IVM allows TVA to apply a range of methods depending on the target vegetation type. As illustrated in Figure 3-3, TVA predominantly uses herbicides during routine floor vegetation maintenance and a mix of manual and mechanical methods to remove trees. Noxious or invasive plant species are predominantly controlled by a mix of methods dominated by mechanical techniques and herbicide application. By comparison, tall growing incompatible trees and shrubs typically are controlled using a more balanced application of all techniques (manual, mechanical, and herbicide).

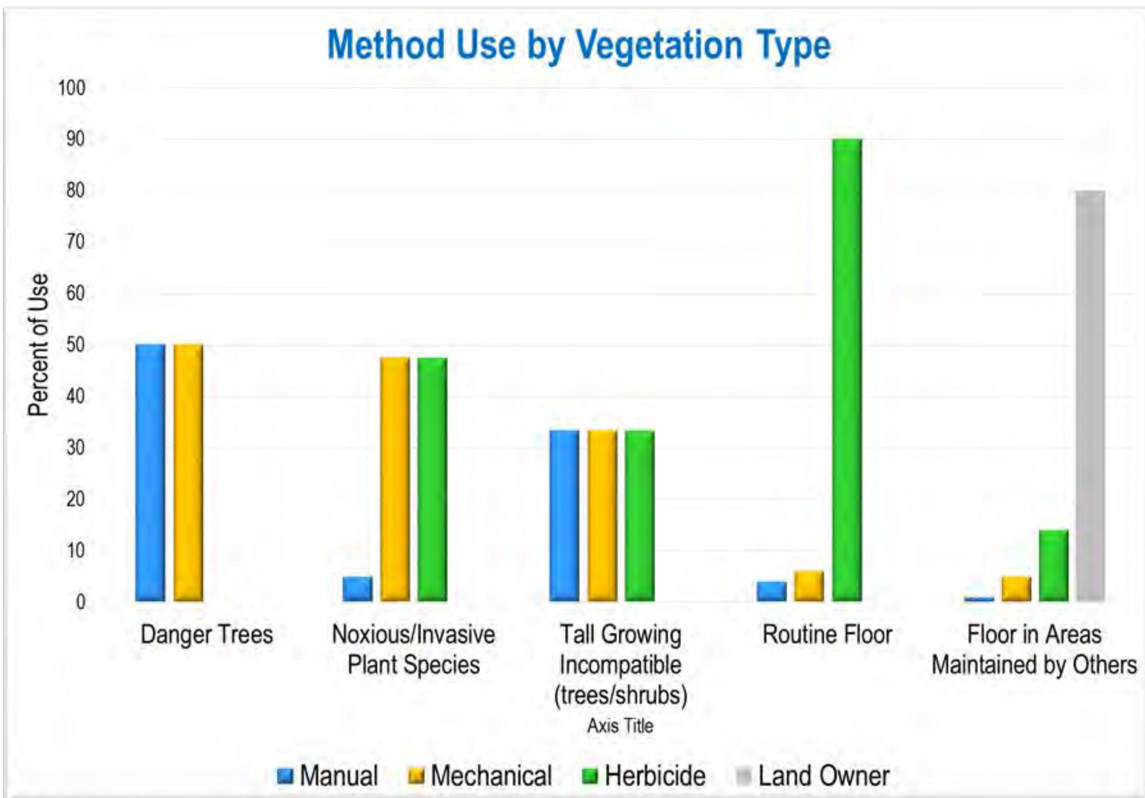


Figure 3-3. Relative Frequency of Method Use by Target Vegetation Type

3.2.3 Alternatives

TVA is considering four alternatives to manage vegetation along its transmission system ROW. As previously described, each of these alternatives is "context sensitive" within an overarching IVM approach in its selection of methods and in its incorporation of TVA's O-SAR process to avoid and minimize impacts. The scope of the potential alternatives is constrained by the need for TVA to eliminate vegetation that interferes with the safe and reliable operation of the transmission system including both the conductor and structures, and therefore, all of the alternatives must include the control of vegetation. Thus, each alternative incorporates the planning steps and adherence to programmatic agreements and consultations previously described. In addition, to enhance flexibility, all of the vegetation control methods identified in Chapter 2, except those eliminated as discussed in Section 2.4, are considered available for use under each alternative, as appropriate, based on the site characteristics, vegetative control objectives and O-SAR review results.

Under all of the proposed alternatives, some vegetation control would be the same. For example, floor work would continue on an established cycle and in general, would be controlled using a mixture of methods, including approximately 90 percent herbicide, 6 percent mechanical and 4 percent manual. However, the net effect of TVA's O-SAR process is to consider the site-specific sensitivity at a given location on the transmission ROW in the development of a context sensitive approach to tools for vegetation management that not only have an effect on method selection for floor work but also for tree work. As summarized in Figure 3-4, this approach allows for selection of different tools by area (floor vs. trees) and for respective environmental settings.

Each of the proposed alternatives incorporates an IVM approach based on a carefully planned, multidimensional strategy developed in consultation with forestry and habitat experts. IVM aims to create conditions on the transmission ROW that improve safety and prevent power outages by creating inherently more compatible and self-sustaining ecosystems while ensuring compliance with regulatory standards (TVA 2016b). These ecosystems foster beneficial, attractive and low-maintenance habitat where incompatible vegetation is discouraged and other, more benign forms of vegetation can thrive. By combining selective use of herbicides with physical vegetation removal, IVM can more thoroughly eradicate incompatible vegetation and allow more "compatible" species to fill in, making it harder for tall-growing vegetation to reestablish. The alternatives considered differ in the selected approach to create the desired "end-state" of the vegetative communities along the transmission line ROW.

Due to *Sherwood v. TVA* litigation, TVA has stopped removing woody vegetation except for trees that are an immediate hazard to the reliability of the transmission system and/or safety of the public. As a result, buffer zones within the existing ROW continue to contain vegetation incompatible with TVA's transmission system. The volume of non-compatible woody vegetation is also increasing within the previously-cleared ROWs due to the court injunction order. Therefore, to ensure the safe and reliable operation of the transmission facilities and to improve the efficiency and effectiveness of vegetation management, Alternatives B, C and D would include an initial removal of vegetation within the buffer areas (except grasses, forbs, and some small shrubs) within the full extent of the ROW. Following the initial removal of vegetation, the full extent of the ROW would be maintained to a low height on a recurring cycle under Alternative B and to a meadow-like end-state under Alternative C. Under Alternative D the buffer zone would be managed to an end-state consisting of compatible vegetation that is variable by zone (compatible shrubs and trees in the border zone). Under both Alternatives C and D compatible trees and shrubs would be allowed in areas maintained actively by others. Initial woody vegetation removal activities would entail the use of both mechanical (about 85 percent) and manual (about 15 percent) methods. Where terrain conditions provide for higher clearances (i.e., ravines, steep slopes etc.), vegetation may not conflict with the safe and reliable operation of the transmission lines, and thus would not need to be removed.

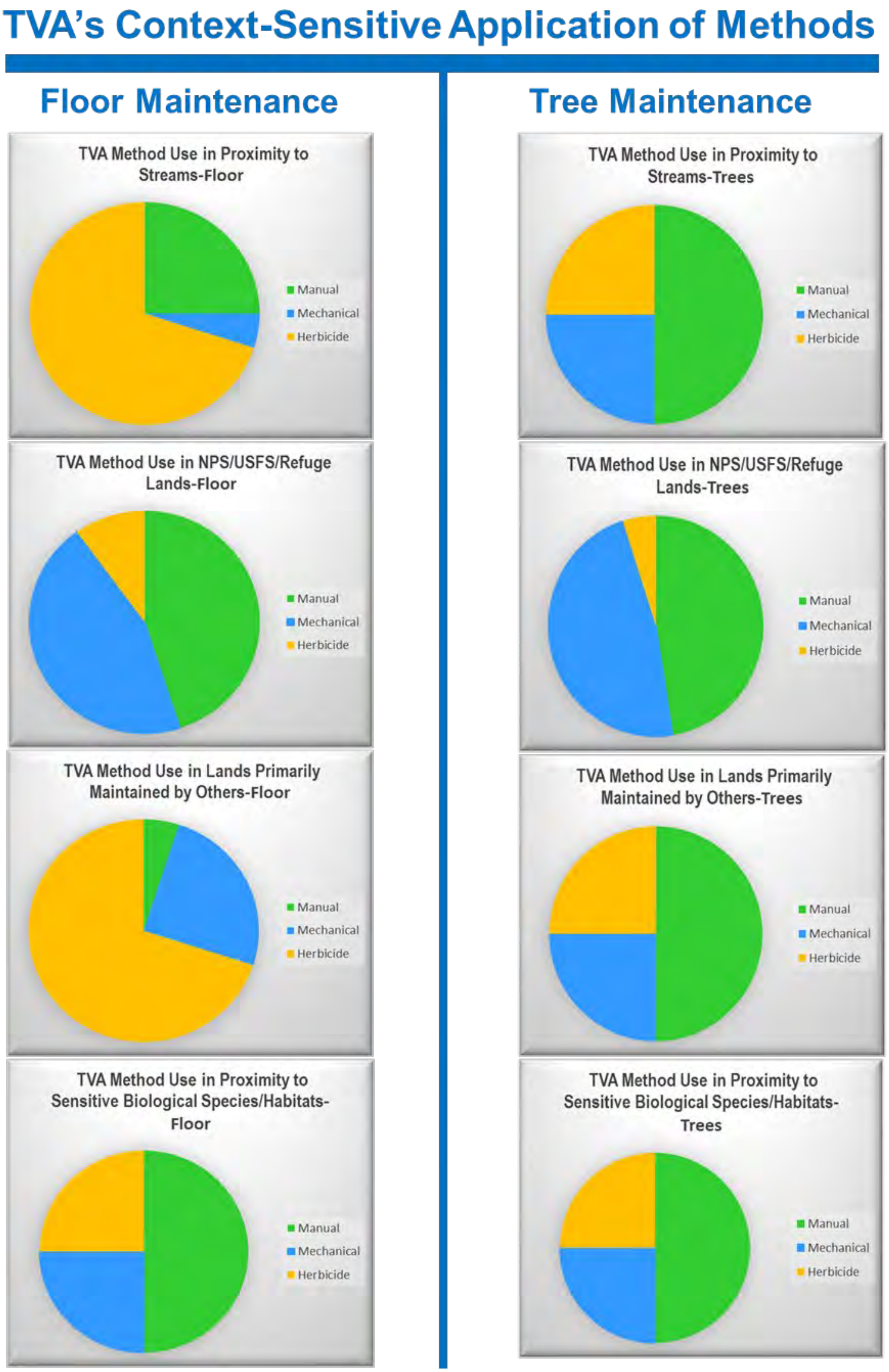


Figure 3-4. TVA's Context Sensitive Application of Vegetation Control Methods

Each of the four alternatives under consideration includes routine assessment methods to establish a basis for vegetation control measures. The assessment process is accomplished by a variety of methods including aerial inspections, ground inspections, as-needed field inspections, and information from TVA personnel, property owners, and the general public.

Another powerful assessment technique available to TVA is aerial three-dimensional imagery to map areas of the transmission ROW (Figure 3-5). This imagery is procured using aerial photography, remote sensing methods, photogrammetry, and Light Detection and Ranging (LIDAR) data. Using these techniques, the height of vegetation growing within the transmission ROW (wire and border) can be measured and assessed to determine its potential to be a current or near-term (i.e., 5 to 10 years depending on growth rate of individual species) threat to transmission lines or structures and thus, to reliability. TVA can use information obtained by these techniques to determine planning needs to conduct both routine and recurring vegetation maintenance and for identifying incompatible vegetation for removal.

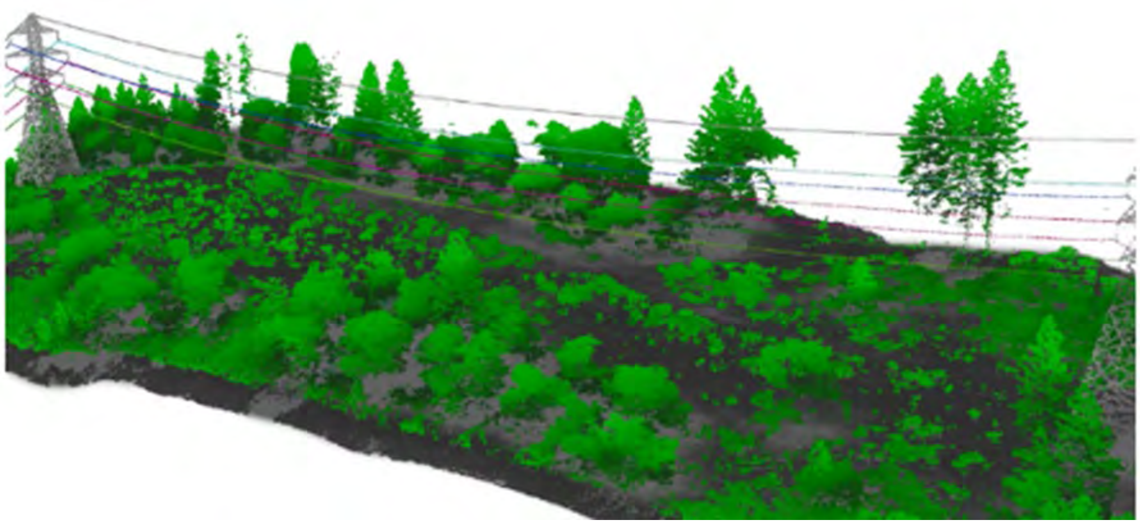


Figure 3-5. Illustration of Light Detection and Ranging Technology Along Transmission Line Right-of-Way

TVA developed four alternatives and two options for evaluation in this PEIS. Characteristics of each alternative are summarized in Table 3-2 and described in each of the following sections.

Table 3-2. Summary and Comparison of Vegetation Management Alternative Attributes

Attribute	Alternative A – No Action	Alternative B – Cyclical Based Control Strategy	Alternative C – Condition-Based Control Strategy – End-State Meadow-like[1], Except for Areas Actively Maintained by Others (Compatible Trees Allowed)[2]	Alternative D – Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone, Except for Areas Actively Maintained by Others (Compatible Trees Allowed) [2]
Elements of Purpose and Need				
Existing/Short-Term[3] Compliance with Safety and Reliability Standards.	Yes	Yes	Yes	Yes
Risk of Future/Long-Term[3] Non-compliance with Safety and Reliability Standards.	High—Increased risk of non-compliance due to reduced margin of clearance associated with removing immediate hazards only.	Low—enhances compliance with reliability standards.	Low—enhances compliance with reliability standards.	Low—enhances compliance with reliability standards.
Worker and Landowner Safety	Safety diminished due to long-term risks associated with manual processes required for individual tree removals Property owner safety diminished due to tree trimming.	Enhanced long-term by controlled vegetation maintenance	Enhanced long-term by controlled vegetation maintenance, but safety enhancement is slightly less than in Alternative B because some compatible trees would remain.	Enhanced long-term by controlled vegetation maintenance, but safety enhancement is slightly less than Alternative C due to higher concentration and increased duration of staff in the field (border zone[6] only).
Long-Term Cost Effectiveness	Low	High	High	Moderate

Attribute	Alternative A – No Action	Alternative B – Cyclical Based Control Strategy	Alternative C – Condition-Based Control Strategy – End-State Meadow-like[1], Except for Areas Actively Maintained by Others (Compatible Trees Allowed)[2]	Alternative D – Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone, Except for Areas Actively Maintained by Others (Compatible Trees Allowed) [2]
Management Strategy[4]				
Assessment Approach	Floor work—none. Tree work—risk based, data focused only on trees which meet the definition of “immediate hazard.”	Floor work—none (see below). Tree work—limited field assessment.	Floor work—none (see below). Tree work—Targeted evaluation with variety of inspection methods.	Floor work—Targeted evaluation with variety of inspection methods (border zone only). Tree work—Targeted evaluation with variety of inspection methods.
Methodology	Full Toolbox of Methods	Full Toolbox of Methods	Full Toolbox of Methods	Full Toolbox of Methods
Other Attributes				
Floor Work	Continue to manage previously cleared and managed areas within the ROW corridor using floor work practices.	Continue to manage previously cleared and managed areas within the ROW corridor using floor work practices – area would increase as previously forested areas are cleared in the short-term.	Continue to manage previously cleared and managed areas within the ROW corridor using floor work practices – area would increase as previously forested areas are cleared in the short-term.	Wire Zone: Continue to manage using floor work practices – area would increase as previously forested areas are cleared in the short-term Border Zone: Remove incompatible species only using limited floor work practices.
Tree Work	Limited to trees that meet the definition of “immediate hazard.”	Clearing of remainder of ROW corridor in the short-term, removal of vegetation that presents an immediate hazard, PLUS danger tree removal outside ROW. The assessment of whether a tree is a danger tree is limited to field evaluation. LIDAR would not be used.	Clearing of remainder of ROW corridor in the short-term, removal of vegetation that presents an immediate hazard PLUS danger tree removal outside ROW. TVA would use LIDAR to identify incompatible trees.	Clearing of remainder of ROW corridor in the short-term, removal of vegetation that presents an immediate hazard, PLUS danger tree removal outside ROW. TVA would use LIDAR to identify incompatible trees.

Attribute	Alternative A – No Action	Alternative B – Cyclical Based Control Strategy	Alternative C – Condition-Based Control Strategy – End-State Meadow-like[1], Except for Areas Actively Maintained by Others (Compatible Trees Allowed)[2]	Alternative D – Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone, Except for Areas Actively Maintained by Others (Compatible Trees Allowed) [2]
Implementation Frequency and Extent	Recurring (3 years typical), limited to existing cleared area of the ROW.	Recurring (3 years typical), full extent of ROW.	Assessment based targeted approach, potential for reduced frequency and extent in long-term.	Assessment based targeted approach, potential for reduced frequency and extent in long-term.
End-State within ROW	Variable composition plant community managed as existing state (low height condition) with removal of trees limited to those that are an immediate hazard.	Variable composition plant community managed to low height condition[7]	Promotes meadow-like state within ROW with lower composition of woody species. Some compatible trees in limited areas actively managed by others.	Promotes meadow-like state with lower composition of woody species in wire zone[5], compatible species of shrubs and trees in border zone. Some compatible trees in limited areas actively managed by others.
Landowner Management of Non-compatible Trees.	Yes, but only where TVA has previously allowed a given landowner to trim his or her own tree(s).	Not allowed, TVA to manage.	Not allowed, TVA to manage.	Not allowed, TVA to manage.

[1]Meadow-like state is defined as a vegetative state dominated by low-growing herbaceous and shrub-scrub species that naturally provide sufficient clearance.
[2]Areas actively maintained by others may include residential lands, orchards, forest plantations, agricultural lands or other similar areas.
[3]Short-Term – equivalent to initial eight-year period; Long-Term – beyond initial eight-year period.
[4]Management strategy requirements under memorandum of understanding (MOU) (e.g., for TVA ROW corridors that cross public lands managed by another federal agency) would remain in place.
[5]Wire zone is defined by TVA as the area within the ROW that is directly below the wires and expands outward in both directions until it meets the inside edge of the Border Zone (defined below). If a ROW does not have a Border Zone, the Wire Zone extends out to the full extent of the ROW (see Figure 1-6).
[6]Border zone is defined by TVA as the area measured from the outside edge of the ROW toward the centerline that would have been left as a “buffer” and not originally cleared as described in TVA’s 1997 and 2008 Line Maintenance Manual. The width of this area varies based upon ROW width, voltage, structure type, and height. Although this area would not have originally been cleared, trees that would present a hazard to the reliability of the transmission system would have initially been removed, as well as maintained in the future.
[7]Low height condition is one in which the physical height of the vegetation is maintained by various methods to a level consistent with that of an herbaceous plant community.

3.2.3.1 Alternative A – No Action Alternative

Under the No Action Alternative, there would be no change to the current process by which TVA manages vegetation along the transmission line ROW pursuant to the injunction entered in the *Sherwood v. TVA* lawsuit. Vegetated ROW buffer would not be removed under this alternative. Figure 3-6 illustrates the end-state of the ROW under the No Action Alternative for a typical transmission ROW. This vegetation management process is prescribed by the court injunction order currently in place in the *Sherwood v. TVA* litigation. Under the Order, TVA must leave existing trees in the maintained area of the ROW so long as they do not pose an immediate hazard to the transmission lines or structures. Additionally, TVA may remove or trim any tree in the previously maintained areas of ROW, or in the non-maintained areas of ROW, or any danger tree outside the transmission ROW, in accordance with its contract rights, that TVA deems to present an immediate hazard to its transmission line or structures. Tree work in remaining buffer areas would be limited as follows (subject to the terms of the court-ordered injunction, which states that any ROWs not already cleared to the extent of the ROW easement cannot currently be maintained to the easement widths):

• 500 kV transmission line.	200-foot-wide ROW.	Clear and maintain a 150-foot-wide center area and leave a 25-foot-wide non-maintained area on each side of the maintained area.
• 500 kV transmission line.	175-foot-wide ROW.	Clear and maintain a 150-foot-wide center area and leave a 12.5-foot-wide non-maintained area on each side of the maintained area.
• 161 kV transmission line.	150-foot-wide ROW.	Clear and maintain a 100-foot-wide center area and leave a 25-foot-wide non-maintained area on each side of the maintained area.
• 161 kV transmission line.	100-foot-wide ROW.	Clear and maintain the entire 100-foot-wide ROW.
• 161 kV transmission line.	75-foot-wide ROW.	Clear and maintain the entire 75-foot-wide ROW.
• 69 kV transmission line.	75-foot-wide ROW.	Clear and maintain the entire 75-foot-wide ROW.

Floor work would continue to be managed on a nominal three-year cycle in previously cleared areas.

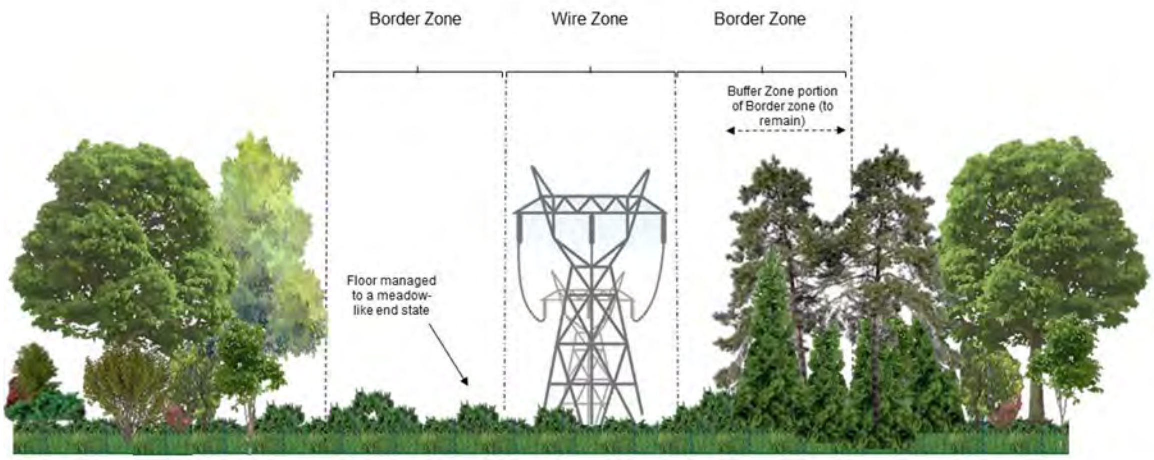


Figure 3-6. Illustration of a Typical Right-of-Way Under the No Action Alternative

As a result, buffer zones within the existing ROW continue to contain vegetation incompatible with TVAs transmission system. The volume of non-compatible woody vegetation is also increasing within the previously-cleared ROWs due to the court injunction order. The No Action Alternative does not adequately address the potential for service outages from trees growing into the line, falling into the line, or creating a fire hazard to the transmission lines and structures and as such creates an increasing risk to reliability. The No Action Alternative also does not adequately address the risk to public safety that can stem from wildfires caused by power lines. In addition, this approach would lead to a marked increase in worker safety concerns, due to the increased risk of serious injuries and fatalities associated with the increased need to undertake manual removal of large danger trees. The net present value (NPV) of the cost to maintain the transmission ROW for the next 20 years under the No Action Alternative is estimated to be approximately $205 million. The cost for initial buffer zone vegetation removal is not included under this alternative, as it is in all of the other alternatives, as that action is not permitted under the injunction. The cost to maintain the floor remains constant assuming an annual inflation rate of 2.5 percent. However, tree work costs are higher for this alternative and would increase over time due to the inefficiencies inherent in removal of only immediate hazard trees, as opposed to removal of all incompatible trees during the vegetation maintenance activity. This increase would be a direct result of continued vegetation growth until the vegetation grows sufficiently to meet the definition of immediate hazard, which would necessitate addressing that imminent hazard in the next maintenance cycle. In addition, the increased costs include management of new trees that sprout and grow as a result of the less aggressive vegetation maintenance under the injunction.

Consequently, this alternative would not satisfy the project purpose and need and, therefore, is not considered a viable or reasonable vegetation management alternative. It does, however, provide a benchmark for comparing the environmental impacts of implementation of Alternatives B, C and D.

3.2.3.2 Alternative B – Cyclical Based Control Strategy

Under Alternative B, the full extent of the transmission ROW subject to TVA vegetation management would be cleared on a recurring cycle (typically every 3 years) to ensure that vegetation would not threaten transmission lines or structures until the next cycle of treatment. Removal of all buffer vegetation (see Figure 1-6) would be conducted under this alternative using a mix of mechanical (about 85 percent) and manual (about 15 percent) methods. Figure 3-7 illustrates the end-state of the transmission ROW under Alternative B for a typical ROW. Vegetation within the floor of the ROW on lands primarily managed by TVA would be controlled using a mix of approximately 90 percent herbicide, 6 percent mechanical and 4 percent manual methods. However, under this alternative TVA would continue to use a context sensitive approach to tool selection for vegetation maintenance as summarized in Figure 3-4. All vegetation with the potential to interfere with the safe and reliable operation of the transmission system would be removed using a combination of mechanical or manual methods depending on the specific site condition. TVA would continue to use all assessment techniques under Alternative B except LIDAR.

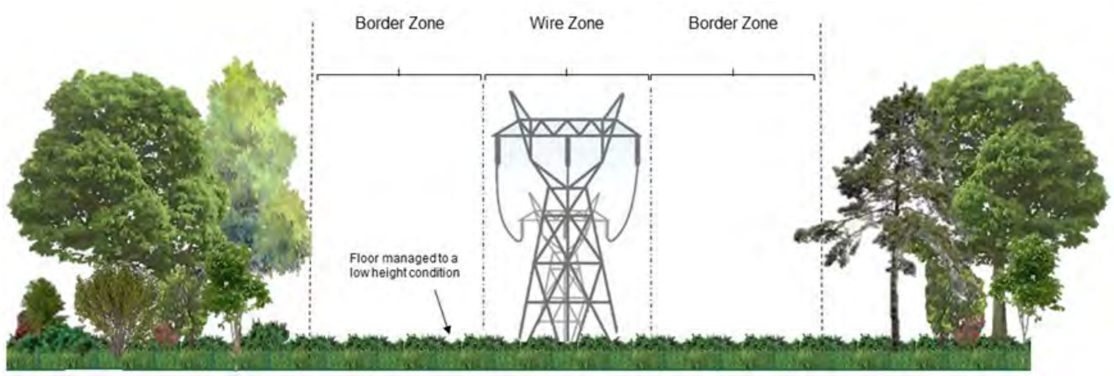


Figure 3-7. Illustration of a Typical Right-of-Way under Alternative B

Because no LIDAR assessment would be used under this alternative, incompatible vegetation would be determined by field inspections. During a ground inspection, the transmission ROW would be visually evaluated to identify vegetation that could interfere with the safe and reliable operation of the transmission system. The process first would require the inspector to visually identify a potential threat and then to utilize a range finder to measure the clearance between the transmission line and the vegetation to confirm its status. The clearance would be measured in the field against the closest point in the transmission line at its current state. The field inspector would then attempt to estimate any potential change in vertical or horizontal positioning of the transmission line from thermal (ambient heat dissipation of the electricity in line from wind velocity/direction, ambient air temperature and precipitation) or physical loading (factors such as ice and wind loading that affect sag and sway of the line). to determine a final clearance estimate. Such manual measurements would be subject to human error. In addition, due to the yearly volume of transmission lines to be inspected and the allotted timeframe, the inspections would be performed by multiple inspectors – leading to potential inconsistencies due to subjectivity in evaluation. Although ground inspection provides another perspective of the conditions, it is

Example of a cleared buffer and “end-state” of low height condition vegetation within the ROW under Action Alternative B. (Photo Credit: USFS 2017) limited to the individual inspector's ability to identify potential threats while navigating the diverse terrain, dealing with environmental factors and coordinating with property owners.

TVA previously has allowed property owners to maintain trees on their property within the transmission ROW. However, this practice is unsafe for the landowner as well as for the reliability of the transmission system because implementation, timing and consistency of owner maintenance can be unreliable. Accordingly, this practice would no longer be allowed under this alternative.

The NPV of the cost to maintain the transmission ROW for the next 20 years under Alternative B is estimated to be approximately $169 million. The cost to maintain the floor remains constant assuming an annual inflation rate of 2.5 percent. This cost estimate assumes that trees that threaten reliability of the transmission system would be identified by field inspection in lieu of LIDAR, which reduces cost but increases the risk of missing a higher priority threat, compared to a LIDAR inspection. As such, costs are strictly budget-based and may be underestimated for this alternative as this estimate does not address danger trees outside of the transmission ROW.

3.2.3.3 Alternative C – Condition-Based Control Strategy – End-State Meadow-like, Except for Areas Actively Maintained by Others (Compatible Trees Allowed)

Under Alternative C, TVA would implement a process of vegetation community conversion within the full extent of the transmission ROW actively maintained by TVA. TVA would use an IVM approach to promote the establishment of a plant community dominated by low-growing herbaceous and shrub-scrub species that do not interfere with the safe and reliable operation of the transmission system. The goal of this vegetation management alternative would be to allow compatible vegetation to establish and propagate to reduce the presence of woody species. TVA would continue to use all assessment techniques, including LIDAR.

Removal of all buffer vegetation (the buffer zone is a subset of the border zone, see Figure 1-6) would be conducted under this alternative using a mix of mechanical (about 85 percent) and manual (about 15 percent) methods. Figure 3-8 illustrates end-state of the transmission ROW under Alternative C for a typical ROW.

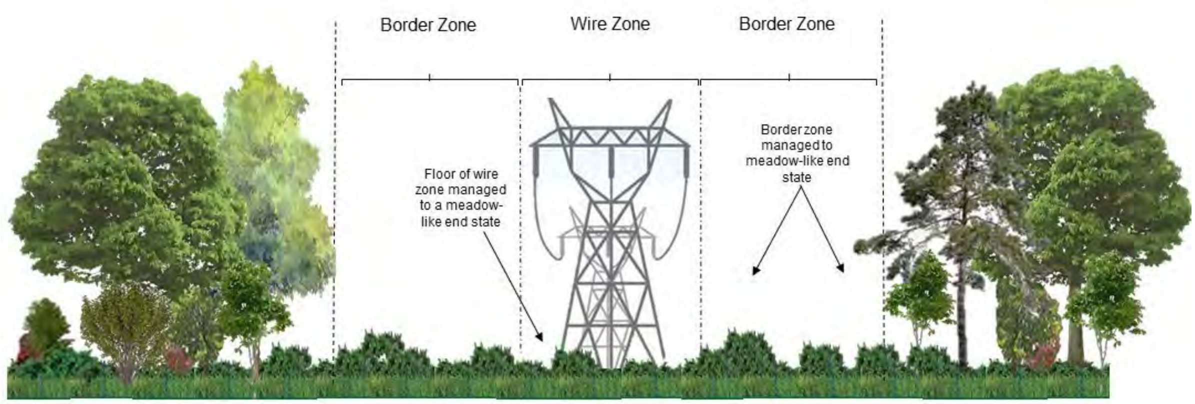


Figure 3-8. Illustration of a Typical Right-of-Way Under Alternative C

Routine vegetation management includes the identification and removal of vegetation within the transmission ROW incompatible with TVA's desired end-state condition. Within transmission ROWs primarily maintained by TVA, floor work would continue on an established cycle and in general, vegetation within the ROW would be controlled using a mix of approximately 90 percent herbicide, 6 percent mechanical and 4 percent manual methods. All danger trees would be removed using a combination of mechanical or manual methods depending on the specific site conditions. However, under this alternative, TVA would continue to use a context sensitive approach to tool selection for vegetation maintenance as summarized in Figure 3-4.

Example of desired "end-state" condition of low growing compatible vegetation in ROW. This corridor maintained by herbicide treatment.
(Photo Credit: USFS 2017)

In the long-run, the frequency of vegetation maintenance within the entire transmission system may be the same as under Alternative B because the continual growth of vegetation will require routine management. However, Alternative C is expected to result in the establishment of a stable, low-growing plant community that would reduce the intensity of vegetation control once the desired end-state in each location has been achieved.

Under this alternative TVA would have the option to allow compatible trees to remain in areas actively maintained by others (such as residential lands, orchards, forest plantations, agricultural lands or other similar areas). Compatible species of trees and shrubs are listed in Appendix H.

The maintenance of trees in these areas would be optimized with the use of various inspection methods. These methods include aerial patrols, ground patrols, photogrammetry, and LIDAR surveys to identify the extent of any tree removal needed. These tools allow TVA to implement a targeted approach through the identification of categories that define the risk and removal of trees in these areas.

All danger trees would be removed using a combination of mechanical and manual methods depending on site-specific conditions.

The NPV of the cost to maintain the transmission ROW for the next 20 years under this alternative is estimated to be approximately $180 million. The cost to maintain the floor remains constant assuming an annual inflation rate of 2.5 percent. The cost of maintaining the transmission ROW under a condition-based strategy would potentially be higher than Alternative B in the near-term. This is because vegetation would most likely need to be controlled more often until low-growing plant communities are established. In the long-term, however, it would be less expensive to maintain the transmission ROW under this alternative because less initial vegetation removal would be needed.

3.2.3.4 Alternative D – Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone, Except for Areas Actively Maintained by Others (Compatible Trees Allowed)

Under Alternative D, TVA would manage vegetation within the transmission ROW using a wire zone/border zone approach. This alternative was formulated based upon input during the scoping process. As with Alternative C, TVA would implement a process of vegetation community conversion within the transmission ROW wire zone using an IVM approach. This alternative would promote the establishment of low-growing compatible herbaceous and shrub-scrub dominated plant communities that do not interfere with the safe and reliable operation of the transmission system. However, under Alternative D, the buffer zone would be allowed to redevelop with compatible species of shrubs and trees. The goal of this vegetation management alternative is to promote a soft or "feathered" edge which could be used to provide a transition from forested habitat into the meadow-like habitat of the wire zone. Figure 3-9 illustrates the end-state of the transmission ROW under this alternative for a typical transmission ROW. TVA would continue to use all assessment techniques under Alternative D including LIDAR.

Removal of all buffer vegetation would be conducted under this alternative using a mix of mechanical (about 85 percent) and manual (about 15 percent) methods.

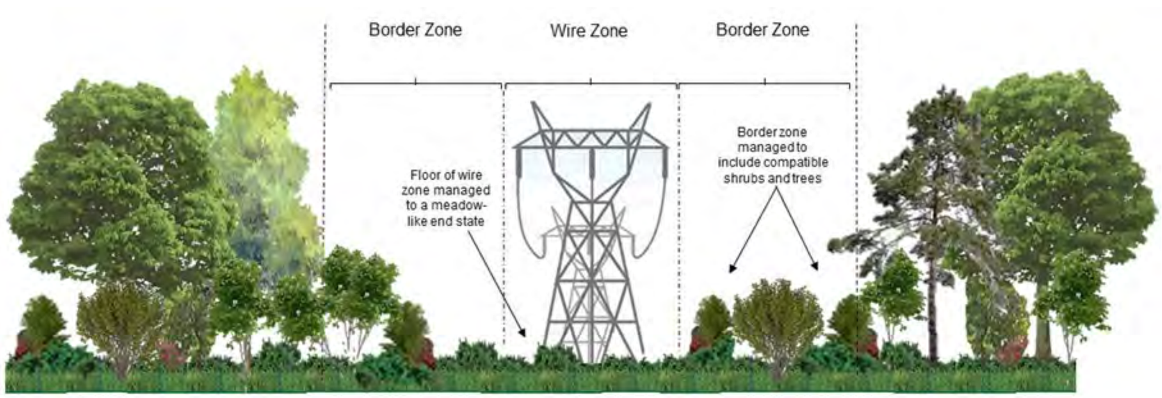


Figure 3-9. Illustration of a Typical Right-of-Way Under Alternative D

Routine vegetation maintenance would include identification and removal of incompatible vegetation within the transmission ROW to achieve the desired end-state condition. Within lands primarily maintained by TVA, floor work would continue on an established cycle and in general, vegetation within the transmission ROW would be controlled using a mix of approximately 90 percent herbicide, 6 percent mechanical and 4 percent manual methods. However, under this alternative TVA would continue to use a context sensitive approach to tool selection for vegetation management as summarized in Figure 3-4.

Under this alternative, TVA would allow compatible trees to remain in areas actively maintained by others (such as residential lands, orchards, forest plantations, agricultural lands or other similar areas).

Management of trees in these areas would be optimized with the use of various inspection methods including aerial patrols, ground patrols, photogrammetry, and LIDAR surveys to identify the extent of tree removal needed. These tools would provide information which would allow TVA to implement a targeted approach through the identification of categories that define the risk and accordingly the need for removal of trees in these areas.

All danger trees would be removed using a combination of mechanical and manual methods depending on site-specific conditions.

The NPV of the cost to maintain the transmission ROW for the next 20 years under this alternative is estimated to be approximately $223 million. The cost of this alternative is greater than Alternative C because of the increased effort required by field crews to include staff trained to identify plant species that require selective control based on species composition and growth form.

3.3 Comparison of Management Alternatives

The environmental impacts of each of the management alternatives under consideration are summarized in Table 3-3. These summaries are derived from the information and analyses vegetation maintenance methods provided in the Affected Environment and Environmental Consequences sections for each resource in Chapter 4 as applied to the broader management alternative for TVA's transmission system.

3.4 TVA's Preferred Alternative

TVA's preferred alternative is Alternative C, which would include implementing a process of vegetation community conversion within the full extent of the actively managed transmission ROW. This alternative is considered to provide the best balance in enhancing system reliability and safety, minimization of environmental impacts, and striving for cost effectiveness.

Vegetation management under this alternative would be accomplished with an IVM approach to promote the establishment of a low-growing herbaceous plant community compatible with the safe and reliable operation of the transmission system. This alternative would entail the initial removal of vegetation to the full width of the existing ROW easement over the first eight years of the program. Removal would target trees and woody vegetation that either remained or have regrown within the transmission ROW since construction. Only three percent of the total ROW (8,094 of the total 238,196 acres of ROW) would require initial woody vegetation removal. All areas within the transmission ROW thereafter would be managed as floor. TVA would also use an approach that is condition based for identification and removal of danger trees that would use LIDAR and other assessment techniques.

Routine vegetation maintenance would include identification and removal of vegetation within the transmission ROW that is incompatible with TVA's desired end-state condition. Within lands primarily managed by TVA, floor work would continue on an established cycle. The resulting end-state, consisting of a mix of herbaceous and low-growing shrub species, is more compatible and is expected to provide improved habitat value that over time is expected to minimize intensity of maintaining the floor.

Under Alternative C there would be greater coordination and interaction with local landowners to identify compatible vegetation. TVA would work with local property owners to evaluate the compatibility of vegetation within or near the transmission ROW. Vegetation compatible with the safe and reliable operation of the transmission system may be allowed to remain within the ROW. Relative to the No Action Alternative, this alternative would enhance compliance with reliability standards.

Impacts associated with this alternative primarily include temporary short-term impacts during vegetation maintenance activities to most natural resources. Initial removal of buffer zones would result in notable but not destabilizing effects on forest resources and associated wildlife. Because vegetation removal activities would be conducted within the buffer zone of the previously established ROW, the overall effect of this alternative on vegetation is considered to be moderate as both the routine maintenance of vegetation and removal of the existing buffer zones would not destabilize the general plant communities within the study area. Long-term impacts of this management alternative are related to loss of forested land and associated wildlife habitat and carbon sequestration capacity as well as the impacts related to the repeated disturbance within the ROW.

The effects of Alternative C include both short-term and long-term impacts; however, sound planning and the incorporation of TVA's O-SAR process and other BMP measures would avoid and minimize long-term impacts. Alternative C provides benefits in terms of habitat quality and management intensity based on differences in the end-state. Because habitat alteration associated with initial woody vegetation removal is considered to be notable but not destabilizing of the associated resources, impacts to wildlife, forested land cover and related factors remain moderate under this alternative.

Impacts on factors related to the human environment (land use, socioeconomics, air, noise, cultural resources, solid/hazardous waste, public and worker safety, etc.) are generally considered to be localized and temporary. TVA would not allow homeowners to maintain incompatible vegetation within and along the transmission ROW. Consequently, this alternative reduces the risk to homeowners' safety.

3.5 Summary of Mitigation Measures

Mitigation measures identified in Chapter 4 to avoid, minimize, or reduce adverse impacts to the environment are summarized below. Any additional project-specific mitigation measures, such as avoiding areas identified from desktop reviews as having a high probability of any sensitive resources, would be identified on a site-specific basis.

TVA has prepared comprehensive standard BMPs that represent mitigation measures that are effective in avoiding, minimizing, rectifying and compensating for effects of vegetation management activities. These BMPs are detailed in TVA's guide for environmental and best management practices (TVA 2017a). Topics addressed in this manual include the following:

- Best Management Practices for Construction and Maintenance Activities including Vegetation Management.
- Sensitive Resources and Buffer Zones.
- Structural Controls, Standards and Specifications.
- Seeding/Stabilization Techniques.
- Practices and procedures are provided that directly relate to the vegetation management activities including initial woody vegetation removal, good housekeeping, waste disposal, herbicide use, and stormwater discharge management.
- Integration of TVA's O-SAR process as described in Section 3.1.2.

Table 3-3. Summary and Comparison of Management Alternatives by Resource Area

Alternative A – No Action	Alternative B – Cyclical Based Control Strategy	Alternative C – Condition-Based Control Strategy – End-State Meadow-Like	Alternative D – Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone
Cost			
Total Cost (NPV) to Maintain for 20 Years			
$205 million	$169 million	$180 million	$223 million
Long-Term Cost (NPV)(Years 9-20)			
$109 million	$67 million	$72 million	$92 million
Reliability			
Increased risk of non-compliance with reliability standards.	Enhances compliance with reliability standards.	Enhances compliance with reliability standards.	Enhances compliance with reliability standards.
Vegetation			
No change in baseline condition. Positive impact in the short-term as ROW buffer would not be removed and only trees that would present an immediate hazard to the reliability of the transmission system would be removed.	Moderate impact to vegetation associated with the direct loss of forest lands; floor maintained as low-growing herbaceous communities.	Impact to vegetation associated with the direct loss of forest lands. Impact would be moderate, yet less than Alternative B as floor vegetation would be managed to a meadow-like state.	Impact to vegetation associated with the direct loss of forest lands. Impact would be moderate, yet less than Alternatives B and C as the border zone would be managed to allow re-growth of compatible shrubs and trees.
Wildlife			
No change in baseline condition Positive impact in the short-term as ROW buffer would not be removed and only trees that would present an immediate	Short-term impact to wildlife as a result of initial vegetation removal. Habitat alteration associated with initial vegetation removal is notably greater than under Alternative A but should not	Short-term impact to wildlife as a result of initial vegetation removal. Long-term impact associated with habitat alteration would be moderate, yet less than Alternative B as floor would be managed to a meadow-like state, which would be of greater value	Short-term impact to wildlife as a result of initial vegetation removal. Long-term impact associated with habitat alteration would be moderate, yet less than Alternatives B and C as the border zone would be managed to allow re-growth of compatible shrubs and trees,

Alternative A – No Action	Alternative B – Cyclical Based Control Strategy	Alternative C – Condition-Based Control Strategy – End-State Meadow-Like	Alternative D – Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone
hazard to the reliability of the transmission system would be removed.	destabilize associated resources. Therefore, impacts are considered to be moderate.	to wildlife.	which would provide marginally improved habitat for wildlife.
Threatened and Endangered Species			
No change in baseline condition Positive impact in the short-term as ROW buffer would not be removed, and only trees that would present an immediate hazard to the reliability of the transmission system would be removed. Impact to threatened and endangered species would be minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures in the TVA's ESA consultations and applicable BMPs.	Potential short-term and long-term impacts to threatened and endangered species/habitats as a result of vegetation management. Impact to threatened and endangered species would be minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures in the TVA's ESA consultations and applicable BMPs.	Potential short-term and long-term impacts to threatened and endangered species/habitats as a result of vegetation management. Impacts to threatened and endangered species would be minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures in TVA's ESA consultations and applicable BMPs.	Potential short-term and long-term impact to threatened and endangered species/ habitats as a result of vegetation management. Impacts to threatened and endangered species would be minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures in TVA's ESA consultations and applicable BMPs.
Surface Water			
No change in baseline condition.	Short-term minor impact associated with runoff and sedimentation during initial vegetation removal. Long-term minor impact related to runoff and sedimentation	Short-term minor impact associated with runoff and sedimentation during initial vegetation removal. Long-term impact related to runoff and sedimentation during cyclical vegetation management would be	Short-term minor impact associated with runoff and sedimentation during initial vegetation removal. Long-term impact related to runoff and sedimentation during floor vegetation management would be less than

Alternative A – No Action	Alternative B – Cyclical Based Control Strategy	Alternative C – Condition-Based Control Strategy – End-State Meadow-Like	Alternative D – Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone
	during cyclical vegetation management would be greater due to more total floor acreage than Alternative A.	greater than Alternative A due to more total floor acreage. However, impacts would be less than Alternative B as once ROW is cleared, end-state ROW vegetation management may be less disruptive.	Alternatives B and C due to smaller floor as vegetation within the buffer zone is allowed to redevelop.
Aquatic Biology			
No change in baseline condition.	Short-term impact associated with loss of tree cover and runoff and sedimentation during initial vegetation removal. Long-term impact associated with sedimentation and erosion as a result of cyclical vegetation management. Impact to aquatic biota avoided or minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures and BMPs. Therefore impact would be minor.	Short-term impact associated with loss of tree cover and runoff and sedimentation during initial vegetation removal. Long-term impact associated with sedimentation during ROW vegetation management. However, impacts would be less than Alternative B as once cleared, end-state ROW vegetation management would be less disruptive. Impact to aquatic biota avoided or minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures and BMPs.	Short-term impact associated with loss of tree cover and runoff and sedimentation during initial vegetation removal. Long-term impact associated with sedimentation during floor vegetation management would be less than Alternatives B and C due to smaller floor as vegetation within the buffer zone is allowed to redevelop. Impact to aquatic biota avoided or minimized through the use of TVA's O-SAR process and adherence to avoidance and minimization measures and BMPs.
Wetlands			
No change in baseline condition.	Short-term impact associated with loss of tree cover and runoff and sedimentation during initial vegetation removal. Long-term impact associated with modification of wetland type and function. Indirect impact resulting from	Short-term impact associated with loss of tree cover and runoff and sedimentation during initial vegetation removal. Long-term impact associated with modification of wetland type and function. Long-term indirect impacts associated	Short-term impact associated with loss of tree cover and runoff and sedimentation during initial vegetation removal. Long-term impact associated with modification of wetland type and function. Long-term indirect impacts associated with sedimentation during floor vegetation management would be less than

Alternative A – No Action	Alternative B – Cyclical Based Control Strategy	Alternative C – Condition-Based Control Strategy – End-State Meadow-Like	Alternative D – Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone
	sedimentation and erosion as a result of cyclical vegetation management. Impact minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs. Therefore impact would be minor.	with sedimentation during floor vegetation management. However, impacts would be less than Alternative B as once cleared, end-state ROW vegetation management would be less intensive. Impact minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs.	Alternatives B and C due to smaller floor as vegetation within the buffer zone is allowed to redevelop. Impact minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs.
Floodplains			
No change in baseline condition.	Potential for floodplain impacts due to vegetation removal and debris.	Potential for floodplain impacts due to vegetation removal and debris.	Potential for floodplain impacts due to vegetation removal and debris.
Geology, Groundwater and Soils			
No change in baseline condition.	Short-term impact associated with limited potential for soil disturbance and erosion during mechanized initial vegetation removal. Increased, albeit limited, potential for soil disturbance and erosion as a result of cyclical vegetation management of the ROW would be minor, yet greater than Alternative A due to more total floor acreage than Alternative A.	Short-term impact associated with limited potential for soil disturbance and erosion during initial vegetation removal. Increased, albeit limited, potential for soil disturbance and erosion in the long-term as a result of vegetation management of the ROW. However, impacts would be less than Alternative B as once cleared, end-state ROW vegetation management would be less intensive.	Short-term impact associated with limited potential for soil disturbance and erosion during initial vegetation removal. Increased, albeit limited, potential for soil disturbance and erosion in the long-term as a result of vegetation management of the ROW. However, impacts would be less than Alternatives B and C as once cleared, ROW vegetation management would be less intensive and the floor area would be smaller as vegetation within the buffer zone is allowed to redevelop.
Land Use and Prime Farmland			
No impact.	Minor potential impact.	Minor potential impact.	Minor potential impact.

Alternative A – No Action	Alternative B – Cyclical Based Control Strategy	Alternative C – Condition-Based Control Strategy – End-State Meadow-Like	Alternative D – Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone
Land Ownership/Management			
No impact.	No impact.	No impact. However, TVA incurs an increased risk of landowners planting incompatible vegetation.	No impact. However, TVA incurs an increased risk of landowners planting incompatible vegetation.
Natural and Managed Areas			
No change in baseline condition.	Short-term impact associated with change in habitat and disruption as a result of initial vegetation removal. Increased impact during cyclical vegetation management relative to Alternative A due to more total floor acreage than Alternative A. Impact minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs. Therefore impact would be minor.	Short-term impact associated with change in habitat and disruption as a result of initial vegetation removal. Impact during ROW vegetation management would be less than Alternative B as once ROW is cleared, the end-state ROW vegetation management would be less intensive. Impact minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs.	Short-term impact associated with change in habitat and disruption during initial vegetation removal. Impact during ROW vegetation management would be less than Alternatives B and C as once ROW is cleared, ROW vegetation management would be less intensive, and the floor area would be smaller as vegetation within the buffer zone is allowed to redevelop. Impact minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs.
Parks			
No change in baseline condition.	Short-term impact associated with disruption in use as a result of initial vegetation removal. Impact as a result of vegetation management would be the same as Alternative A.	Short-term impact associated with disruption in use as a result of initial vegetation removal. Impact as a result of vegetation management would be less than Alternative B as once ROW is cleared, the end-state ROW vegetation management would be less intensive.	Short-term impact associated with disruption in use as a result of initial vegetation removal. Impact during ROW vegetation management would be less than Alternatives B and C as once ROW is cleared, ROW vegetation management would be less intensive, and the floor area would be smaller as vegetation within the buffer zone is allowed to redevelop.

Alternative A – No Action	Alternative B – Cyclical Based Control Strategy	Alternative C – Condition-Based Control Strategy – End-State Meadow-Like	Alternative D – Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone
Cultural Resources			
No change in baseline condition.	Limited potential for impact to cultural resources during initial vegetation removal. In limited cases where impacts exist during ROW vegetation management, those impacts would be minimized through adherence to BMPs and Section 106 or program alternative, such as the PA, where applicable.	Limited potential for impact to cultural resources during initial vegetation removal. Provides flexibility in the improvement and management of visual quality of historic properties such as the Congressionally designated Trail of Tears National Historic Trail. In limited cases where impacts exist during ROW vegetation management, those impacts would be minimized through adherence to BMPs and Section 106 or program alternative, such as the PA, where applicable.	Limited potential for impact to cultural resources during initial vegetation removal. Provides flexibility in the improvement and management of visual quality of historic properties such as the Congressionally designated Trail of Tears National Historic Trail. In limited cases where impacts exist during ROW vegetation management, those impacts would be minimized through adherence to BMPs and Section 106 or program alternative, such as the PA, where applicable.
Visual Resources			
No change in baseline condition. Positive impact in the short-term as ROW buffer would not be removed and only trees that would present an immediate hazard to the reliability of the transmission system would be removed.	Potential for impact to the viewscape during initial vegetation removal. Increased short-term impacts during cyclical vegetation management relative to Alternative A due to more total floor acreage than Alternative A. Impacts avoided or minimized through the use of TVA's O-SAR process and adherence to mitigation measures and BMPs. Therefore impacts would be minor.	Potential for impact to the viewscape during initial vegetation removal. Impact during ROW vegetation management would be less than Alternative B as once ROW is cleared, end-state ROW vegetation management would be less intensive, and the ROW would be managed to a meadow-like state.	Potential for impact to the viewscape during initial vegetation removal. Impact during ROW vegetation management would be less than Alternatives B and C as once ROW is cleared, ROW vegetation management would be less intensive and the floor area would be smaller as vegetation within the buffer zone would be managed to allow re-growth of compatible shrubs and trees.
Health and Safety			
Reduced risk to workers	Minor increase in worker health	Minor increase in worker health and	Minor increase in worker health and safety

Alternative A – No Action	Alternative B – Cyclical Based Control Strategy	Alternative C – Condition-Based Control Strategy – End-State Meadow-Like	Alternative D – Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone
solely by virtue of having fewer workers in the short-term as initial vegetation removal would not be conducted. Short- and long-term safety diminished for those who are working due to risks associated with manual processes required for individual tree removals. Property owner safety diminished due to tree trimming.	and safety associated with initial vegetation removal. Minor impact associated with long-term increase in potential impacts to worker safety during cyclical vegetation management due to increase in man hours relative to Alternatives C and D. Enhanced property owner safety due to TVA controlled vegetation management.	safety associated with initial vegetation removal. Enhanced worker safety in the long-term by controlled vegetation management but safety enhancement is slightly less because some compatible trees would remain. Enhanced property owner safety due to TVA controlled vegetation management.	associated with initial vegetation removal. Enhanced worker safety in the long-term by controlled vegetation management but safety enhancement is slightly less because some compatible trees would remain. Worker safety reduced compared to Alternatives B and C due to higher concentration and increased duration of staff in the field (border zone only). Enhanced property owner safety due to TVA controlled vegetation management.
Solid and Hazardous Waste			
No change in baseline condition.	Increase in solid and hazardous wastes associated with initial vegetation removal. Minor impacts during cyclical vegetation management relative to Alternative A due to more total floor acreage than Alternative A.	Increase in solid and hazardous wastes associated with initial vegetation removal. Impact during ROW vegetation management would be less than Alternative B as once ROW is cleared, end-state ROW vegetation manage-ment would be less intensive.	Increase in solid and hazardous wastes associated with initial vegetation removal. Impact during ROW vegetation management would be less than Alternatives B and C as once ROW is cleared, ROW vegetation management would be less intensive, and the floor area would be smaller as buffer areas would be managed to allow re-growth of compatible shrubs and trees.
Transportation			
No change in baseline condition.	Minor impact to transportation system as a result of additional vehicles and transportation of machinery needed to support	Minor impact to transportation system as a result of additional vehicles and transportation of machinery needed to support initial vegetation removal.	Minor impact to transportation system as a result of additional vehicles and transportation of machinery needed to support initial vegetation removal.

Alternative A – No Action	Alternative B – Cyclical Based Control Strategy	Alternative C – Condition-Based Control Strategy – End-State Meadow-Like	Alternative D – Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone
	initial vegetation removal. Impacts to transportation during cyclical vegetation management would be negligible.	Impacts to transportation during end-state ROW vegetation management would be negligible.	Impacts to transportation during end-state ROW vegetation management would be negligible.
Air Quality and Climate Change			
No change in baseline condition.	Potential for minor impacts during initial vegetation removal. Increased minor, short-term temporary impacts during cyclical vegetation management relative to Alternative A due to more total floor acreage than Alternative A. Long-term loss of carbon sequestration capacity due to loss of forested buffer. Would not impact regional climate change.	Potential for minor impacts during initial vegetation removal. Increased impacts during end-state ROW vegetation management would be less than Alternative B as ROW vegetation management would be less intensive. Long-term loss of carbon sequestration capacity due to loss of forested buffer.	Potential for minor impacts during initial vegetation removal. Increased impacts during end-state ROW vegetation management would be less than Alternatives B and C as ROW vegetation management would be less intensive and floor areas would be smaller. Long-term loss of carbon sequestration capacity due to loss of forested buffer.
Noise			
No change in baseline condition.	Increased minor short-term temporary impacts during cyclical vegetation management relative to Alternative A. Increased short-term temporary impacts during cyclical vegetation management relative to Alternative A due to more total floor acreage than Alternative A.	Potential for minor impacts during initial vegetation removal. Increased impacts during end-state ROW vegetation management would be less than Alternative B as ROW vegetation management would be less intensive.	Potential for minor impacts during initial vegetation removal. Increased impacts during end-state ROW vegetation management would be less than Alternatives B and C as ROW vegetation management would be less intensive and floor areas would be smaller.
Socioeconomics and Environmental Justice			
No impact.	No impact.	No impact.	No impact.

Alternative A – No Action	Alternative B – Cyclical Based Control Strategy	Alternative C – Condition-Based Control Strategy – End-State Meadow-Like	Alternative D – Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone
Cumulative Effects			
Impact of land cover alteration associated with the development of new transmission ROW. Minor cumulative impact relative to context of the study area.	Cumulative effects to vegetation as a result of ongoing transmission corridor vegetation management and actions by others within the study area are expected to be the same as those under Alternative A.	Incremental benefits to habitat are negligible given the context of the study area.	Incremental benefits to habitat are negligible given the context of the study area.

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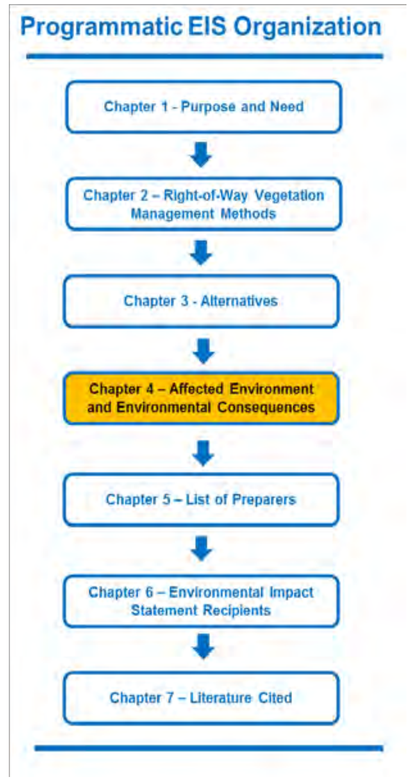
CHAPTER 4 – AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES



This chapter provides a description of the potentially affected environmental resources of the study area and the general impacts of vegetation control. Impacts specific to the methods of vegetation control (identified in Chapter 2) are identified and a summary comparison of impacts is presented. Impacts related to each of the management alternatives under consideration are also identified in Chapter 4. A summary comparison of the impacts of each management alternative is included in Chapter 3.

4.1 Vegetation

4.1.1 Affected Environment

4.1.1.1 Ecoregions

The study area for the proposed TVA PEIS is divided into nine distinct Level III ecoregions as described by Omernik (1987). Terrain, plant communities, and associated wildlife habitats in these ecoregions vary from bottomland hardwood and cypress swamps in the floodplains of the Mississippi Alluvial Plain to high elevation balds and spruce-fir and northern hardwood forests in the Blue Ridge. About 3,500 species of herbs, shrubs and trees occur within the TVA study area (Ricketts et al. 1999; Tennessee Wildlife Resources Agency [TWRA] 2005). Although many plant species are widespread across the study area, others are restricted to just a few ecoregions. For example, high elevation communities in the Blue Ridge support several plants found nowhere else in the world, as well as isolated populations of species typically found in more northern latitudes (White et al. 1993; Ricketts et al. 1999). Level III ecoregions within the TVA transmission system ROWs and study area are summarized in Table 4-1 and are depicted in Figure 4-1.

Table 4-1. Summary of Level III Ecoregions within the TVA Study Area

Level III Ecoregion	ROW (acres)	Study Area (acres)
Blue Ridge	5,416	2,413,366
Central Appalachians	1,957	708,210
Interior Plateau	84,015	15,904,508
Interior River Valleys and Hills	4,015	996,373
Mississippi Alluvial Plain	705	903,107
Mississippi Valley Loess Plains	23,420	5,239,175
Ridge and Valley	46,588	6,751,274
Southeastern Plains	44,363	12,723,149
Southwestern Appalachians	27,717	7,080,348
Total	**238,196**	**52,719,510**

Source: EPA 2017c

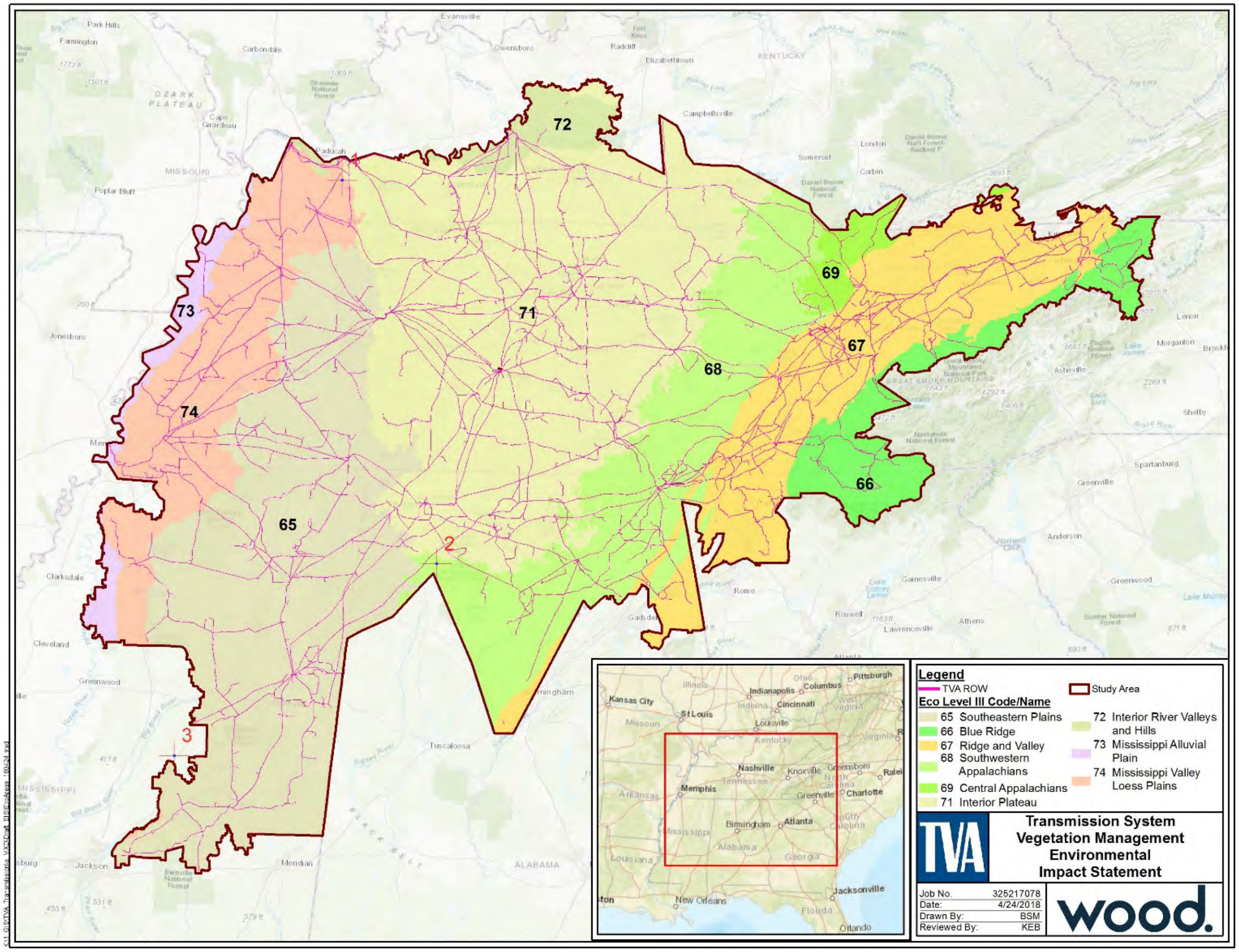


Figure 4-1. Ecoregions Within the TVA Study Area

Blue Ridge Ecoregion: This ecoregion corresponds to the Blue Ridge physiographic province and is one of the richest areas of biodiversity in the eastern United States (Griffith et al. 1998). Land cover is 80 percent forested, dominated by diverse hardwood-rich mesophytic forests, Appalachian oak forests, and high elevation spruce-fir forests (Dyer 2006; Loveland and Acevedo 2016). Approximately 14 percent of the land cover is agricultural and most of the remaining area is developed (TVA 2015).

Central Appalachian Ecoregion: A small portion of this ecoregion extends into the northeastern section of the study area in parts of Virginia, Kentucky, and northern Tennessee. It is heavily forested (83 percent), primarily with mesophytic forests including large areas of Appalachian oak and northern hardwood forests (Dyer 2006; Loveland and Acevedo 2016). The remaining land cover is mostly agriculture (7 percent), developed areas (3 percent) and mined areas (3 percent). This ecoregion has been extensively mined (Loveland and Acevedo 2016).

Interior Plateau Ecoregion: A large portion of the central study area is comprised of the Interior Plateau ecoregion. Approximately 38 percent of the ecoregion is forested, 50 percent is in agriculture, and 9 percent is developed (Loveland and Acevedo 2016). Forests are predominantly mesophytic, with a higher proportion of American beech, American basswood and sugar maple than in the Appalachian oak subtype (Dyer 2006).

Interior River Valley and Hills Ecoregion: A small portion of the northern study area is comprised of the Interior River Valley and Hills ecoregion, which overlaps part of the Highland Rim Physiographic Province section. This ecoregion consists of relatively flat lowlands dominated by agriculture (68 percent), with about 20 percent forested hills, 7 percent developed, and 5 percent wetlands. It includes much of the Illinois Basin coalfield. Bottomland deciduous forests and swamp forests were historically common on wet lowland sites, with mixed oak and oak-hickory forests on uplands. However, a large portion of the lowlands have been cleared for agriculture (TVA 2015).

Mississippi Alluvial Plain Ecoregion: This is a flat floodplain area along the Mississippi River originally covered by bottomland deciduous forests. Much of this ecoregion has been cleared for agriculture and subjected to drainage activities including stream channelization and extensive levee construction. Most of the land cover is agricultural and the remaining forests are southern floodplain forests dominated by oak, tupelo and bald cypress (Loveland and Acevedo 2016).

Ridge and Valley Ecoregion: This ecoregion is located within the study area in portions of Virginia, Tennessee, Georgia, and Alabama. The Ridge and Valley ecoregion is a diverse area stretching in a north-south fashion between higher, more rugged mountainous ecoregions. More than half of this ecoregion is forested, comprised predominantly of mesophytic forest and Appalachian oak subtype. In the southern portion of the region, oak-pine forest is more common (Dyer 2006; Loveland and Acevedo 2016). Approximately 30 percent of the area is agricultural, and 9 percent is developed (Loveland and Acevedo 2016).

Southeastern Plains and Mississippi Valley Loess Plain Ecoregions: Located primarily in Mississippi, western Tennessee, and western Kentucky, these ecoregions are characterized by a mosaic of forests (52 percent of the land area), agriculture (22 percent), wetlands (10 percent) and developed areas (10 percent). Forest cover decreases and agricultural land increases from east to west. Natural forests of pine, hickory, and oak once covered most of the ecoregions, but much of the natural forest cover has been replaced by heavily managed timberlands, particularly in the Southeastern Plains (Loveland and Acevedo 2016). The Southeastern Plains in Alabama and Mississippi include the Black Belt, an area of rich dark soils and prairies. Much of this area has been cleared for agricultural purposes and only remnant prairies remain. The rate of land cover change in the Southeastern Plains ecoregion is the highest of the nine ecoregions in the study area, with intensive forest management practices being the leading cause (TVA 2015).

Southwestern Appalachian Ecoregion: This ecoregion corresponds to the Cumberland Plateau Physiographic Province. More than 75 percent of the land cover is forest, with mesophytic forest being largely confined to deeper ravines and escarpment slopes, whereas upland forests are dominated by mixed oak and shortleaf pine. The remaining landbase is agricultural (16 percent) and developed (3 percent). The rate of land cover changes from 1973 through 2000 is relatively high, mostly due to forest management activities (EPA 2013; Loveland and Acevedo 2016).

4.1.1.2 Land Cover

Land cover within the transmission ROW and study area is depicted in Figure 4-2. Land cover within the study area is summarized in Table 4-2, and within the ROW it is summarized in Table 4-3. The most common land cover type in the transmission ROW is hay/pasture (27.3 percent) followed by cultivated crops (13.7 percent). National Land Cover Database (NLCD) data is based on a spatial resolution of 30-meter pixels, which makes it unsuitable for use on narrow transmission line corridors. As such, forest cover within the transmission ROW is consistent with the estimate developed for the programmatic BA for evaluation of the impacts on federally listed bats (TVA 2017e).

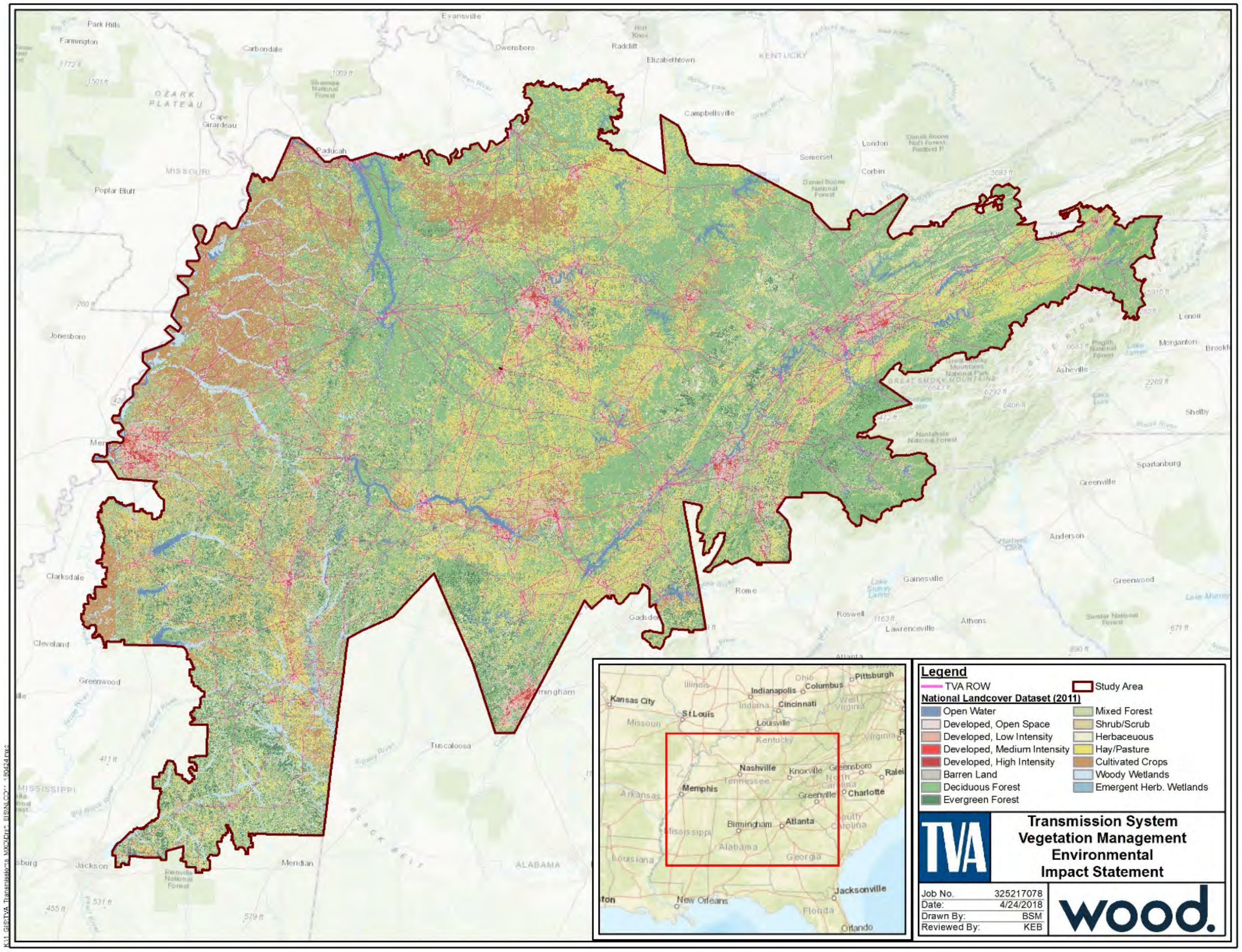


Figure 4-2. Land Cover Within the TVA Study Area

Table 4-2. Land Cover Within the TVA Study Area

Land Cover	Study Area (acres)	Percent of Study Area
Agriculture (crops/hay/pasture)	15,351,807	29.1%
Forest (deciduous/evergreen/mixed)	24,909,183	47.2%
Developed	4,597,823	8.7%
Shrub/Scrub	2,234,426	4.2%
Herbaceous	2,594,834	4.9%
Wetlands (woody/herbaceous)	1,662,107	3.2%
Open Water	1,273,723	2.4%
Barren Land	95,606	0.2%
Total	**52,719,510**	**100%**

Source: Homer et al. 2015

Table 4-3. Land Cover Within the TVA Transmission Line Rights-of-Way

Land Cover	ROW (acres)	Percent of ROW
Cultivated Crops	32,575	13.7%
Hay/Pasture	65,023	27.3%
Forest Land[1]	9,332	3.9%
Developed	25,126	10.6%
Open Water	2,137	0.9%
Barren Land	587	0.2%
All Other (Shrub, Herbaceous, Wetland)	103,416	43.4%
Total	**238,196**	**100.0%**

Source: Homer et al. 2015

[1]Forested lands within transmission ROW derived from TVA 2017g.

4.1.1.1 Forest Regions

The major forest regions in the TVA study area include Mesophytic Forest, Southern-Mixed Forest, and Mississippi Alluvial Plain (Dyer 2006). Mesophytic Forest Region is the most diverse with 162 tree species. The mesophytic forest of the Appalachians represents one of the most biologically diverse temperate regions of the world, often supporting a high diversity of tree species and containing a rich understory of ferns, fungi, herbs, and woody species. The Mesophytic Forest Region harbors some of the richest and most endemic land snail, amphibian, and herbaceous plant biotas in the U.S. and Canada. The region's freshwater communities are the richest temperate freshwater ecosystems in the world, with globally high richness and endemism in mussels,

What are "endemic" species?

Endemic species are narrowly distributed within a specific location, area, or habitat type. Endemic species are typically limited to a unique habitat by specialized life history characteristics that reduce their ability to survive in other habitats.

fish, crayfish, and other invertebrates (World Wildlife Fund 2018). While canopy dominance is shared by several species, red maple and white oak have the highest average importance values (TVA 2017e).

A distinct section of the Mesophytic Forest Region, the Appalachian oak section, is dominated by several species of oak including black oak, chestnut oak, northern red oak, scarlet oak, and white oak. The Nashville Basin of the Mesophytic Forest Region has close affinities with the beech-maple-basswood forest that dominates much of the Midwest. The oak-pine section of the southern mixed forest region occurs in portions of Alabama, Georgia and Mississippi, where the dominant species are loblolly pine, sweetgum, red maple and southern red oak (Dyer 2006). The Mississippi Alluvial Plain Region is restricted to floodplains associated with the Mississippi River. The bottomland forests in this region are dominated by American elm, bald cypress, green ash, sugarberry and sweetgum (TVA 2017e).

Prior to European settlement, forest was the dominant land cover type in the eastern U.S. Significant and unprecedented modification of the eastern forests took place in the 18th and 19th centuries as forests were cleared for agriculture, timber production, fuel, and urban development. Although forest cover has increased dramatically in parts of the eastern U.S. in the past century, most forested land is successional and different than the pre-settlement old growth forests (Dyer 2006).

4.1.1.2 Important Herbaceous Habitat

Many other plant communities occur in the study area. Some of these communities are rare, restricted to very small geographic areas and/or are threatened by human activities. Examples include glades, grasslands, prairies, barrens, marshes, bogs, fens, and seeps. Declines in prairie ecosystems since 1830 have exceeded that of any other major ecosystem in North America, and the problem of habitat loss in herbaceous prairie communities since European settlement has been well documented in the Midwest and Great Plains (Schroeder 1982; McClain 1986; Smith 2001; Samson et al. 2004; Sampson and Knopf 1994). A few generations ago, native grasslands were relatively abundant in portions of the South as well; today they are rare (Noss 2013). Among other things, habitat loss in natural open areas has occurred as a result of farming/cultivation, development, fire suppression, and invasive species. As a result, maintained transmission line ROWs are some of the only relatively intact open herbaceous habitats remaining on the landscape.

Important herbaceous habitats can and do persist within the TVA transmission system ROWs. Approximately 20 globally rare herbaceous communities, as defined by NatureServe (2017), have the potential to occur within TVA transmission ROWs (Table 4-4). Globally rare communities are of high conservation importance and are rare everywhere they occur. These plant communities have been assigned conservation ranks of G1-G3 in accordance with the NatureServe conservation ranking system: G1 = critically imperiled, G2 = imperiled, and G3 = vulnerable. The herbaceous communities summarized in Table 4-4, or communities very similar to those defined here, are commonly identified as either glades, barrens, prairies, or grasslands, and could occur within TVA transmission ROW. Three habitat types, the Cumberland Plateau Clifftop Sandstone Barrens, the Central Limestone Glade, and the Little Bluestem – Bluestem Grassland, have the greatest likelihood of occurring within TVA transmission ROWs. This assumption is based on their conservation rank and their relatively broad distribution throughout the project area. Each of these habitat types is ranked as G3, indicating a given community is represented by the highest number of sites of the three conservation ranks.

Cumberland Plateau Clifftop Sandstone Barrens – Predominant herbaceous species in the Cumberland Plateau Clifftop Sandstone Barrens include little bluestem, silky oatgrass, poverty dropseed, small-head blazing-star, creeping aster, orangegrass, blue toadflax, daisy fleabane, prickly pear, Menges' fameflower, and in some examples, Appalachian stitchwort and Cuthbert's onion.

Central Limestone Glade – Characteristic grasses of the Central Limestone Glade include little bluestem, Indiangrass, three awn grasses, side-oats grama, and tall dropseed, with big bluestem occurring in deeper soils. Tree canopy is often sparse with chinquapin oak, post oak, and eastern red cedar appearing most frequent.

Little Bluestem – Bluestem Grassland – This plant community is a mixed-grass association that represents a variety of essentially native perennial grasslands which are (or have been) human-maintained to some extent and contain a variable mix of little bluestem and various broomsedges.

A more complete description of each community is provided in Appendix I and includes information on species composition, habitat description, and distribution.

Table 4-4. Important Herbaceous Habitats Potentially Occurring Within the TVA Transmission Line Right-of-Way

Common Community Name	Scientific Community Name	Distribution	Rank
Alabama Cumberland Sandstone Glade	*Bigelowia nuttallii – Coreopsis pulchra - Liatris microcephala* Grassland	NE Alabama	G2
Black Belt Prairie	*Schizachyrium scoparium – Sorghastrum nutans – Dalea candida – Liatris squarrosa – (Silphium terebinthinaceum*) Black Belt Grassland	Central AL, northeast MS, and McNairy County, TN	G1
Central Limestone Glade	*Quercus muehlenbergii - Juniperus virginiana/Schizachyrium scoparium – Manfreda virginica* Wooded Grassland	AL, GA, IL, IN, KY, OH, TN, WV and VA	G2G3
Coosa Valley Wet Barrens	*Schizachyrium scoparium – Andropogon gerardii – Silphium terebinthinaceum* Coosa Valley Barren Grassland	Northeast AL and northwest GA	G1
Cumberland Plateau Clifftop Sandstone Barrens	*Schizachyrium scoparium – Danthonia sericea – Liatris microcephala – (Eurybia surculosa*) Grassland	Cumberland Plateau in AL, KY, and TN	G3
Cumberland Sandstone Flatrock Glade	*Diamorpha smallii – Minuartia glabra* Sandstone Grassland	Franklin, Grundy, Putnam, and Marion Counties (TN)	G2G3
Highland Rim Wet-Mesic Prairie	*Andropogon gerardii – Schizachyrium scoparium – Dichanthelium scoparium – Rhynchospora glomerata* Grassland	Eastern Highland Rim of south-central TN	G1
Jackson Prairie Calcareous Clay Prairie	Schizachyrium scoparium – Sorghastrum nutans – Dalea purpurea – Silphium integrifolium Jackson Prairie Grassland	Coastal Plain of MS and AL	G1
Kentucky Glade Seep	*Eleocharis (bifida, compressa) – Nothoscordum bivalve* Seep Grassland	KY	G3Q
Kentucky-Tennessee Big Barrens	*Schizachyrium scoparium – (Helianthus mollis, Helianthus occidentalis, Silphium trifoliatum*) Grassland	Highland Rim in TN and adjacent KY	G2
Limestone Annual Grass Glade	*Sporobolus (neglectus, vaginiflorus) – Aristida longispica – Panicum flexile – Panicum capillare* Grassland	Nashville Basin in central TN and KY, and Moulton Valley in northwest AL	G3
Limestone Glade Streamside Meadow	*Dalea foliosa – Mecardonia acuminata – Mitreola petiolata* Seep Grassland	Central Basin of TN	G2
Limestone Seep Glade	*Eleocharis (bifida, compressa) – Schoenolirion croceum –*	Central Basin of TN and Moulton Valley in northwest	G2

Common Community Name	Scientific Community Name	Distribution	Rank
	Carex crawei – Allium cernuum Seep Grassland	AL	
Little Bluestem - Bluestem Grassland	*Schizachyrium scoparium – Andropogon (gyrans, ternarius, virginicus*) Grassland	KY, TN, and possibly AL	G3
Moulton & Tennessee Valley Limestone Hill Barrens	*Juniperus virginiana/Schizachyrium scoparium – (Andropogon gerardii, Sorghastrum nutans) – Silphium terebinthinaceum* Wooded Grassland	Northwest AL, south-central KY, central TN, and potentially western VA.	G2
Southeastern Highland Rim Barrens (Big Bluestem – Bushy Bluestem Wet-Mesic Type)	*Andropogon gerardii – (Andropogon glomeratus, Panicum virgatum, Sorghastrum nutans*) Grassland	Highland Rim in TN, potentially in KY	G2
Southeastern Highland Rim Barrens (Big Bluestem – Reedgrass Mesic Type)	*Andropogon gerardii - Schizachyrium scoparium - (Calamagrostis coarctata, Panicum virgatum*) Grassland	Southeastern Highland Rim of TN	G2
Southern Ridge and Valley Annual Grass Glade	*Sporobolus vaginiflorus (var. ozarkanus, var. vaginiflorus) – Hypericum dolabriforme* Grassland	Northwest GA and possibly adjacent TN	G2G3
Southern Ridge and Valley Dry-Mesic Grassland	*Schizachyrium scoparium – Sorghastrum nutans – Silphium* spp. Grassland	Southern Ridge and Valley physiographic province in TN	G2
Southern Ridge and Valley Mesic Grassland	*Andropogon gerardii – Panicum (anceps, virgatum*) Grassland	Ridge and Valley physiographic province in TN	G2?

Source: NatureServe 2017

Within the study area, a large number of federally and state-listed rare, threatened, and endangered plant species have a high likelihood of occurrence within TVA's open, herbaceous transmission line ROWs. According to TVA's Regional Natural Heritage database, 167 state-listed plant species and 10 federally listed plant species have occurrence records within or close to (within 50 feet) the TVA transmission ROW. Using their O-SAR database, TVA has identified approximately 2,500 areas of transmission ROW with habitat to support, or potentially could support, federally or state-listed plant species. As described in Section 3.2.2 Alternatives, TVA uses information from the O-SAR process to consider the site sensitivity of each project area in the development of a context sensitive approach to tools for vegetation maintenance. This process guides decisions regarding vegetation maintenance activities in the vicinity of previously documented species. Section 4.3 provides more detailed information on listed species.

4.1.1.3 Common Plant Species in the TVA Transmission Line ROW

Routine vegetation maintenance such as mowing and herbicide application influences habitat type and species richness within the transmission ROW. Other factors that affect plant quality and distribution include previous and current land use, landscape position, soils, geology, depth to bedrock, aspect, climate, invasive species, and the date the transmission line was constructed. Older transmission lines that were put into service several decades ago often contain higher plant quality than newer lines. Presumably this is because native herbaceous habitats, those relatively free of exotic species, were historically more common on the landscape. Therefore, as trees were cleared and construction was completed on older lines, the resulting transmission ROW became colonized with higher-quality and mostly weed-free native herbaceous plant material.

Although some smaller portions of the TVA transmission line ROW contain important herbaceous habitat, the vast majority of the transmission ROW is dominated by species that are tolerant of disturbance. NLCD data indicated that much of the transmission ROW is disturbed (see Table 4-3). In addition, periodic mowing, tree removal, and herbicide applications typically used to maintain clear, safe, and reliable transmission line ROWs, generally result in degraded open habitat. Indiscriminate transmission ROW vegetation maintenance leads to a loss of native plant species diversity and creates pathways for the spread of nuisance and invasive species. Although dominant plant species would vary depending on location and site conditions, a representative list some commonly encountered herbaceous species within the transmission ROW is provided in Table 4-5.

Table 4-5. Common Herbaceous Species within TVA Transmission Line Rights-of-Way

Common Name	Scientific Name
Well-Drained Sites	
Aster species	*Symphyotrichum* spp.
Black-eyed Susan	*Rudbeckia hirta*
Broomsedge	*Andropogon virginicus*
Canada goldenrod	*Solidago canadensis*
Common ragweed	*Ambrosia artemisiifolia*
Gray goldenrod	*Solidago nemoralis*
Horseweed	*Conyza canadensis*
Hyssop-leaved thoroughwort	*Eupatorium hyssopifolium*
Little bluestem	*Schizachyrium scoparium*
Ox-eye daisy	*Leucanthemum chrysanthemum*
Panicgrass species	*Panicum* spp.
Round-leaved thoroughwort	*Eupatorium rotundifolium*
Moderately Drained Sites	
Aster species	*Symphyotrichum* spp.
Bushy bluestem	*Andropogon gomeratus*
Creeping bentgrass	*Agrostis gigantea*
Foxtail grass species	*Setaria* spp.
Giant ragweed	*Ambrosia trifida*
Purpletop	*Tridens flavus*
Rough-leaved goldenrod	*Solidago rugosa*
Tall fescue	*Festuca arundinacea*
Tall goldenrod	*Solidago altissima*
Wingstem	*Verbesina alternifolia*
Poorly Drained Sites	
Broad-leaved cattail	*Typha latifolia*
Common rush	*Juncus effusus*
Plumegrass species	*Erianthus* spp.
Swamp smartweed	*Persicaria hydropiperoides*
Tall Joe-Pye weed	*Eutrochium fistulosum*
Woolgrass	*Scirpus cyperinus*

4.1.1.4 Invasive Species

Much of the TVA study area has been affected by invasive plants, which are a major threat to federally and state-listed rare, threatened, and endangered native species. Certain non-native species are considered invasive and pose a significant threat to the natural environment. Executive Order (EO) 13112, Invasive Species (February 3, 1999) directed TVA and other federal agencies to prevent the introduction of invasive species (both plants and animals), control their populations, restore invaded ecosystems and take other related actions. EO 13751 issued on December 8, 2016, amends EO 13112 and directs actions by federal agencies to continue coordinated federal prevention and control efforts related to invasive species. This order incorporates considerations of human and environmental health, climate change, technological innovation, and other emerging priorities into federal efforts to address invasive species; and it strengthens coordinated, cost efficient federal action.

Some invasive plants have been introduced accidentally, but most were brought here as ornamentals or for livestock forage. Because these robust plants arrived without their natural predators (insects and diseases) their populations increase across the landscape with little opposition (Miller 2003), regardless of control and reclamation measures applied by landowners and TVA on individual land holdings.

Transmission ROW vegetation maintenance activities – clearing, mowing, and herbicide application – often result in pathways for invasive plant introduction and migration, thus, invasive species are widespread within the transmission system ROWs. The Southeast Exotic Pest Plant Council (https://www.se-eppc.org/) supports the management of invasive plants in the southeastern United States. TVA consults the state chapter lists for information on species control within the transmission system ROWs. Some of the invasive plant species within the TVA study area are identified in Table 4-6.

Table 4-6. Invasive Plant Species Within the TVA Study Area

Common Name	Scientific Name
Trees	
Tree of heaven	*Ailanthus altissima*
Mimosa	*Albizia julibrissin*
Princess tree	*Paulownia tomentosa*
Chinaberry	*Melia azedarach*
Chinese tallow tree	*Triadica sebifera*
Shrubs	
Silverthorn	*Elaeagnus pungens*
Autumn olive	*Elaeagnus umbellata*
Burning bush	*Euonymus latus*
Chinese and European privets	*Ligustrum sinense* and *L. vulgare*
Japanese and glossy privets	*Ligustrum japonicum* and *L. lucidum*
Bush honeysuckles	*L. morrowii, L., tartarica, L. fragrantissima,* and *L. xbella*
Nandina	*Nandina domestica*
Multiflora rose	*Rosa multifora*
Vines	
Nonnative climbing yams	*Dioscorea oppositifolia* and *D. bulbifera*
Wintercreeper	*Euonymus fortunei*
English ivy	*Hedera helix*
Japanese honeysuckle	*Lonicera japonica*
Kudzu	*Pueraria montana*
Periwinkles	*Vinca minor* and *V. major*
Nonnative wisterias	*Wisteria sinensis* and *W. floribunda*
Oriental bittersweet	*Celastrus orbiculatus*
Grasses	
Giant reed	*Arundo donax*
Tall fescue	*Festuca arundinacea*
Cogongrass	*Imperata cylindrica*
Nepalese browntop	*Microstegium vimineum*
Chinese silvergrass	*Miscanthus sinensis*
Nonnative bamboos	*Phyllostachys* spp.
Ferns and Forbs	
Japanese climbing fern	*Lygodium japonicum*
Garlic mustard	*Alliaria petiolata*
Shrubby lespedeza	*Lespedeza bicolor*
Sericea lespedeza	*Lespedeza cuneata*

Source: TVA 2017e, f

4.1.1.5 Compatible Vegetation within TVA Rights-of-Way

Existing vegetative conditions within the TVA transmission ROW include two management zones – the wire zone and border zone (see Figure 1-6). Throughout the TVA transmission system, the wire zone of non-ravine areas would be managed by ongoing floor work such that the condition of the plant community can be characterized as a “compatible” plant community (i.e., herbaceous plants, low-growing shrubs). Deep ravine areas within the transmission ROW also contain compatible plant communities where the maximum height of trees does not infringe upon the safe separation distance from transmission line conductors and support structures. TVA estimates a total of 1,996 acres of spanned forested areas occur in ravines.

Incompatible vegetation is known to exist in two areas – standing timber within the border zone and danger trees located outside of, but immediately adjacent to, the transmission ROW. The border zone would be more variable in its composition than the wire zone and currently includes herbaceous vegetation, low-growing shrubs, and in several locations taller trees that are not compatible with safe, reliable, electric transmission system infrastructure. TVA estimates a total of 8,094 acres of incompatible standing timber exists within the TVA transmission system ROWs. In addition, some trees immediately adjacent to (but outside of) the transmission ROW are considered danger trees because their proximity and size make them capable of hitting transmission line conductors and structures if they fall. Such danger trees represent a major risk for the safe and reliable operation of TVA’s transmission system.

4.1.2 Environmental Consequences for Vegetation

4.1.2.1 General Impacts to Vegetation

Plant communities located on and adjacent to TVA transmission ROW vary greatly across the study area, ranging from highly disturbed, early successional habitats dominated by invasive species to rich, diverse herbaceous communities that possess landscape level conservation importance. The relative quality of plant habitats found in any given portion of TVA transmission ROW depends on a multitude of factors, including many that are unrelated to vegetation management decisions implemented by TVA. Factors outside of TVA control that influence plant communities include land use (previous and current), geology, landscape position, soil texture, depth to bedrock, aspect, and rainfall. However, the method TVA chooses to use to manage vegetation often is the most important factor driving vegetation composition. Without vegetation management within the transmission ROW areas, virtually all of these open habitats actively managed by TVA would transition to forest over time (see Table 1-1 for breakdown of land management responsibilities).

4.1.2.2 Impacts from Vegetation Control Methods

4.1.2.2.1 Impacts to Vegetation from Manual Methods

Manual vegetation control methods typically have a relatively small impact on the overall vegetation composition of a transmission ROW. Hand tools used in clearing activities are highly selective and can only be implemented on a small scale, because the equipment is labor intensive to employ and, therefore, costly to operate. Chainsaws regularly would be used to remove individual trees from transmission ROW floor and margins. While this tool effectively removes individual trees, there would be relatively few indirect effects to nearby vegetation. If a tree needs to be removed from the wire zone within the regularly managed transmission ROW floor using a chainsaw or other hand tool, it is likely that the tree was overlooked during previous vegetation maintenance cycles. In this case, the tree or trees would be removed and the local area immediately adjacent to the tree would be converted to herbaceous vegetation and maintained in that condition during future floor work. On the transmission ROW margins, manual methods could be used to remove trees. Manual methods would normally be used only in steep, difficult to access areas, or because of some other constraint that prohibits the use of other available methods. Once the trees are removed, the area would be maintained in an open herbaceous condition with subsequent cycles of vegetation control. On a landscape level, this would result in a small amount of forest conversion to herbaceous vegetation. When working in residential, commercial, agricultural or other areas of highly disturbed vegetation, manual methods would have no appreciable impact on the surrounding plant community.

4.1.2.2.2 Impacts to Vegetation from Mechanical Methods

Clearing of vegetation using a bulldozer, track-hoe, skid steer, or feller-buncher occurs primarily in areas where previous vegetation maintenance has been infrequent and woody plants have encroached into a transmission ROW, or in areas that had not been previously cleared. Of the mechanical clearing tools, bulldozers and other similar equipment that move the soil by pushing trees and dislodging root balls have the greatest potential to degrade plant communities and encourage the proliferation of weedy or invasive species. Exposed and disturbed soil provides ideal conditions for the establishment of invasive plants, which are difficult to remove. While this type of clearing is more damaging to plant communities relative to other methods that do not disturb the soil, it would also be used very infrequently on existing transmission ROW compared to other methods.

Removing trees using feller-bunchers or other similar machinery, which cut standing trees at ground level without disturbing the soil profile, typically results in minimal disturbance to the herbaceous layer. In drier portions of a transmission ROW, particularly areas surrounded by forest, this method of removal can be very effective at promoting herbaceous habitat dominated by native plant species. These areas would then be continually cleared during subsequent vegetation maintenance of the floor. If mechanical methods were implemented where a transmission ROW intersects a rare plant community (see Table 4-4), the result would often be an increase in the rare habitat type. When combined with subsequent vegetation management, which most often includes selective application of herbicide, this type of mechanical tree removal can be compatible with maintaining quality herbaceous habitats relatively free of invasive weeds.

Mowing would remove nearly all woody stems; however, the amount of re-growth can be rapid depending on conditions on the ground. For example, in drier areas with sandy or rocky soils, the rate of tree establishment and growth is relatively slow, so mowing in dry areas with sandy or rocky soils can help to maintain high quality native plant communities. However, in all but the driest habitats in the eastern U.S., tree invasion is rapid, and woody plants quickly replace herbaceous species. In addition, repeated mowing of transmission ROW encourages stump resprouting (sucker growth) and promotes dense stands of woody species. This is particularly problematic in wetlands or on sites with rich soils. Using mowing alone, or as the primary mechanism for vegetation removal on transmission ROW, would reduce species diversity and encourage the dominance of woody plants able to proliferate through root resprouting.

Side-wall trimming, either from the air or the ground, would have a small impact on vegetation found on and adjacent to a transmission ROW. Trimming would directly affect trees being pruned, but it would have few other effects apart from a marginal increase in light levels due to the removal of individual limbs. Any soil disturbance from ground based side-wall trimming would be minimal and short-term in duration.

4.1.2.2.3 Impacts to Vegetation from Herbicide Application Methods

The use of herbicides for the control of woody plants can have great impacts on vegetation, lasting for multiple years after application. The extent and magnitude of effect on any individual transmission ROW depends to a large extent on the method of application used. More selective methods that limit the application of herbicides on non-target vegetation can have a demonstrable positive effect in fostering relatively stable plant communities with a large component of native plants. However, methods that use higher volumes of herbicide and do not narrowly target woody plants can notably degrade plant communities. The choice of herbicide application method has the greatest potential to adversely affect vegetation within transmission ROW supporting high-quality habitats. Lower-quality habitat within transmission ROW dominated by early successional weedy species, including invasive plants, are less likely to be severely impacted by herbicide because the areas have already been degraded.

Table 4-7 summarizes the potential effect to transmission ROW vegetation by herbicide application method. Negative impacts to transmission ROW vegetation would include reduction of herbaceous species diversity and removal of native species from the transmission ROW, which is often the only place in the vicinity where remaining native species occur, especially in agricultural areas or other landscapes where native habitats have been replaced due to more intrusive land uses. Other negative impacts from herbicide applications may include promotion of weedy native species and promotion of exotic plants that may quickly take over once native vegetation has been removed. All estimates of potential impacts assume adequate control of target woody plants in the transmission ROW.

Table 4-7. Potential Effect of Herbicide Application Method on TVA Transmission Line Rights-of-Way Vegetation

Application Category	Application Method	Herbicide Volume	Specificity	Potential for Negative Impact
Spot	Stump	Low	High	Low
	Hack and Squirt	Low	High	Low
Localized	Basal	Medium	Medium	Medium -Low[1]
	Low-volume Foliar	Medium	Medium	Medium
	Granular	Medium	Medium	Medium
	Bare-ground	Medium	Low	Medium
Broadcast	High-volume Foliar	High	Low	High
	Cut-stubble	High	Low	High
	Broadcast Granular	High	Low	High
	Broadcast Bare-ground	High	Low	High
Aerial	Fixed-wing Aircraft	High	Low	High
	Helicopter	High	Low	High

[1]When application is made during the dormant season.

Generally, aerial and broadcast applications have a similarly high potential to negatively affect vegetation on a wholesale, fundamental level. Both of these high-volume, non-targeted methods can transform diverse, herbaceous plant communities, which are rare in the southeastern U.S., into a patchwork of disturbed habitats dominated by annual weeds, other early successional pioneer species, and invasive plants. Repeated aerial and broadcast application of herbicide would be incompatible with establishing transmission ROWs that support stable plant communities dominated by native species.

Localized applications of herbicide would result in some level of off-target impact. In situations where the woody stem count is high on a given transmission ROW, even localized application of herbicides could produce substantial impacts to non-target species. However, these areas of high woody stem count would be unlikely to support high-quality herbaceous habitats, usually because of site-specific conditions unrelated to TVA vegetation management (i.e., owner land use, soil type, landscape position, etc.). In drier transmission ROW areas with rocky or sandy soils, where woody stem count is inherently lower, localized herbicide application could foster herbaceous plant communities that are rare on the landscape. These important plant habitats may be globally rare (see Table 4-4) or just relatively diverse herbaceous communities, with limited distribution remaining in the southeastern U.S.

Spot application and dormant season basal application would have a low potential to negatively impact surrounding vegetation, but the relatively high cost and low efficacy limits the method to small areas.

4.1.2.3 Impacts to Vegetation from Debris Management

Debris management of cut vegetation would not have great, long-term impacts to transmission ROW vegetation, but there would be some differences between the various methods. For example, the effects of cut and leave methods of debris management would vary based on the size and amount of woody debris remaining. The “left in place” method typically would have little direct effect on vegetation where woody debris falls, but subsequent vegetation maintenance could be hindered by larger piles. Specifically, low-volume foliar herbicide applications could be less targeted because applicators have a difficult time moving amongst the downed branches. This effect would diminish over time as the woody material decomposes.

Larger trees and woody vegetation at the edges of the transmission ROW areas that would be killed by herbicides are allowed to naturally degrade at their rooted locations. Eventually the dead trees would drop their branches and the trunks would fall and decompose onsite. This method would have little negative impacts to remaining understory vegetation and may have some minor positive impacts by allowing more light penetration to remaining herbaceous habitats that were previously shaded by the foliage of the live trees.

The “lopping and scattering” method would have a near negligible effect on vegetation, because material is distributed throughout the transmission ROW. However, this method may still hinder future vegetation maintenance activities within the transmission ROW due to obstructions caused by remaining large branches left throughout the transmission ROW.

Chipping and mulching in-place would have similar short-term effects on vegetation where material is placed. Wood chips would be left at depths that depend on the amount of material chipped. Chip depth, which could be several inches, typically retards herbaceous plant growth for some amount of time, but after less than one growing season grasses and forbs begin to regrow through the chips. Conversely, offsite debris management of cut vegetation and chip and haul methods could allow for immediate regrowth of herbaceous plants, but it may result in some additional soil disturbance compared to chipping and mulching in place because of additional equipment traffic on site.

Landowner use of debris (logs/limbs) would result in some soil disturbance, but the additional effect would be minor as it would be localized.

4.1.2.4 Impacts to Vegetation from Restoration

Reseeding would have little potential to negatively affect transmission ROW vegetation because standard BMPs would dictate revegetation efforts to avoid the use of invasive weed species (TVA 2017a). While not all species used in revegetation projects are native to the TVA PSA, TVA uses no invasive species. The non-native grass species Bermuda grass and tall fescue are approved for use in established pastures and developed areas (i.e. dam reservations, public use areas, and other facilities), but not in areas with naturalized vegetation.

4.1.2.5 Mitigation Measures for Impacts to Vegetation

Broadcast and aerial herbicide use would have the greatest potential to negatively affect important plant communities occurring on TVA transmission ROW because these application methods can fundamentally degrade quality habitats. TVA uses the O-SAR process to avoid impacts to important plant habitats within transmission ROWs by limiting the use of these methods to areas unlikely to contain herbaceous habitats dominated by native plant species. Currently, broadcast and aerial herbicide is restricted on about 17 percent (about 41,000 acres) of TVA transmission ROW that are likely to contain important habitat. Manual, mechanical, and localized herbicide methods can be used in these areas. These methods likely serve to perpetuate important herbaceous habitats found in the transmission ROW by eliminating trees that rapidly encroach into open areas without appropriate disturbance. Slightly less that 1 percent (about 2,000 acres) of TVA transmission ROW is known to contain rare plant habitats. These areas are denoted in the O-SAR database, and when vegetation maintenance is scheduled to occur in such locations, TVA biologists and operations staff would work together to ensure the habitats are protected. Sometimes the proposed work would not affect the plant communities found within the transmission ROW, but sometimes operations staff augments the timing or method of proposed work to protect sensitive resources.

4.2 Wildlife

4.2.1 Affected Environment

The study area for the proposed TVA PEIS encompasses nine ecoregions that generally correspond with the Physiographic Provinces and sections (see Figure 4-1). The terrain, plant communities, and associated habitats in these ecoregions vary from bottomland hardwood and cypress swamps in the floodplains of the Mississippi Alluvial Plain to high elevation balds, spruce-fir, and northern hardwood forests of the Blue Ridge. Approximately 76 species of mammals, 55 species of reptiles, 72 species of amphibians, and 182 species of breeding birds occur in the TVA study area (TVA 2015). Although many animals are widespread across the region, others are restricted to one or a few ecoregions. For example, high elevation communities in the Blue Ridge support several animal species found nowhere else in the world, as well as isolated populations of species typically found in more northern latitudes (TVA 2015).

4.2.1.1 Regulatory Framework

Several species of wildlife are protected under the ESA and related state laws as described further in Section 4.3 Threatened and Endangered Species. In addition to these laws, the regulatory framework for protecting birds that is relevant to TVA includes EO 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds. EO 13186 addresses migratory birds occurring in the United States. EO 13186 focuses on federal agencies taking actions with the potential to have adverse impacts on populations of migratory birds. It provides broad guidelines on avian conservation responsibilities and requires agencies whose actions affect or could affect migratory bird populations to develop a memorandum of understanding (MOU) on migratory bird conservation with the USFWS. TVA is currently developing an MOU in coordination with the USFWS and is developing an Avian Protection Plan. In addition, there are state laws regulating the hunting, trapping, other capture, and possession of some species.

4.2.1.2 Available Habitats for Wildlife

Wildlife habitat on TVA-managed lands (such as easements and fee-owned) includes developed areas such as low-quality maintained lawns near residential and industrial areas, disturbed forest fragments around power-generating facilities, moderate-quality early successional and herbaceous communities within and along transmission lines bordered by forest edges, as well as higher-quality contiguous blocks of forest along reservoir shorelines. Important habitats found within and near TVA lands include riparian corridors, bluffs, swamps, grasslands, rivers and associated stream tributaries, reservoirs, islands, larger un-fragmented forested landscapes, and karst (cave) habitats (TVA 2016a).

In non-agricultural settings, established transmission line ROWs represent environments with managed plant communities often in contrast with adjacent land cover types. Some species of wildlife, called “edge species”, take advantage of this difference in habitat type. Red-tailed hawk, for example, will often nest in forested habitats adjacent to transmission line ROW corridors, but will hunt and forage in the open habitats within the corridor. Other common edge species include barn swallow, American crow, song sparrow, field sparrow, dark-eyed junco, northern cardinal, Carolina wren, fence lizard, white-tailed deer, and eastern cottontail rabbit.

In urban and suburban areas, transmission line ROW corridors can provide habitat for a variety of wildlife, including various songbirds, small mammals, and even larger mammals, such as deer and coyote (TVA 2011a).

4.2.1.3 Open Land Habitats

Habitat conditions (the type and amount of food, cover, and water) determine the wildlife species and number of individuals. Transmission line ROW corridors are typically dominated by open herbaceous habitats. Land cover within the TVA study area is illustrated in Figure 4-2. Undeveloped open lands are comprised of cultivated fields, hayland/pasture, shrub/scrub, and other non-forested cover types. Undeveloped open lands throughout the TVA study area account for approximately 42 percent of the available habitat (see Table 4-2). The majority of land within the TVA transmission ROW consists of undeveloped open lands, accounting for 85 percent of the transmission ROW areas (see Section 4.1). Most of these areas have been greatly modified by intensive row cropping and timber harvesting. Yet these habitats also provide a needed environment for species favoring early successional habitats (TVA 2016a). These areas produce grain and seed crops, grasses and legumes, berries, twigs/shoots, and wild herbaceous plants. Winter cover crops and grain stubble fields also provide winter feeding areas for many wildlife species.

Birds commonly observed in herbaceous, shrub and thicket types of open land habitats may include Carolina wren, tufted titmouse, American goldfinch, northern mockingbird, northern cardinal, eastern towhee, eastern bluebird, brown thrasher, field sparrow and eastern meadowlark. Raptors such as red-tailed hawk and American kestrel also forage along transmission ROWs. Mammals routinely observed in this type of landscape include Virginia opossum, raccoon, eastern cottontail, striped skunk, white-tailed deer, eastern mole, groundhog, and rodents such as white-footed mouse and house mouse. Common reptiles associated with these habitats include black racer, black rat snake and eastern garter snake.

4.2.1.4 Forested Habitats

Many TVA transmission line ROWs are located parallel or adjacent to forested areas dominated by evergreen, deciduous, and/or mixed forested habitats. Forested lands within the TVA study area, based on NLCD land cover types of deciduous, evergreen and mixed forests, are displayed in Figure 4-2. Forested lands throughout the TVA study area account for approximately 47 percent of the available habitat (see Table 4-2). Forested habitat in the TVA study area is mostly fragmented and/or isolated, but in some instances, may also consist of larger, more contiguous blocks of forest. Forested lands make up only 4 percent of the land cover within the TVA transmission ROW (see Table 4-3). Birds in forested areas typically include American crow, Carolina chickadee, tufted titmouse, American goldfinch, common yellow throat, blue-gray gnatcatcher, woodpeckers, and various species of warblers. Mammals typically found in the forested habitat may include eastern chipmunk, eastern gray squirrel, white-tailed deer, bobcat, coyote, and red fox. Amphibian and reptile species that may be found in forested habitat include ring-necked snake, rat snake, five-lined skink, copperhead snake, spring peeper, and upland chorus frog.

4.2.1.5 Riparian and Wetland Habitats

Riparian and wetland habitats within and near TVA transmission line ROW corridors are associated with stream valleys, depressional areas, reservoir systems and areas with localized groundwater discharge. Wetlands within the TVA study area include forested, emergent, and scrub-shrub (see Section 4.6). Open water accounts for approximately 2 percent of the study area and 1 percent of the transmission ROW (see Tables 4-2 and 4-3). Riparian habitats associated with major rivers within the TVA study area, such as the Tennessee River and Cumberland River, provide important habitats for wildlife. Coupled with unique features such as vernal pools, oxbows, bluffs and islands, these areas provide a diverse array of nesting and foraging habitats for wildlife (TVA 2011a). Riparian habitats occur in the transitional zone between aquatic and upland areas. Wetland habitats can be permanently or intermittently flooded, and include such areas as freshwater marshes, swamps, bogs, seeps, wet meadows, and shallow ponds and lakes. Some of the wildlife attracted to these riparian and wetland habitats are beaver, muskrat, mink, raccoon, bald eagle, osprey, northern harrier, ducks, geese, coots, rails, herons, kingfishers, snipe, sandpipers, plovers, killdeer, swallows, common yellowthroat, painted turtle, garter snake, newts, salamanders, toads, and several species of frogs.

4.2.1.6 Other Habitats for Wildlife

Special and unique habitats within the study area or transmission ROW include the following:

- *Pollinator Habitat* – Early successional landscapes, such as those occurring naturally or man-made, have the potential to support a variety of pollinator species (Wojcik and Buchmann 2012). Where feasible, TVA manages the transmission line ROW by encouraging the development of a native compatible vegetation community and managing encroaching aggressive and invasive vegetation to promote pollinator habitat diversity and abundance.

- *Snags* – Snags are standing dead trees. Snags provide cavities for shelter and may support abundant insect populations that are a food source for some wildlife such as woodpeckers. Within the TVA study area, snags occur in forested areas outside, but adjacent to the transmission ROW. Snags also provide important summer roosting habitat for several bat species.
- *Cliffs and Bluffs* – These areas provide secure habitat for nesting hawks and falcons as well as lizards and snakes. Steep terrain limits human and predator access, thus providing wildlife refuge. Cliffs and bluffs occur throughout the study area.
- *Heron, Osprey, and Bald Eagle Nests* – Transmission line structures (poles and towers) within established ROWs may be used by various herons, ospreys, and bald eagles. Ospreys are known to establish nests on transmission line towers within the study area. In contrast, while bald eagles typically do not nest on transmission line towers, they may use structures for perching or may forage within wetland, shorelines and associated habitats within the ROW. Based on a review of the TVA Regional Natural Heritage database, there are 247 O-SAR features associated with heron, osprey, and bald eagle nests that are potentially subject to vegetation control measures along the existing transmission line ROWs within the study area. As described in Section 3.2.2 Alternatives, TVA uses information from the O-SAR process to consider the site sensitivity of each project area in the development of a context sensitive approach to tools for vegetation management. This process guides decisions regarding vegetation maintenance activities in the vicinity of previously documented features.
- *Caves* – Karst topography is prominent throughout the Valley and Ridge Physiographic Province and Interior Low Plateau Physiographic Province in the study area (see Section 4.8 Geology and Soils). Karst topography refers to a type of bedrock condition formed when rocks with high carbonate content, such as limestone and dolomite, are dissolved by groundwater to form sink holes, caves, springs, and underground drainage systems. These sites provide a unique mixture of microhabitats used by a diverse array of cave-dependent species, some endemic to single cave systems (TVA 2016a). TVA's O-SAR database indicated that 165 caves have been documented to occur on or near TVA's transmission ROW.

4.2.1.7 Population Trends in Wildlife

Many animals are wide-ranging throughout the TVA study area; most species tolerant of humans have stable or increasing populations. The populations of many animals have been greatly affected by habitat alteration resulting from agriculture, mining, forestry, urban and suburban development, and the construction of reservoirs. For example, some species such as gulls, wading birds, waterfowl, raptors, upland game birds (except for the northern bobwhite) and game mammals are stable or increasing in the TVA study area (TVA 2015).

While some species flourish under habitat alterations, others have shown noticeable declines. For example, populations of some birds that are dependent on grasslands and woodlands have displayed dramatic decreases in their numbers. Across North America, 48 percent of grassland-breeding birds are of conservation concern because of declining populations, as are 22 percent of forest-breeding birds (North American Bird Conservation Initiative 2009). A large number of the declining birds are Neotropical migrants, species that nest in the United States and Canada and winter south of the U.S. (American Bird

Conservancy 2009). Approximately 27 species of birds breeding in the TVA study area are considered to be of conservation concern (Table 4-8).

In addition, global amphibian declines have been well-documented, and declines in amphibian populations in the TVA study area have also been reported. The primary causes for these declines are the loss and fragmentation of habitats from urban and suburban development, and agriculture and forest management practices. Introduced pathogens have also contributed to wildlife population declines (Muths et al. 2012).

Bat populations have been greatly reduced across their range and within the TVA study area following the introduction and spread of a fungal pathogen causing white-nose syndrome, a fatal disease to which most cave-dwelling bats are susceptible (Lankau and Moede-Rogall 2016).

Invasive terrestrial animals at TVA facilities, including transmission line ROWs, include the rock pigeon, European starling, house sparrow, and fire ant. These species have little effect on the operation of TVA's transmission line ROW system (TVA 2015).

Table 4-8. Migratory Birds of Conservation Concern within the TVA Study Area

Common Name	Scientific Name	Status[1]
American golden plover	*Pluvialis dominica*	BCC rangewide
Bald eagle	*Haliaeetus leucocephalus*	Non-BCC vulnerable
Black-billed cuckoo	*Coccyzus erthropthalmus*	BCC rangewide
Bobolink	*Dolichonyx oryzivorus*	BCC rangewide
Eastern whip-poor-will	*Antrostomus vociferus*	BCC rangewide
Golden eagle	*Aquila chrysaetos*	Non-BCC vulnerable
Golden-winged warbler	*Vermivora chrysoptera*	BCC rangewide
Henslow’s sparrow	*Ammodramus henslowii*	BCC rangewide
King rail	*Rallus elegans*	BCC rangewide
Le Conte’s sparrow	*Ammodramus leconteii*	BCC – BCR
Lesser yellowlegs	*Tringa flavipes*	BCC rangewide
Long-eared owl	*Asio otus*	BCC rangewide
Marbled godwit	*Limosa fedoa*	BCC rangewide
Nelson’s sparrow	*Ammodramus nelsoni*	BCC rangewide
Prothonotary warbler	*Protonotaria citrea*	BCC rangewide
Red-headed woodpecker	*Melanerpes erythrocephalus*	BCC rangewide
Red-throated loon	*Gavia stellate*	BCC rangewide
Rusty blackbird	*Euphagus carolinus*	BCC rangewide
Semipalmated sandpiper	*Calidris pusilla*	BCC rangewide
Short-billed dowitcher	*Limnodromus griseus*	BCC rangewide
Smith’s longspur	*Calcarius pictus*	BCC – BCR
Swallow-tailed kite	*Calidris pusilla*	BCC rangewide
Whimbrel	*Numenius phaeopus*	BCC rangewide
Willet	*Tringa semipalmata*	BCC rangewide
Wood thrush	*Hylocichla mustellina*	BCC rangewide
Yellow rail	*Coturnicops noveboracensis*	BCC rangewide

Source: USFWS IPaC 2017a

[1]Status code: BCC rangewide = Bird of conservation concern throughout its range; Non-BCC vulnerable = Not a BCC, but is of concern due to the Eagle Act or due to potential susceptibilities in offshore areas from certain development activities; BCC-BCR = Bird of conservation concern only in particular bird conservation regions.

4.2.2 Environmental Consequences for Wildlife

4.2.2.1 General Impacts

The TVA study area is inhabited by thousands of species of terrestrial wildlife, each with a diverse life history and habitat needs. Essential components of habitat include access to food, water, cover, and space. Constructing and operating a transmission line ROW and managing vegetation within it can cause direct impacts to individuals or changes to habitat features. A change to any aspect of habitat may benefit some wildlife species and be harmful to others. Each of the vegetation management methods considered have the potential to cause one or more of the following impacts:

- *Direct injury* – Tree clearing, mowing, vehicle operation, and ground disturbance may cause direct injury or death to individuals unable to disperse quickly such as juveniles, eggs, or burrowing animals.
- *Disturbance* – Many species are sensitive to human presence. Noise, odor, or the sight of humans and equipment performing construction and maintenance activities (including vegetation control) may disrupt activities such as feeding, resting, movement, and reproduction. Disturbance may cause stress, displacement from home range, and competition with individuals in the surrounding habitat as animals disperse.
- *Habitat conversion* – Clearing of forested lands would result in a reduction in available habitat for species adapted to forest or forested wetland, although similar suitable habitat can typically be found within a short distance. For species adapted to early successional habitats or edge (the transition zone between different habitats), transmission ROWs are beneficial because they increase suitable habitat. Overall, plant and wildlife species diversity within the transmission line ROWs may be higher than in adjacent forests by managing for low-growing shrubs, forbs, and grasses beneath the transmission lines and taller, compatible growing vegetation in the border zones (Yahner 2004).
- *Habitat fragmentation* – Some species require contiguous areas of wooded habitat. Because of the low-growing vegetative species found within a transmission line ROW corridor, the ROW may present a barrier for some species unable to cross either physically or because cover is insufficient. For other species that prefer early successional habitats, transmission line corridors may actually facilitate movement.
- *Toxic chemicals* – Herbicides, fuel, and mechanical fluids used in vegetation maintenance activities may have toxic effects on wildlife. These chemicals may wash or leach into streams or caves damaging these ecosystems. Animals may drink, inhale, or absorb toxins present in the environment or eat toxins present on/in vegetation or prey.
- *Impacts to soil and water* – Vegetation maintenance activities have the potential to disturb soil, potentially increasing erosion and stream sedimentation. Changes to water quality and hydrology could result if these impacts are not mitigated. Increased sediment loads can have detrimental effects to both aquatic and terrestrial wildlife (Berry et al. 2003); for example, sediment deposited on the stream bed can bury the crevices inhabited by aquatic salamanders and smother invertebrates that provide food for bats, birds and other animals. Impacts of this nature are unlikely given the rare and infrequent occurrence of stream crossings as part of routine vegetation maintenance activities.

- *Invasive species* – Clearing of natural land cover and transmission ROW vegetation maintenance may inadvertently introduce invasive plants or animals or create habitat conditions that favor invasives. Disturbance related to human activity provides a competitive advantage to invasive plants over natives (Daehler 2003).

4.2.2.2 Impacts to Wildlife from Vegetation Control Methods

4.2.2.2.1 Impacts to Wildlife from Manual Control Methods

Manual control methods result in a greater degree of disturbance to wildlife than herbicide treatment, as manual methods entail a more prolonged presence of humans and the use of chainsaws that would create more noise and odor in the short-term. Chainsaw use would be prohibited near nest sites for colonial wading birds and ospreys during nesting season (February 1 to July 15). No clearing would be permitted within 660 feet of known bald eagle nests from December 1 to July 1. Because manual methods are less efficient than mechanical and herbicide treatments, manual work ultimately requires more frequent treatments, increasing overall disruption of wildlife.

4.2.2.2.2 Impacts to Wildlife from Mechanical Control Methods

In the short-term, mechanical methods have a greater negative impact to wildlife than manual control methods. While mechanical methods may be more efficient than manual control methods, they are also characterized as having greater noise emissions that may result in avoidance and greater wildlife stress. Mowing may also affect ground-nesting birds and other less mobile animals unable to quickly disperse. Ground-based machinery also results in greater soil disturbance, potentially leading to erosion and sedimentation. Indirect effects may include impacts to water quality and amphibians or reptiles, and indirect effects to invertebrates, foraging bats and birds. Heavy equipment may also result in indirect effects to subsurface resources (cave systems) via sedimentation, contamination, or collapse that may injure or destroy subterranean animals, burrows, or nests. Impacts of this nature are unlikely given the rare and infrequent use of soil disturbing equipment.

4.2.2.2.3 Impacts to Wildlife from Herbicide Application Methods

Herbicide use is not only effective in controlling target plant species, but it typically has the benefits of improving plant diversity and density. Greater plant diversity can create suitable conditions for a wider variety of animal species. Meadow-like environments of native species are especially beneficial to pollinators. When used alone, herbicides have been shown to decrease the density of targeted shrubs and trees more than mechanical or manual methods and are even more effective when combined with mowing (Bramble and Byrnes 1996). Increased density of low-growing plants prevents establishment of unwanted woody species. Both of these factors decrease the frequency of treatment and environmental disturbance. Besides decreasing the frequency of treatment, herbicide use is less disturbing to wildlife in terms of noise and duration than mechanical and manual methods.

Spot, localized, and aerial application of herbicides would be less damaging to soils than most mechanical methods. In contrast, ground-based (i.e., manual or mechanical) broadcast application uses wheeled or tracked vehicles. Avoiding vehicle use in the transmission ROW would reduce the potential for erosion, stream sedimentation, and damage to nesting and tunneling wildlife. Keeping groundcover intact would benefit wildlife by retaining cover, food, and insect communities.

The primary concern with herbicides is the potential to impact non-target organisms, soil, and water. Wildlife can be exposed to active ingredients, adjuvants, and carriers through the skin, by inhalation, or by swallowing. Herbicides have been designed to target biochemical processes unique to plants, such as photosynthesis. Thus, herbicides typically are not acutely toxic to animals. Some herbicides, however, can have subtle, but significant, physiological effects on animals, including developmental effects. Herbicide use may alter soil pH, microbial, and fungal activity (USFWS 2009). Spills and leaks are inherent risks when using chemicals. Herbicides may drift, run-off, or leach into waterbodies, groundwater, and caves. Contamination of water presents a risk to amphibians and aquatic species as well as to terrestrial species that drink it. Caves are sensitive ecosystems and can be easily damaged by input from the surface. However, TVA would use BMPs (TVA 2017a) to minimize potential herbicide-related effects (see mitigation measures in Section 4.6.2.5).

4.2.2.2.4 Potential Herbicide Toxicity to Wildlife

Potential toxic effects of herbicides to wildlife depend on the toxicity of the herbicide and the chemical exposure amount to the animal. TVA applies and handles all herbicides in accordance with manufacturer and EPA labeling requirements. All but one of the herbicides currently used as part of TVA's vegetation management program have a low toxicity to wildlife when applied at the recommended label rates (BPA 2000). EPA's recommended label application methods and rates are intended to reduce risks to both the applicator and receptors in the environment (EPA 2017a). Table 4-9 provides the toxicity ratings for mammal and bird species based on the active ingredient of herbicides currently used in TVA's vegetation management as discussed in Section 2.1.3. The ratings are based on the amount of herbicide product (in milligrams) that would be needed for each kilogram of animal body weight to have a toxic impact on the animal. Typically, the greater the amount of herbicide it takes to harm an animal, the less toxic that particular herbicide is to that animal (BPA 2000).

EPRI also investigated potential toxicity (including Margin of Safety [MOS]) for a range of herbicides. EPRI concluded that the risk to wildlife is within the acceptable range in all cases, under typical application (MOS values ranging from 7 to greater than 800). Under maximum application rates, the summary shows that fosamine ammonium, glyphosate, imazapyr, metsulfuron methyl, picloram and sulfometuron methyl have an adequate MOS for wildlife species at either typical or maximum rates of application. 2,4-D and triclopyr amine and ester also have an adequate MOS at typical rates of application, but not at maximum rates of application (EPRI 2004).

TVA normally does not apply herbicides at the maximum recommended concentration. Herbicides infrequently may be applied at the maximum recommended concentration when broadcast application is selected as a method for control of the vegetation. For example, in the use of Glyphosate TVA ROW workers typically utilize a 4 percent mix of Glyphosate (Rodeo) applied to only the woody stems of trees on the ROW. According to the attached label the maximum application rate of 8 quarts (2 gallons) of Glyphosate can be used on 1 acre of land per year. The range of gallons of aggregate (herbicide and water) applied per acre ranges from 7-22 gallons per acre. This translates into 0.28-0.88 gallons of Glyphosate which is well limits. the maximum limits. Further, the ranges per acre (7 to 22 gallons of aggregate) are from previous applications and, due to the success of TVA's vegetation management program, are decreasing every year. Low-volume backpack spraying should never reach maximum application rates.

For broadcast application, TVA contracts are structured to include herbicide cost as a cost to the contractor, thus encouraging minimal application of herbicide. TVA, however, has utilized maximum application rates in the past when site conditions make it necessary for effective vegetation control. Such situations were in the minority (i.e., less than 50 percent of broadcast applications).

Due to the potential for 2,4-D to be highly toxic to aquatic life if it comes in direct contact with an aquatic environment (EPRI 2004 and BPA 2000), it is not currently used in TVA's vegetation management program. For areas in need of herbicide application near aquatic environments, TVA is committed to the use of EPA-registered herbicides specifically formulated and approved for safe use near aquatic environments (e.g., Rodeo – active ingredient glyphosate).

Table 4-9. Toxicity to Wildlife by Herbicides Currently used for TVA's Vegetation Management

	Acute Toxicity		
Active Ingredient	**Mammals**	**Birds**	**Terrestrial Invertebrates (Bees)**
Glyphosate	practically non-toxic	practically non-toxic	practically non-toxic
Imazapyr	practically non-toxic	practically non-toxic	slightly toxic
Metsulfuron Methyl	practically non-toxic	practically non-toxic	practically non-toxic
Triclopyr	practically non-toxic	practically non-toxic	practically non-toxic
Fosamine Ammonium	practically non-toxic	practically non-toxic	practically non-toxic
Aminopyralid	practically non-toxic	slightly toxic	practically non-toxic
Clopyralid	practically non-toxic	slightly toxic	practically non-toxic
Diuron	slightly toxic	slightly toxic	practically non-toxic
Tebuthiuron	moderately toxic	slightly toxic	slightly toxic

Toxicity Definitions:

Practically non-toxic – Mammals and Birds (acute oral) >2,000 mg/kg, Birds (dietary) >5,000 mg/kg
Slightly toxic – Mammals and Birds (acute oral) 501-2,000 mg/kg, Birds (dietary) 1,000-5,000 mg/kg
Moderately Toxic – Mammals and Birds (acute oral) 51-500 mg/kg, Birds (dietary) 501-1,000 mg/kg

Source: Bonneville Power Administration 2000

4.2.2.3 Impacts to Wildlife from Debris Management

Debris management methods used on TVA transmission ROWs can be beneficial to wildlife by creating cover, nutrient recycling, and erosion control. Debris management also can be detrimental to wildlife by altering habitat, increasing wildfire fuel load, harboring tree diseases and pests, and offsite debris removal involves mechanical equipment that increases wildlife disturbance and erosion.

The cut and leave methods are the least disturbing to soils, making it the preferred choice on steep slopes or in sensitive areas such as wetlands and SMZs. Benefits to wildlife include the availability of debris piles as cover, nutrient recycling, and erosion control provided by woody material. Negative consequences of this method are the increased wildfire fuel load (i.e., potential to promote wildlife fire that results in injury or mortality) and the ability of dead wood to harbor tree diseases and pests.

Chipping, mulching and offsite disposal methods involve the use of mechanical equipment and increase the potential to disturb soil and wildlife. All three avoid increasing wildfire fuel and potential for disease and insects but also eliminate the erosion control, nutrient recycling, and wildlife habitat provided by coarse woody debris. Overall, offsite debris management and landowner use would result in some soil disturbance, but the additional effect would be minor when considered in the context of the original vegetation clearing.

Leaving standing snags in place following herbicide treatments provides excellent habitat for a variety of wildlife species. These trees are used as perches by raptors and frequently contain cavities or are excavated for shelter by other birds and mammals. Decaying bark and solar exposure benefits reptiles and roosting bats. Invertebrates use snags for food and shelter and in turn provide food for larger species.

4.2.2.4 Impacts to Wildlife from Restoration

Reseeding has beneficial effects for wildlife when performed correctly. Revegetating the transmission ROW provides both cover and food. The greater the diversity in vegetation species and structure, the more wildlife species would benefit. Reseeding disturbed areas would result in decreased erosion equating to less sedimentation and degradation of water quality. Some methods could involve machinery that can disturb soil in the short-term but would provide stabilization once vegetation is reestablished. Revegetation with native seeds and plants can prevent the establishment of invasive species. Successful establishment of low-growing species would inhibit succession by undesirable trees, avoiding the need for frequent disturbance and would thereby minimize wildlife impacts.

4.2.2.5 Mitigation Measures for Impacts to Wildlife

TVA would employ a number of mitigation measures that would benefit a wide range of wildlife species; these include:

- Conducting pre-treatment field surveys for sensitive resources.
- Placing buffers around sensitive resources.
- Enforcing seasonal or permanent restrictions on clearing, spraying, access, and disturbance.
- Preventing cave access except by authorized personnel.
- Implementing standard BMPs for clearing, herbicide use, SMZs, rare plants, wetlands, and restoration (TVA 2017a).

Among the manual vegetation control methods, chainsaw use would be prohibited near nest sites for colonial wading birds and ospreys during nesting season (February 1 through July 15). No clearing would be permitted within 660 feet of known bald eagle nests from December 1 through July 1. In rare circumstances in which clearing needs to take place during these time frames, TVA would coordinate with U.S. Department of Agriculture (USDA) Wildlife Services to ensure any actions comply with the conditions specified under USDA's Take permit.

As with manual methods, mechanical clearing would be prohibited near nest sites for colonial wading birds and ospreys during nesting season (February 1 through July 15). Mowing and brush-hogging would be permitted. No vegetation clearing would be permitted within 660 feet of known bald eagle nests from December 1 through July 1. To minimize impacts to ground nesting birds, when practicable, mowing would be avoided during the height of the breeding season (May 1 to July 15) (Vickery et al. 2000) and would ideally occur before mid-March and after August. Heavy equipment may also be seasonally excluded from certain habitats that support unusual characteristics or sensitive species as determined by TVA biologists. Large equipment would be prohibited within 200 feet of cave openings unless on an access road. Clearing around cave entrances would be limited to machinery such as chainsaws, brush hogs, and mowers.

4.3 Threatened and Endangered Species

4.3.1 Affected Environment

The TVA study area provides habitat for numerous species of plants and animals that have declining populations or are otherwise rare and considered to be endangered, threatened, or of special concern at the national and/or state level.

4.3.1.1 Regulatory Framework for Threatened and Endangered Species

The ESA (16 United States Code [USC] §§ 1531-1543) was passed to conserve the ecosystems upon which threatened and endangered species depend and to conserve and recover those species. An endangered species is defined by the ESA as any species in danger of extinction throughout all or a significant portion of its range. A threatened species is defined as one likely to become endangered within the foreseeable future throughout all or a significant part of its range. Areas known as critical habitats, essential to the conservation of federally listed species, can also be designated under the ESA. The ESA establishes programs to conserve and recover federally listed species and makes their conservation a priority for federal agencies. Under Section 7 of the ESA, federal agencies are required to consider the potential effects of their proposed actions on federally listed species and critical habitats. If the proposed action has the potential to affect these resources, the federal agency is required to consult with the USFWS.

There are laws protecting listed species in all seven states in the study area. In a few states, protection is limited to species listed under the ESA, but in other states, legal protections are extended to additional species designated by the state as endangered, threatened, or other classifications such as “in need of management.”

Due to the programmatic nature of this evaluation, the following discussion will focus primarily on federally listed threatened and endangered species. These species (or groups of species) will serve as a surrogate for the numerous species on each state’s protected species lists. Conservation measures and avoidance and minimization measures identified in Sections 4.1.2.5 Mitigation Measures for Impacts to Vegetation and 4.2.2.5 Mitigation Measures for Impacts to Wildlife, as well as routine use of BMPs and project planning and environmental review processes, in some cases apply to state-listed species and habitats as well as to federally listed species and habitats.

TVA has consulted with USFWS per Section 7(a)(2) of the ESA concerning the potential impacts of routine vegetation maintenance activities to affect federally threatened and endangered species within the study area. This consultation was completed and the USFWS issued a Biological Opinion in May 2019 concurring with TVA’s effects determinations (Appendix B).

4.3.1.2 Threatened and Endangered Species in the TVA Study Area

A summary of federally and state-listed species within the study area is provided in Table 4-10. Appendix J includes a report of all federally listed species and critical habitats within the TVA study area obtained from the USFWS Information for Planning and Consultation (IPaC) online tool (USFWS 2017a) and a list of all sensitive species by county within the study area obtained from the TVA Regional Natural Heritage database.

According to the USFWS IPaC database and the TVA Regional Natural Heritage database, 168 species listed under the ESA as endangered, threatened, proposed for listing, or candidates for listing have been reported from within the TVA study area. In addition, about 1,350 individual plant and animal species have been formally listed as protected species by one or more of the states, or otherwise identified as a species of conservation concern (TVA 2017e). Additionally, critical habitats for 43 federally listed species identified in Figure 4-3 are located within the study area (USFWS 2017a).

The highest concentrations of terrestrial and aquatic species federally listed under the ESA occur in the Blue Ridge ecoregion (see Section 4.1.1 for ecoregion descriptions). Relatively few listed species occur in the Mississippi Alluvial Plain ecoregion. The taxonomic groups with the highest proportion of species listed under the ESA are fish and mollusks (see Section 4.5). Factors contributing to the high proportions of vulnerable species in these groups include the high number of endemic species within the study area and the alteration of their habitats that increased the risk to these species. River systems with the highest numbers of listed aquatic species include the Tennessee, Cumberland and Coosa rivers (TVA 2015).

Population status trends for federally listed species in the TVA study area are variable (i.e., increasing, stable, or decreasing). For example, populations of a few listed species have increased, primarily because of conservation efforts, to the point where they are no longer listed under the ESA (e.g., bald eagle, peregrine falcon, and Tennessee coneflower). Other species have had their listing status downgraded from endangered to threatened (e.g., snail darter, large-flowered skullcap, and small whorled pogonia) due to increased population estimates and habitat protections. Among the federally listed species with populations that continue to decline are the American hart's tongue fern, Indiana bat, and northern long-eared bat. The formerly common northern long-eared bat recently was federally listed as threatened under the ESA due to dramatic population declines caused by white-nose syndrome. This pathogen was first reported in the TVA study area in 2009, and signs of mortality were first observed in 2011 (Samoray 2011). Population trends of many of the other listed species in the TVA study area are poorly understood.

Many species listed under the ESA occur in the immediate vicinity of the TVA transmission system ROW and would potentially be affected by its vegetation management. The major habitats supporting federally listed species in the TVA study area include free-flowing rivers and streams, caves, limestone cedar glades, high elevation areas, shorelines, and bluff/rock outcrops. TVA has taken multiple actions to minimize the adverse effects of vegetation management on federally listed species (e.g., seasonal restrictions on select activities to avoid impacts to federally listed roosting bats and nesting turtles) (TVA 2011b) and has taken steps to conserve listed species occurring in other habitats (TVA 2015).

Table 4-10. Total Number of Federally and State-Listed Threatened and Endangered Species Within the TVA Study Area

Species	Alabama	Georgia	Kentucky	Mississippi	North Carolina	Tennessee	Virginia	TVA Study Area
Mammals								
State[1]	11	8	8	3	15	19	6	33
Federal[2]	3	2	2	3	5	6	4	6[3]
Birds								
State	10	4	29	5	23	26	7	51
Federal	3	1	3	3	1	3	2	5
Reptiles								
State	7	5	115	3	4	7	2	26
Federal	1	1	1	1	1	1	0	4
Amphibians								
State	3	1	6	3	12	13	0	28
Federal	3	1	0	1	1	2	1	4
Fish								
State	35	38	49	10	12	78	14	156
Federal	9	7	5	2	1	21	5	28 (34 IPaC)
Mollusks								
State	73	16	37	20	27	50	34	119
Federal	51	15	24	27	4	52	24	71
Crustaceans								
State	2	3	6	0	3	12	5	29
Federal	1	0	1	0	0	1	1	4
Insects and Other Invertebrates								
State	1	0	6	1	25	5	7	40
Federal	0	0	1	2	2	3	0	4
Plants								
State	180	51	96	186	104	465	76	859
Federal	17	9	2	3	10	24	1	36 (39 IPaC)

[1] Species without a State status listed in the TVA Regional Natural Heritage database were excluded from the count of state-listed species.
[2] Represents total number of federal species with known occurrence records within the TVA study area. Because species may be listed in multiple states and federally listed species can occur in multiple states, these numbers are not added to derive total study area numbers.
[3] Total numbers of federally listed species were derived from the TVA Regional Natural Heritage database, unless otherwise noted. This data includes total numbers of species listed within the TVA study area and includes species listed as PS, C, LE LT, DM (see Appendix J for definitions of species codes). Complete lists of species by county from the TVA Regional Natural Heritage database are included in Appendix J. The complete IPaC list is also included in Appendix J.

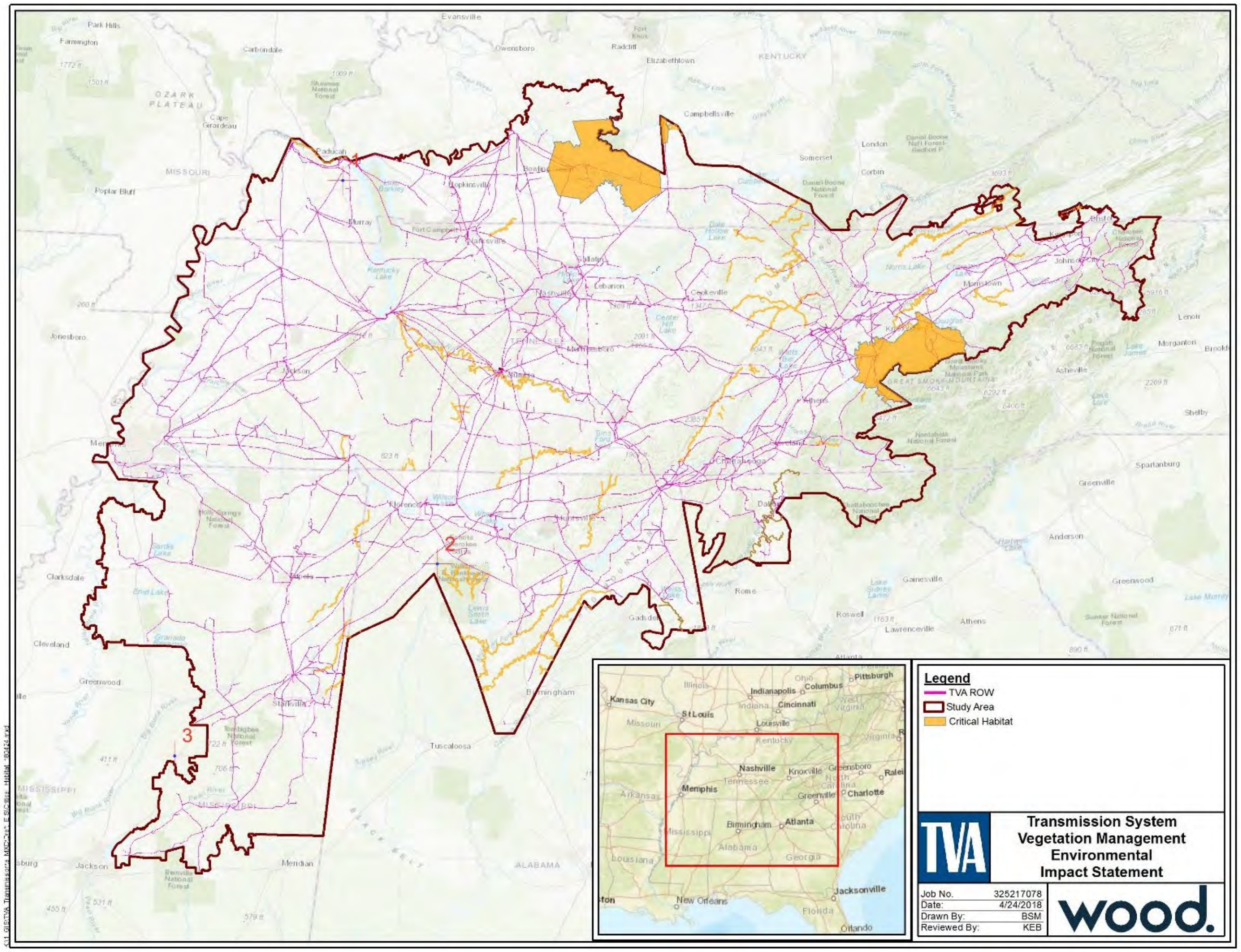


Figure 4-3. Designated Critical Habitats for Federally Listed Species under the ESA Within the TVA Study Area

4.3.1.3 Threatened and Endangered Aquatic Animals

Within the TVA study area are over 100 species of aquatic animals, primarily fish and mollusks, federally listed as endangered, threatened, or candidates for such listings (Table 4-10 and Appendix J). Additional aquatic species are listed in the TVA study area by the states. A summary of the number of federally and state-listed species known from the study area is presented in Table 4-10. Detailed lists of the species reported from the TVA study area in each of the seven states are presented in Appendix J. Several listed species are known to occur within or immediately adjacent to TVA transmission system ROWs. According to the TVA Regional Natural Heritage database, a total of 448 aquatic sensitive species occurrences are documented within the study area. As described in Section 3.1 (description of O-SAR and BMP process), TVA reviews these features and uses this information to assign class rankings to sensitive areas that are used to guide management decisions regarding vegetation maintenance activities in the vicinity of recorded features to avoid and/or minimize impacts.

The watersheds of the Tennessee, Cumberland, and Coosa rivers support an unusually diverse group of aquatic animals, but human activities have resulted in adverse impacts to the streams and aquatic organisms therein (Etnier 1998). Previous evidence suggests that the pristine stream habitats in the Tennessee River system had been inhabited by 91 freshwater mussel species (Parmalee and Bogan 1998). Mussels were beginning to be affected by human activities by the mid-1800s, and many of these freshwater mussels were already extirpated before the Tennessee River main stream impoundments (dams) were constructed (TVA 2011a). The lack of early fish collections does not allow a similar comment about the impact of these activities to Tennessee River main stream fish assemblages, but there likely were species of Tennessee River fish that became extinct before they were known to science (TVA 2011a). Diversity was higher in the study area in the past. However, exceptional species diversity is still observed in fish; mollusks, crayfish, aquatic insects, and various other invertebrate groups (see Section 4.5).

4.3.1.4 Threatened and Endangered Terrestrial Animals

More than 15 federally listed, protected, or candidate terrestrial animal species and over 175 state-listed terrestrial animal species occur within the TVA study area (see Table 4-10 and Appendix J). The list includes a diverse array of birds, mammals, reptiles, amphibians, and invertebrates, most of which are cave-dwelling species. Most terrestrial animal listed species are found in the Blue Ridge, Southwestern Appalachian, and Interior Plateau ecoregions (TVA 2011a). Many species have widespread distributions within the TVA study area; examples include Indiana bat and green tree frog; however, some species are endemic to specific locales, especially the cave-dwelling species.

Some of the terrestrial species listed in Appendix J are known or have potential to occur (based on location and presence of suitable habitat) on or immediately adjacent to TVA transmission line ROWs subject to vegetation maintenance activities. These documented and potential occurrences have been mapped, catalogued, and classified in TVA's O-SAR Database (see Section 3.1) such that any necessary restrictions in the vicinity of these occurrences are available to operations staff during planning and implementation.

Populations of several listed terrestrial species have improved since the ESA was enacted. Results of surveys performed by TVA and others indicate ospreys appear to have increasing or stable numbers in the TVA study area (TVA 2011a). Numbers of some other species, such as Indiana bats, continue to decline or remain low despite protective measures implemented by various federal and state agencies. Recent discovery of white-nose syndrome, a highly virulent disease impacting cave-dwelling bats, could exacerbate population declines for listed bat species. Therefore, both gray bat and Indiana bat populations, along with other cave-dwelling bats, are being monitored closely to assess ongoing trends. White-nose syndrome has spread throughout the eastern U.S. including states within the study area. TVA has closed the caves on TVA fee-owned and managed lands to public access, as requested by the USFWS in an effort to control the spread of this disease; and TVA works with several conservation agencies to monitor the spread of the disease in the study area (TVA 2011b).

4.3.1.5 Threatened and Endangered Plants

A total of 39 plant species federally listed as endangered, threatened, or candidates for listing under the ESA and 859 state-listed plant species are known to occur within the TVA study area (USFWS 2017a and TVA 2017e).

Among the listed plants, a total of 10 federally listed plants and 167 state-listed plants are known to occur within the TVA transmission line ROWs, or within 50 feet of those ROWs, and therefore could be impacted by TVA vegetation maintenance actions. A complete list, and a list of species known to be present within and immediately adjacent to the TVA transmission ROWs, can be found in Appendix J. TVA records known locations of these species so vegetation maintenance activities can be planned in a manner to avoid and/or minimize impacts in those areas. Based upon the O-SAR database, there are about 2,500 documented or potential locations of federally or state-listed plant species or unique plant communities within those areas subject to vegetation management along ROWs within the TVA study area. As described in Section 3.1, TVA uses this information to assign class rankings to sensitive areas that are used to guide management decisions regarding vegetation maintenance activities in the vicinity of recorded features.

Within the TVA study area, a large percentage of the state-listed plant species are found in the Interior Plateau, the Blue Ridge, and the Southwestern Appalachians ecoregions (TVA 2011a). The three ecoregions with high numbers of state-listed plants also contain a large proportion of the rare plant associations known from the TVA study area as discussed in Section 4.1.

Despite continued threats from invasive species and residential and commercial development within the TVA study area, there are success stories about endangered and threatened plants being removed from the ESA listing or being proposed for removal. Previously unknown populations of other species have recently been discovered. One success story is Eggert's sunflower. When listed as threatened in 1997, the species was known from 34 populations in Kentucky and Tennessee. Due to conservation efforts on federal lands and additional surveys, nearly 300 populations were located in three states by 2005. The newly discovered populations included several on TVA lands in northwest Alabama. TVA has zoned several of these population sites for Sensitive Resource Management (TVA 2011a). In 2006, Eggert's sunflower was removed from listing under the ESA. A similar story is emerging for the Tennessee coneflower, listed as Endangered in 1979. After 30 years of conservation management, the USFWS considers this species as no longer in need of protection by the ESA. New populations have also recently been discovered for Braun's rock-cress, large-flowered skullcap, Morefield's leather-flower, and leafy prairie clover (TVA 2011a).

However, several listed plant species are noted to have declining population trends that may be attributable to both an environmental and economic development stresses. These species include the green pitcher plant, Pyne's ground plum, and Virginia spiraea (TVA 2011a).

Conservation efforts led by TVA for spreading false foxglove contributed to its down-listing from Endangered to Species of Special Concern in Tennessee. Because insufficient population data are known for many state-listed plants, field surveys conducted by TVA staff have added to the distributional data for many of these species and aided in the reassessment of listing status by states within the TVA study area.

4.3.2 Environmental Consequences for Threatened and Endangered Species

4.3.2.1 General Impacts to Threatened and Endangered Species

This section of the PEIS provides a narrative regarding the potential for TVA's vegetation control program to affect threatened and endangered species. Differences in potential effects to threatened and endangered species would be relatively minor across alternatives. Under any alternative chosen, TVA would implement the same screening, environmental review and planning program as described in Section 3.1.2.

TVA reviews transmission ROWs prior to annual maintenance activities and identifies appropriate vegetation control methods, appropriate conservation activities, BMPs, and avoidance and minimization measures to guide vegetation maintenance actions based on the known or likely occurrence of sensitive species or habitats within TVA ROWs.

While some methods of vegetation control could have significant impacts on individuals or populations of listed species (e.g., aerial herbicide application on a known population of federally endangered plants), TVA's screening process (O-SAR) identifies these potential impacts and identifies the appropriate vegetation control methods (hand clearing, mechanical clearing or spot application of herbicide) in this instance. Species- and/or group-specific (e.g. SMZs) restrictions and guidance have been developed for all federally listed and most state-listed resources in the study area.

The General Impacts determinations presented below are in the context of implementation of the O-SAR process to avoid or substantially minimize potential for impacts to threatened and endangered species and their habitats.

4.3.2.1.1 Overall Impacts to Threatened and Endangered Fish, Freshwater Mussels, Freshwater Snails, and Crustaceans

The TVA transmission system frequently intersects waterbodies, ranging from smaller streams to larger rivers. Many of these are highly diverse, aquatic systems that possess global conservation significance due to the many federally listed aquatic species they support. While the TVA transmission lines and ROWs physically intersect streams and rivers at crossings across the TVA study area, there is little meaningful nexus between TVA vegetation management activities and listed aquatic species or their habitats.

The single largest reason for this lies in the TVA ROW vegetation management program's focus on controlling woody vegetation in terrestrial environments. Aquatic systems supporting listed species are physically separated from terrestrial ROWs. This physical separation between the terrestrial environments where vegetation management takes place and the aquatic systems that comprise habitats for listed species serves to buffer aquatic animals from most of the potential direct and indirect negative effects of floor and tree work.

While the targeted, terrestrial focus of the program inherently limits the potential to directly affect listed aquatic species, it does not fully preclude the possibility that aquatic species could be indirectly or cumulatively affected by TVA vegetation management activities. Work occurring within or immediately adjacent to SMZs has the greatest potential to result in adverse effects. This is because SMZs are ecotones (or areas of transition) between transmission line ROWs and aquatic environments supporting listed species. TVA employs a host of BMPs that are designed to minimize environmental impacts like soil disturbance/erosion, stream bank destabilization, in stream deposition of woody debris, damage to in steam habitats (vehicle/equipment traffic), and inadvertent discharge of herbicides or other petrochemical to aquatic environments.

TVA biologists also use the O-SAR process to identify portions of transmission line ROW where listed species are likely to occur and to prescribe vegetation management practices designed to avoid or minimize impacts to riparian and aquatic habitats. As of August 2018, the most restrictive O-SAR designation (Class 2), which mandates coordination with TVA biologists before any work is conducted, has been assigned to 315 areas covering more than 1,000 acres. These areas include waterbodies with known or likely presence of federally listed aquatic species or designated critical habitat for those species. The TVA ROW vegetation management program physically intersects habitats containing listed species, but it does not measurably affect aquatic species because of a robust environmental program focused on avoidance and minimization of impacts.

During early coordination, the USFWS expressed concerns about the potential effect of mechanical tree clearing within previously unmaintained sections of TVA ROW in the Conasauga River basin in northern Georgia and southeast Tennessee. The concern was not related to removal of single danger trees. Mechanical tree clearing includes the use of bulldozers, track-hoes, skid steers, shears (e.g., feller-buncher), mulcher/chippers, or Hydro-axes (including various other attachments) to clear trees and shrubs where previous vegetation management has been infrequent and woody plants have encroached into the ROW. To address these concerns and prevent any measurable adverse impacts to aquatic species, TVA would coordinate with the USFWS in advance of all future mechanical tree clearing that occur within:

- 200 feet of the Conasauga River mainstem upstream of the Loopers Bend; and
- 200 feet of any 2nd order tributary (or greater) that converges with the Conasauga River upstream of Loopers Bend.

These conservation measures would be recorded in the O-SAR database and would ensure TVA coordination with the USFWS in advance of any future tree clearing project meeting the above criteria. TVA would not automatically coordinate with the USFWS if using other vegetation control, debris management, or restoration tools in these sensitive areas, but all BMPs and SOPs previously discussed would still be fully implemented.

With implementation of BMPs, SOPs, and O-SAR process, and conservation measures listed above TVA has determined that the ROW vegetation management program is not likely to adversely affect aquatic animal species, including all fishes, freshwater mussels, freshwater snails, and crustaceans included in the BA (listed in Appendix J). Consultation with USFWS was completed in May 2019 and the USFWS issued a Biological Opinion concurring with TVA's effects determinations for all aquatic species (Appendix D).

4.3.2.1.2 Overall Impacts to Threatened and Endangered Terrestrial Animals

Species-specific impacts to federally listed species, avoidance and minimization measures, and conservation measures appropriate to each species are addressed in the Endangered Species Act Section 7 consultation documents.

The TVA study area is inhabited by 19 species federally listed as either endangered, threatened, candidate for listing, or delisted and monitored. These include five mammals, five birds, two reptiles, two amphibians, two snails, two insects, and one arachnid. Many of these species occupy only small or very specific habitat types. Some species have been threatened by habitat loss or change, and others by persecution, pollution, or disease.

Threatened and Endangered Mammals

Pursuant to Section 7(a)(2) of the ESA, TVA entered into consultation with the USFWS in 2014 to programmatically assess the impact of 96 routine TVA actions on the four federally listed bat species known to occur in the TVA study area: Indiana bat, northern long-eared bat, gray bat and Virginia big-eared bat. This consultation included activities associated with transmission ROW vegetation management. TVA determined that none of the activities associated with ROW vegetation management have the potential to adversely affect gray bat or Virginia big-eared bat. Transmission ROW maintenance activities (primarily tree removal), were determined to be likely adversely affect Indiana bat and northern long-eared bat. The USFWS issued a Biological Opinion in April 2018, concurring with TVA's effects determinations and issued an Incidental Take Statement that authorizes TVA's ROW vegetation management practices over a 20-year term (Appendix D).

TVA has determined that ROW vegetation maintenance activities addressed in this PEIS are not likely to adversely affect the federally listed endangered Carolina flying squirrel. Only one transmission line within the TVA system occurs at sufficient elevation to potentially intersect Carolina northern flying squirrel habitat. This approximately 2.5-mile section of ROW occurs on Beech Mountain in North Carolina. Field surveys conducted in 2013 found that the forest adjacent to the ROW could potentially support the species, but that conditions within the ROW were unsuitable.

TVA prohibits the use of broadcast application of herbicide along this section of ROW to avoid the potential for off-ROW spray drift that could impact the Carolina northern flying squirrel. If tree clearing is proposed alongside this section of ROW, species habitat surveys would be conducted by TVA. TVA would consult with the USFWS if removal of suitable habitat for Carolina northern flying squirrel is proposed. Presence/absence surveys may occur in conjunction with this consultation.

Threatened, Endangered, and Protected Birds

TVA has determined that ROW vegetation maintenance activities addressed in this PEIS are not likely to adversely affect the federally listed piping plover, interior least tern, whooping crane, or wood stork.

Piping plover and Interior Least Tern - In the TVA study area, occupied habitats for piping plover and interior least tern have little chance of meaningfully intersecting ROW vegetation management activities. Both species utilize sandbars and similar habitats along major river systems. In the TVA study area, the interior least tern and piping plover are primarily found near the Mississippi River.

The piping plover has been documented in both eastern and western Tennessee, though occurrences are rare. A 5-year study of shorebirds in the Tennessee Valley observed only three individual piping plovers between 2004 and 2009. This species is a very rare spring migrant and uncommon fall and summer migrant in Tennessee. The open shoreline habitats used by both piping plover and interior least tern do not require active vegetation management. The likelihood of vegetation management activities affecting interior least tern and piping plover is discountable.

Whooping crane - Whooping cranes found in the TVA study area are transitory, non-breeding, and are classified by the USFWFS as non-essential experimental populations. As such, they are not subject to Section 7 consultation except when individuals occur on National Wildlife Refuge (NWR) and National Park Service lands. About 6.7 miles of TVA ROW occurs on Wheeler NWR. Whooping crane has been documented from agricultural fields that intersect TVA ROW on the refuge. These lands are kept open by the management activities of others. The birds feed on planted crops while migrating and are only present for short periods of time. Given that areas utilized by cranes are maintained agricultural fields, little if any tree clearing on ROW is needed in areas that could be occupied by the species; herbicide work would not occur in a season when birds would be present. Therefore, TVA has determined that the likelihood of TVA vegetation management intersecting occupied habitat for the whooping crane is negligible and any effects would be discountable.

Wood Stork - The U.S. breeding range of the wood stork is restricted to coastal areas of Georgia, Florida, North Carolina and South Carolina, hundreds of miles south of the TVA study area. Although breeding does not occur in the TVA region, seasonal migrants occur further to the north in Mississippi within the TVA study area. This species could use permanently inundated, open wetlands in ROWs for foraging and trees alongside of the ROW for roosting at night. Because of the extremely low likelihood of vagrant individuals being present during ROW vegetation management activities, any potential for direct, indirect, or cumulative impacts to wood storks is discountable.

Red-cockaded Woodpecker - TVA ROW vegetation management has the potential to intersect habitat for the red-cockaded woodpecker at several locations in Mississippi, including Bienville and Tombigbee National Forest (NF) and the Sam D. Hamilton Noxubee NWR. In 1993, TVA completed construction of about 13.8 miles of transmission line through Bienville NF. Design and construction of the line was coordinated with U.S. Forest Service and USFWS to avoid impacting nesting colonies of red-cockaded woodpecker.

TVA also has about 10.3 miles of transmission line crossing Tombigbee NF and Sam D. Hamilton Noxubee NWR, portions of which are located adjacent to each other in Winston County, Mississippi. No extant colonies are known to occur in Tombigbee NF and local land managers at both Bienville NF and Sam D. Hamilton Noxubee NWR units have supplied TVA with the current location of red-cockaded woodpecker colonies. Based on data from 2018, Bienville NF is the only area in Mississippi where extant colonies are known to occur within two miles of the TVA transmission line ROW.

TVA has used information on known red-cockaded woodpecker colony locations to establish 0.5-mile buffers around these locations in the O-SAR database. TVA would restrict ROW vegetation management, such that no activity would occur during the breeding season, between April–July. As part of the O-SAR desktop review process, TVA will request any new data from the local land managers to update O-SAR buffers before planned floor work in Tombigbee NF, Bienville NF, and Sam D. Hamilton Noxubee NWR. TVA would also contact local land managers before tree work to determine if the location of proposed work overlaps with colonies. TVA would initiate a stand-alone consultation with the USFWS if nest trees are proposed for removal. TVA has determined that routine vegetation management activities are not likely to adversely affect (NLAA) red-cockaded woodpecker, and that non-routine activities with potential to affect this species would be subject to individual ESA Section 7 consultations.

Bald eagles are considered federally delisted and monitored under the ESA, but they are still protected under the Bald and Golden Eagle Protection Act. This species is associated with large mature trees capable of supporting its massive nests. These are usually found near larger waterways where the eagles forage. Field surveys would be performed on all tree clearing projects and appropriate buffers would be established around active nests to prohibit disturbance from vegetation maintenance activities.

Threatened and Endangered Reptiles

TVA has determined that ROW vegetation maintenance activities addressed in this PEIS are not likely to adversely affect the federally listed threatened ringed map turtle, or the federally listed threatened flattened musk turtle.

Ringed map turtle - The ringed map turtle is known to nest along the Pearl River, Bogue Chitto River, Strong River, and Yockanookany River in Mississippi and in Louisiana (personal communication with Bob Jones, April 2016). TVA transmission lines cross the Pearl River at four locations within this area, but do not intersect the Bogue Chitto River, Strong River, or Yockanookany River

This species nests in loose sandy substrates adjacent to the rivers and is vulnerable to crushing if mechanical equipment would be used during the nesting season in areas that support the turtle. TVA has identified all transmission line crossings of the Pearl River in the O-SAR database and has restricted access of mechanized equipment within 100 feet of the Pearl River during the ringed map turtle breeding season (April – August). With these avoidance measures, TVA has determined that TVA ROW vegetation management activities are NLAA map turtle.

Flattened musk turtle - Flattened musk turtle occurs in the Black Warrior River system in Alabama. Similar to the ringed map turtle, the flattened musk turtle requires sandy areas adjacent to rivers and streams for nesting and breeding. Transmission line crossings of the Black Warrior River that potentially overlap with habitat for this species are identified in the O- SAR database. In these areas, TVA standard BMPs that limit soil disturbance and herbicide runoff in SMZs will be part of a strategy to prevent measurable impacts to the species. In addition, TVA will prohibit vehicular traffic and laydown areas within sandy areas at perennial stream crossings of the Black Warrior River during the May-September breeding season of flattened musk turtle. With these avoidance measures, TVA has determined that the ROW vegetation management activities are NLAA flattened musk turtle.

Threatened and Endangered Amphibians

Berry Cave salamander - This species is known from eleven discrete locations in Knox, Roane, Meigs, and McMinn counties, Tennessee. None of these locations intersect TVA transmission line ROW. TVA has determined that BMPs designed to limit sedimentation and herbicide run-off to subterranean environments are sufficient to preclude measurable impacts to the species should a population be identified within or adjacent to a TVA transmission ROW. TVA has determined that ROW vegetation management activities are NLAA the Berry Cave salamander should it be listed under the ESA.

Black Warrior waterdog - The Black Warrior waterdog occurs only in the Black Warrior River system in Alabama. The final listing rule for this species states*: "the following actions are unlikely to result in a violation of section 9, if these activities are carried out in accordance with existing regulations and permit requirements; this list is not comprehensive: (1) Normal agricultural practices, silvicultural practices, and transmission line ROW maintenance, including herbicide and pesticide use, which are carried out in accordance with any existing regulations, permit, and label requirements, and certified best management practices; and…"* . Transmission ROW crossings of the Black Warrior River that potentially overlap with habitat for the Black Warrior waterdog have been identified in the O-SAR database. In these areas, TVA standard BMPs that limit soil disturbance and herbicide runoff in SMZs will be part of a strategy to prevent measurable impacts to the species. TVA has determined that ROW vegetation management activities are NLAA the species.

Threatened and Endangered Land Snails

Painted snake coiled forest snail - The painted snake coiled forest snail is known from a very small portion of the TVA study area in Franklin County, Tennessee. The species inhabits mesic to submesic forest typified by extensive rock outcrops and is only known to occur in a few square miles near Sherwood, Tennessee.

TVA has one transmission line that runs through the Crow Creek Valley. Populations of the painted snake coiled forest snail occur on forested slopes on both the east and west sides of this ROW. While the single transmission line is close in proximity to the species, conditions in and adjacent to the ROW do not contain suitable habitat for this species, and do not contain known populations of the snail. The likelihood of TVA ROW vegetation management activities affecting the painted snake coiled forest snail is discountable and TVA has determined the program is NLAA painted snake coiled forest snail.

Noonday Snail - This species occurs only on the extreme periphery of the TVA study area such that their ranges do not extend to where TVA ROW are situated. TVA has concluded that that ROW vegetation management activities would have no effect on this species.

Threatened and Endangered Insects

Rattlesnake-master borer moth - This species occurs only on the extreme periphery of the TVA study area such that their ranges do not extend to where TVA ROW are situated. TVA has concluded that that ROW vegetation management activities would have no effect on this candidate species should it become listed under the ESA.

Mitchell's satyr - Mitchell's satyr is a butterfly that, in the TVA study area, occurs only in small portions of Mississippi. The species prefers herbaceous vegetation with a component of sedges (*Carex* spp.), often in association with wetlands. ROW vegetation management is not mutually exclusive with Mitchell's satyr and can produce conditions favorable for the species by maintaining the ROW in a low-growing, primarily herbaceous condition.

While the species has not been documented on TVA ROW, TVA uses the O-SAR process to predict portions of TVA ROW that contain habitat which could support the species. For floor work in these areas, TVA does not allow mowing or broadcast herbicide application (aerial or ground-based) but would use low volume foliar application of herbicide to target woody species. With these avoidance measures, and with the maintenance of ROWs within the species' range in a condition which may benefit Mitchell's satyr, TVA has determined that vegetation management activities are NLAA the Mitchell's satyr.

Threatened and Endangered Arachnids

Spruce-fir moss spider - TVA has determined that ROW vegetation maintenance activities addressed in this PEIS would have no effect on the federally listed spruce-fir moss spider. This species has an extremely limited distribution and does not intersect the TVA transmission system within the study area.

4.3.2.1.3 Overall Impacts to Threatened and Endangered Plants

Several of the herbaceous habitats found on TVA transmission line ROWs are of regional conservation importance, and in general, TVA transmission line ROWs tend to support rare plant species at disproportionately high rates. In fact, federally and state-listed plant species are about ten times more likely to occur on ROW than in the surrounding, off-ROW habitats. Many of these species are adapted to grasslands, which were once more common in the eastern U.S., but are now largely absent from the landscape (Noss 2013). Today, ROWs can serve as a proxy for natural grasslands and support some of the best herbaceous habitats in the study area.

TVA has determined that ROW vegetation maintenance activities addressed in this PEIS would have no effect on the following federally listed plant species: American hart's-tongue fern, smooth coneflower, spreading avens, rock gnome lichen, mountain bluet, swamp-pink, dwarf-flowered heartleaf, mountain golden heather, Ruth's golden aster, Michaux's sumac, reflexed blue-eyed grass, Blue Ridge goldenrod, and Alabama streak-sorus fern. These plants are extremely unlikely to occur in TVA transmission ROW habitats due to very specific habitat needs not found in ROWs and very narrow geographic distribution within the study area.

Plants are inherently susceptible to damage from methods and tools used in the TVA ROW vegetation management program. However, ROW vegetation management is not likely to have a measurable effect to eight plant species because the species are either extremely unlikely to occur in the ROW or specific methods and tools used to clear ROW vegetation are extremely unlikely to intersect the species.

Plant species that are extremely unlikely to occur in a TVA ROW include Georgia rockcress, Heller's blazing star, pondberry, and gentian pinkroot. In the TVA study area:

- Georgia rockcress only occurs on bluffs associated with the Oostanaula River. TVA has no transmission lines in potential habitat. One newly constructed transmission line ROW does cross the Oostanaula River, but field surveys confirmed the species and its habitat are not present.
- Heller's blazing star occurs only at high elevation openings in the Blue Ridge Mountains and only one transmission line within the TVA system occurs at a

sufficient elevation to potentially support the species. This approximately 2.5-mile section of ROW occurs on Beech Mountain in North Carolina, but most likely does not possess areas of shallow soil preferred by this species.

- No TVA transmission lines are located in the counties within the study area that support pondberry. Habitat for pondberry is very restricted and is unlikely to occur in a TVA ROW.
- Potential habitat for gentian pinkroot, as defined by IPaC, intersects one 2.5-mile section of TL ROW southwest of Birmingham, Alabama. Aerial photos suggest the area is highly urbanized, and the nearest locations for the species are within the glades of Bibb County, an area about 20 miles distance from the ROW.

TVA believes that the likelihood of these species occurring in a transmission line ROW is discountable and that the ROW vegetation management activities are NLAA affect Georgia rockcress, Heller's blazing star, pondberry, and gentian pinkroot.

Plant species that may occur in the TVA study area but are extremely unlikely to be affected by methods and tools TVA uses to clear ROW vegetation include: Cumberland rosemary, harparella, Kral's water-plantain, and Virginia spiraea. All four of these plant species principally occupy free-flowing riverine environments with steep banks or valleys on either side of the river. Where transmission lines cross these types of steep valleys, TVA does no vegetation management work because the conductor is well above the mature trees below. While these species may occur in riparian areas within a TVA ROW in a handful of locations across the TVA transmission system, the likelihood of adversely affecting the species at those locations is negligible. This is because:

- All crossings have O-SAR polygon prohibiting broadcast herbicide application.
- In-steam herbicide use or tree clearing is not needed because of landscape position – usually mature forest on river banks.
- BMPs and SOPs prohibit mechanical equipment near streams.

TVA believes the likelihood of vegetation management activities adversely affecting these species is discountable and has determined that the ROW vegetation management activities are not likely to adversely affect Cumberland rosemary, harparella, Kral's water-plantain, and Virginia spiraea.

TVA has determined that ROW vegetation maintenance activities addressed in this PEIS are likely to adversely affect the federally listed Price's potato-bean, Braun's rock-cress, Pyne's ground plum, Morefield's leather flower, Alabama leather flower, leafy prairie-clover, whored sunflower, small whorled pogonia, fleshy-fruit gladecress, lyre-leaf bladderpod, Spring Creek bladderpod, Mohr's Barbara's buttons, Cumberland sandwort, Shorts bladderpod, white fringeless orchid, green pitcher plant, large-flower skullcap, and Tennessee yellow-eyed grass. These determinations acknowledge that the above federally listed species are currently known to occur on TVA ROW, or they have a reasonable potential to occur on TVA transmission ROW and be impacted by vegetation management tools into the future. By its nature, vegetation maintenance would have measurable adverse impacts on these species.

The fact that listed plant species occur relatively frequently on existing TVA ROWs implies that current vegetation maintenance practices and rare plant conservation are not mutually exclusive. Without the continued ROW vegetation management needed to maintain transmission system reliability, trees would quickly invade these open areas and the vast majority of rare plant occurrences would be extirpated. Vegetation removal is needed to maintain both rare plant populations and the TVA transmission system, but different vegetation maintenance methods employed by TVA do have different types of potential impacts, both positive and negative, on listed species.

4.3.2.2 Impacts to Threatened and Endangered Species from Vegetation Control Methods

TVA reviews TVA's transmission ROWs and identifies appropriate vegetation control methods, appropriate conservation activities, BMPs, and avoidance and minimization measures to guide management decisions regarding use of the following vegetation maintenance activities in the vicinity of sensitive resources (see Section 3.1.2 TVA's Integrated Sensitive Area Review Process).

4.3.2.2.1 Impacts to Threatened and Endangered Species from Manual Methods

4.3.2.2.1.1 Impacts to Threatened and Endangered Aquatic Animals from Manual Methods

Manual control methods are very selective, and therefore minimally disturbing to soils and sensitive biological areas such as wetlands and streams that may support listed species.

Manual clearing generally results in fewer potential impacts to streams or waterbodies when compared to mechanical clearing techniques, such as use of a bulldozer, track-hoe, skid-steer, or use of a tractor for mowing or mulching. An exception to this is in the use of equipment such as a feller-buncher. Use of a feller-buncher allows for cutting of trees and debris removal from the vicinity of streams or other waterbodies without equipment approaching the stream closely or disturbing the soil profile. Such equipment can operate within an SMZ, but is rarely used during routine vegetation management.

Powered hand tools and mechanical equipment require petroleum products that have the potential to leak or spill and impact aquatic threatened and endangered species. However, acute toxicity to aquatic life is seldom found in response to oil concentrations below 10 parts per billion (ppb) (Irwin et al. 1997); and effects are often mitigated by the rapid dispersion and weathering of oil in freshwater (Lee et al. 2015). In addition, TVA has BMPs in place that actively minimize the chance that spilled or leaked petroleum products could enter streams (TVA 2017a).

Proper application of standard TVA BMPs (TVA 2017a), including effective SMZs, would reduce direct and indirect effects of manual vegetation management methods on aquatic threatened and endangered species to negligible levels.

4.3.2.2.1.2 Impacts to Threatened and Endangered Terrestrial Animals from Manual Methods

Manual control methods are very selective and therefore are minimally disturbing to soils and sensitive biological areas such as wetlands and caves that may support listed species. These methods are often employed to avoid or minimize impacts to threatened or endangered species or other sensitive resources.

While there is a small potential for toxic inputs to habitats from manual control (e.g., chainsaw bar oil or fuel leakage), it has lower potential for toxic inputs to the environment than herbicide (which involve direct application of herbicides to habitats) or mechanical methods (which may leak greater quantities of fuel, oil, or hydraulic fluid). Manual control also causes less immediate disturbance (e.g. physical displacement and noise) to animal activities than mechanical methods, but it may cause more disturbance than herbicide application.

Manual control can result in more physical disturbance to wildlife than herbicide treatment because it requires more manpower and creates more noise and odor in the short-term. Also, because it is less efficient than mechanical and herbicide treatments, manual work ultimately requires more frequent treatments, increasing overall disruption of wildlife. Manual control methods remove the potential for direct exposure of organisms to herbicides.

4.3.2.2.1.3 Impacts to Threatened and Endangered Plants from Manual Methods

Manual vegetation control methods typically have few impacts on rare plant species when compared to other vegetation control methods. Use of hand tools in clearing activities is highly selective and only used on relatively small scales. Chainsaws may be used to remove individual trees from the transmission ROW floor, margins of the border zone, vegetation that may risk to the reliability of the transmission system, and danger trees adjacent to the ROW. The potential for direct effects to rare plants from manual clearing is very small. Manual clearing is routinely used to avoid and minimize impacts to listed plant species.

Both mechanical clearing and broadcast herbicide applications (both ground-based and aerial) are indiscriminate. These methods have a higher potential to negatively affect listed plant species than manual control.

4.3.2.2.2 Impacts to Threatened and Endangered Species from Mechanical Methods

4.3.2.2.2.1 Impacts to Threatened and Endangered Aquatic Animals from Mechanical Methods

Mechanical vegetation control would have greater potential to impact listed aquatic species compared to manual methods due to use of heavy equipment. Bulldozers, track-hoes, skid steers, shears (e.g., feller-bunchers), mulchers, chippers, or hydro-axes for clearing trees and shrubs cause ground disturbance that could cause some indirect affects to aquatic threatened and endangered species. Use of heavy equipment and access roads for this equipment can also exacerbate erosion issues, particularly along steep slopes and at stream crossings. Heavy equipment has the potential to disturb the soil through compaction and rutting, but activities that utilize this type of equipment are infrequent. For example, once completed on a given ROW, tree clearing using mechanical equipment may not be needed again because the cleared area would be treated as floor and maintained in an herbaceous state into the future. For this reason, and because TVA employs BMPs to prevent erosion (TVA 2017a), impacts to aquatic species resulting from soil erosion are expected to be temporary and discountable.

Disturbed ground is susceptible to surface water runoff that washes suspended solids off of the ROW and into adjacent waterbodies. Increased sedimentation in the waterbody can have multiple adverse effects on aquatic threatened and endangered species, particularly for immobile species such as mussels. However, the use of bulldozers and other major ground disturbing equipment is rare, such that impacts of this nature are unlikely.

Mowers, brush hogs, and ground-based tree trimmers similarly have the potential to cause ground disturbance, but they leave behind a base of vegetation and vegetative debris that reduces the severity of disturbance. Less exposed soils mean lower potential for sediment issues in aquatic environments. Aerial side-wall trimming would avoid all ground disturbances and associated erosion issues.

Case Study – Potential Negative Impacts Avoided: The federally listed threatened slackwater darter requires flooded lowland areas with spring seepages to spawn. Slackwater darters could be directly impacted by heavy equipment when spawning, due to eggs being attached to flooded vegetation within the transmission ROW or as hatched fry trying to reach the main stream channel (Etnier and Starnes 1993). TVA O-SAR data notes restrictions on work in areas where this species may occur, and any direct impacts would be avoided by adherence to these restrictions.

This species could also be indirectly impacted if its remaining spawning habitats are irreparably altered by ground disturbance (e.g., rutting) outside of the spawning period. Adults and juveniles could be further impacted through loss of instream habitat through increased erosion and loss of riparian vegetation.

Slackwater darter
(*Etheostoma boschungi*), federally threatened endemic species
Source: Natureserve 2018

Impacts to the slackwater darter can be mitigated by avoiding vegetation maintenance work during this species spawning period, using only minimal disturbance vegetation control methods in their known spawning habitats, and restricting use of herbicides in areas known or likely to contain slackwater darter.

Proper application of standard TVA BMPs (TVA 2017a), including effective SMZs, would minimize the potential for direct and indirect effects of vegetation management to slackwater darter and other aquatic threatened and endangered species in the ROW. In addition, TVA also uses the O-SAR process to seasonally restrict vegetation management activities in all parts of ROW that could potentially contain Slackwater darter, thereby preventing any measurable direct or indirect effects to that species.

4.3.2.2.2.2 Impacts to Threatened and Endangered Terrestrial Animals from Mechanical Methods

Mechanical methods result in more short-term, direct impacts to wildlife than manual methods, but their effectiveness minimizes the need for repeated disturbance to wildlife. Mechanical control at proper intervals (3 years or less in the study area) can result in an early successional community of low-growing shrubs, forbs, and grasses within the ROW that would be compatible with transmission system operations and favorable to deer, small mammals, birds, and butterflies (Bramble and Byrnes 1996).

However, in some areas re-growth can be rapid depending on conditions on the ground, resulting in a proliferation of woody species that form a dense, rapidly growing, low canopy that reduces habitat diversity and availability for wildlife species.

Mechanical equipment is loud and may be stressful to wildlife. Heavy equipment may cause the greatest soil disturbance, potentially leading to some amount of erosion and water quality impairment. Heavy equipment may cause sedimentation and contamination and the associated disturbance could injure or crush subterranean animals, burrows, or nests. However, soil disturbing equipment is infrequently used, and buffers are in place to protect caves. Mowing may also affect ground nesting birds and other animals unable to escape. The potential for larger fuel or lubricant leaks and spills exists with mechanical equipment when compared to manual methods or selective herbicide application. Mechanical methods would result in less direct exposure of wildlife to chemicals than broadcast herbicide application.

Over the long-term, these negative effects may be mitigated by the lower frequency of treatment needed compared to manual methods. Disturbance frequency would likely be similar when comparing mechanical methods and herbicide use.

Mechanical methods would result in more direct disturbance within ROWs and has a higher potential for wildlife mortality than manual methods or herbicide use.

TVA uses BMPs and the O-SAR process to avoid or prevent adverse effects of mechanical methods on terrestrial animal species. With implementation of these avoidance measures, any effects to listed terrestrial animal species are expected to be minor and discountable.

Harper's buckwheat
(*Eriogonum harperi*)—a rare endemic species
Source: USDA Plants Database

4.3.2.2.2.3 Impacts to Threatened and Endangered Plants from Mechanical Methods

Mechanical control methods (in general) result in more disturbance of vegetation and sensitive terrestrial communities than manual control methods. Of the various mechanical clearing tools, bulldozers and other similar equipment that move soils by pushing trees and dislodging root balls have the greatest potential to affect listed species. If rare plants are present where the bulldozers are being used, they would likely be eliminated from the site. However, equipment of this type is used infrequently.

Clearing using feller-bunchers or other similar equipment, which remove standing trees at ground level without disturbing the soil profile, typically results in minimal disturbance to the herbaceous layer and may promote growth of some species.

Case Study – Beneficial Effects: Following clearing of trees by mechanical methods, the globally-rare, Alabama-listed Harper's buckwheat was newly documented in this formerly forested section of a ROW. Altered habitat conditions made this area more suitable for this species. Subsequent vegetation maintenance in this area would consider the presence of this species and inform future maintenance.

Mowing removes nearly all woody stems when utilized, but the amount of re-growth can be rapid depending on conditions on the ground, resulting in a proliferation of woody species that form a rapidly growing, low canopy that suppresses rare herbaceous species. Using mowing alone, or as the primary mechanism for vegetation removal on ROW, reduces species diversity and encourages the dominance of woody plants able to proliferate through root sprouting.

Side-wall trimming, either from the air or the ground, would have a small impact on rare plants found on and adjacent to a transmission line ROW. Trimming would directly affect trees being pruned, but it would have few other effects other than a marginal increase in light levels due to the removal of individual limbs. Any soil disturbance from ground based side-wall trimming would be minimal and short-term.

When compared to broadcast herbicide use, mechanical control methods typically have fewer direct, indirect, or cumulative impacts to rare plant species. Selective herbicide application to control woody vegetation (especially when used in conjunction with other control methods) can have less overall impact to listed plant species than mowing alone.

4.3.2.2.3 Impact to Threatened and Endangered Species from Herbicide Application Methods

4.3.2.2.3.1 Impact to Threatened and Endangered Aquatic Animals from Herbicide Application Methods

Herbicides applied to the TVA transmission ROW are frequently used for maintenance of the floor (see Figures 3-3 and 3-4) and have the potential to impact water quality via inadvertent application to stream channels, excess surface runoff, spray drift, and leaching through the soil profile (Annett et al. 2014; Tatum et al. 2017), though TVA BMPs are specifically designed to prevent this type of impact. Field measures for concentration and durations of exposure to herbicides are typically well below standard toxicity endpoints (Scarbrough et al. 2015; Rolando et al. 2017). Spot and localized herbicide applications have little chance of contacting aquatic systems when applied correctly. Spot application is intended to use the least amount of herbicide possible to treat individual plants. Similarly, localized herbicide application consists of treating individual or small groupings of plants via basal, low-volume foliar, granular, and bare-ground treatments to minimize any overspray or excess runoff.

Herbicide toxicity to aquatic threatened and endangered species is unlikely if products are used correctly. Heavy rains could carry herbicides (e.g., granular pellets) offsite and into adjacent streams; however, rain would also serve to dilute any excess herbicide and limit any acute or chronic effects to listed aquatic life (Scarbrough et al. 2015). Inadvertent application to aquatic environments via overspray and drift are most likely with ground-based or aerial broadcast application methods. Drift is the airborne movement of herbicides through wind or evaporation to non-target areas. However, TVA uses BMPs, prior planning, proper herbicide mixtures, and advanced technology to reduce or eliminate drift during application (see Section 2.1.3).

Transport vehicles (i.e., ATV, truck, or tractor) for localized and broadcast application of herbicide have some small potential to negatively impact aquatic threatened and endangered species. Trucks and tractors can disturb the soil and increase erosion when driving through the ROW, but less so than mechanical methods that use heavy equipment. Use of ATVs likely eliminates major ground disturbance. Similarly, spot, some localized, and aerial herbicide application methods are not damaging to soils due to their various transport equipment needs. All transport vehicles have the potential for fuel leaks and spills (e.g., during refueling). Sedimentation and hydrocarbons in waterbodies have multiple detrimental effects to aquatic threatened and endangered species, as previously discussed.

Use of herbicides has more potential for indirect effects to when compared to manual methods. Because herbicide use and mechanical equipment use is restricted within SMZs, there is likely little difference in their potential to affect aquatic species other than the potential for herbicides to inadvertently enter waterbodies.

TVA's standard practices prohibit application of herbicides directly to waterbodies either by spraying from ground equipment or from aerial application. Herbicides rated by EPA for 'aquatic use' may be used in limited quantities for spot applications in SMZs.

Proper application of standard TVA BMPs (TVA 2017a) and the O-SAR process, including effective SMZs, would avoid or reduce direct and indirect effects of herbicide application on aquatic threatened and endangered species in to negligible levels.

4.3.2.2.3.2 Impact to Threatened and Endangered Terrestrial Animals from Herbicide Application Methods

Environmental advantages to the herbicide application method are its effectiveness at achieving control and improvements to plant diversity and density. Greater plant diversity can create suitable conditions for a wider variety of animal species. Meadow-like environments are especially beneficial to pollinators. Standing dead vegetation is beneficial for many animals including woodpeckers, reptiles, songbirds, raptors, bats and some pollinating insects such as bumble bees.

When used alone, herbicides have been shown to decrease the density of target trees more than mechanical or manual methods and are even more effective when combined with mowing (Bramble and Byrnes 1996). Increased density of low-growing plants prevents establishment of unwanted woody species. Both of these factors decrease the frequency of treatment and environmental disturbance. Besides decreasing the frequency of treatment, herbicide use is less disturbing in terms of noise and duration than mechanical and manual methods. One exception would be aerial broadcast, which is noisy but is completed more quickly than any alternative method. Herbicide use is also less likely to cause direct injury to wildlife than hand or mechanical clearing.

When compared to mechanical methods, spot, localized, and aerial application of herbicides are much less damaging to soils. Broadcast application from wheeled or tracked vehicles produces slightly less disturbance compared to mechanical methods due to the equipment used. Avoiding vehicle use in the ROW reduces damage to nesting and tunneling wildlife, and it reduces spread of undesirable species. Herbicides have the additional benefit of keeping ground cover and providing cover, food, and insect communities.

The primary concern with herbicides is their potential impacts to non-target organisms, soil, and water. Wildlife can be exposed to active ingredients, adjuvants, and carriers through the skin, by inhalation, or by swallowing. Herbicides have been designed to target biochemical processes, such as photosynthesis, that are unique to plants. Thus, they typically are not acutely toxic to animals; however, some herbicides can have subtle but significant physiological effects on animals, including developmental effects (USFWS 2009).

Their use may alter soil pH, microbial, and fungal activity (USFWS 2009). Spills and leaks are inherent risks when using chemicals. Herbicides may drift, run-off, or leach into waterbodies, groundwater, and caves. Contamination of water presents a risk to amphibians and aquatic species as well as to terrestrial species that drink it. Caves are sensitive ecosystems and can be easily damaged by input from the surface.

All but one of the herbicides that are currently being used for TVA's vegetation management are either practically non-toxic or have an extremely low toxicity to wildlife when applied at the recommended label rates. EPA's recommended label application methods and rates are intended to reduce risks to both the applicator and receptors in the environment (EPA 2017a). Section 4.2 provides an analysis of the toxicity ratings for mammal and bird species based on the active ingredient of herbicides discussed in Section 2.1.3 that are currently being used for TVAs vegetation management.

TVA uses a variety of handling and application BMPs to minimize side-effects from herbicides. For more information see mitigation measures in Section 4.3.2.5.

4.3.2.2.3.3 Impact to Threatened and Endangered Plants from Herbicide Application Methods

Use of herbicides for the control of woody plants can have large impacts on vegetation that last for multiple years after application. The extent and magnitude of effect on any individual transmission line ROW depends to a large extent on the method of application used. More selective methods that limit damage to non-target vegetation can have a demonstrable positive effect in fostering relatively stable plant communities with a rare plant component, but methods that use higher volumes of herbicide and do not narrowly target woody plants notably degrade plant communities on the ROW. The choice of herbicide application method has the greatest potential to adversely affect vegetation on sections of the ROW that support high quality habitats. Lower quality sections of ROW dominated by early successional weed species, including invasive plants, are less likely to support federally or state-listed plant species because the areas have already been degraded.

Table 4-7 summarizes the potential effect to vegetation species on transmission ROWs by herbicide application method. Negative impacts would include off target damage to federally or state-listed species that threatens the viability of populations over the long-term. All estimates of potential impacts assume adequate control of target woody plants in the ROW.

Generally, aerial and ground-based broadcast applications have similar high potential to negatively affect vegetation on a wholesale, fundamental level. These high-volume, non-targeted methods can transform diverse, herbaceous plant communities containing rare plant species into a patchwork of disturbed habits dominated by annual weeds, other early successional pioneer species, and invasive plants. Repeated aerial and ground-based broadcast application of herbicide is actively avoided on ROWs that support federally and state-listed plant species. Further, aerial application of herbicide has not been used by TVA since 2011, and if it is used in the future, it would be used only in rare cases.

Localized applications of herbicide do result in some level of off-target damage. In situations where the woody stem count is high on a given ROW, even localized application of herbicides can produce substantial damage to non-target species. However, these areas of high woody stem count are unlikely to support rare plants, usually because of site conditions unrelated to TVA vegetation management (i.e. owner land use, soil type, landscape position, etc.). In drier transmission ROW areas with rocky or sandy soils, where woody stem count is inherently lower, localized herbicide application can foster quality herbaceous plant communities as well as federally and state-listed plant species.

Many such sites are located across the TVA transmission system, but rare plants and rare plant communities in ROWs are particularly concentrated in the Interior Plateau, Ridge and Valley, and Southwestern Appalachians ecoregions. From an ecological perspective, the disturbance associated with localized application of herbicide on ROW with rare plant species has taken the place of fire and large animal grazing, which would have been the primary mechanisms maintaining grasslands before European settlement of the region. Many of these open areas would rapidly transition to forest and the majority of rare plants and communities occurring there would disappear from the landscape without tree removal and localized herbicide use in the ROW.

“Targeted” herbicide application has been shown to be effective at controlling woody vegetation in areas where listed plant species occur, while minimizing impacts to listed plants. Spot application and dormant season basal application have a low potential to negatively impact federally or state-listed plant species, but the relatively high cost limit the method to small portions of ROW.

Herbicide methods, in general, can have more potential to affect listed plant species than manual methods. When combined with selective herbicide use, manual methods can be an effective maintenance technique in areas where sensitive plants are present.

Mechanical clearing may have less impact when compared to the method of broadcast or aerial herbicide application. Mechanical clearing methods typically have more impacts than selective or spot herbicide applications.

4.3.2.3 Impacts to Threatened and Endangered Species from Debris Management

4.3.2.3.1 Impacts to Threatened and Endangered Aquatic Animals from Debris Management

Debris that is left in place can have negative and positive consequences for listed aquatic life throughout the TVA transmission system ROWs. Negative consequences could arise from excess debris clogging streams and reducing water quality. For example, debris that is cut and left in place may fall into waterbodies and could result in woody debris jams, which could locally alter streamflow, reduce aquatic habitat, and erode banks. However, TVA does not allow large pieces of debris from vegetation management to remain in streams. Some smaller limbs and brush may remain in SMZs following vegetation management, but all large debris is removed from streams and SMZs and disposed of by other methods. Additionally, the introduction of woody debris into streams is a naturally occurring process within streams that run through forested watersheds; therefore, minor additions of small woody debris within SMZs would have a neutral or small beneficial effect on in-stream habitats.

Lopping and scattering, chip in place and mulch in place could result in excess debris loading into adjacent waterbodies if material is left in low-lying parts of the ROW. Leafy debris, chips, and mulch in waterways could also affect water quality by depleting dissolved oxygen. However, TVA actively manages debris such that it is not placed in proximity to stream channels or other aquatic environments within the ROW. Debris left in place can reduce the erosion potential caused by runoff during heavy rain and may limit the runoff of fine sediments into streams.

Aside from the equipment used to collect debris, burning methods of debris control have no deleterious effects to water quality and aquatic threatened and endangered species (Hubbert et al. 2015).

4.3.2.3.2 Impacts to Threatened and Endangered Terrestrial Animals from Debris Management

Leaving debris in place is the least disturbing to soils, making it the preferred choice on steep slopes or in sensitive areas. Potential benefits to listed terrestrial animals include the availability of debris piles as cover, nutrient recycling, and erosion control provided by woody material. Leaving standing snags along ROW provide excellent habitat to a variety of wildlife species. These trees are used as perches by raptors and frequently contain cavities or are excavated for shelter by birds and mammals. Decaying bark and solar exposure benefits reptiles and roosting bats. Invertebrates use snags for food and shelter and in turn provide food for larger species. Negative consequences of this method are the increased wildfire fuel load and the ability of dead wood to harbor tree diseases and pests.

Burning requires disturbance by mechanical equipment and does not foster erosion control, nutrient recycling, or wildlife habitat. Additionally, it reduces fuels, pests, and diseases. Pile burning carries the risk that the fire may escape and container burning involves both noise, which may displace listed terrestrial animals, and the possibility of minor contamination from fuel spills.

4.3.2.3.3 Impacts to Threatened and Endangered Plants from Debris Management

Debris management of cut vegetation does not have substantial, long-term impacts to federally or state-listed plants in ROW, but there are some differences between the various methods.

The left in place method typically has little direct effect on vegetation where woody debris falls, but subsequent vegetation maintenance can be hindered by larger debris piles. Specifically, low-volume foliar herbicide applications can be less targeted around piles because applicators have a difficult time moving amongst the downed branches. This problem has been observed on the Widows Creek–Sequoyah 500 kV Transmission Line ROW located just north of Chattanooga, Tennessee on the Cumberland Plateau.

The federally threatened plant large flowered skullcap was observed growing through piles of cut trees along with other small tree seedlings along the recently cleared ROW margin. TVA did not apply herbicide directly adjacent to plants, because the location was known. However, localized herbicide application would be more likely to produce off-target damage to surrounding vegetation amongst slash piles, which could affect undocumented rare plant occurrences that occur on ROW across the system. This potential negative effect would diminish over time as the woody material decomposes.

Chipping and mulching in place would have similar short-term effects to rare plants where material is placed. Wood chips are left at depths that depend on the amount of material present. Chip depth, which can be several inches, typically retards herbaceous plant growth for some amount of time, but after less than one growing season grasses and forbs begin to regrow. Large-flowered skullcap was also noted along portions of the Widows Creek–Sequoyah 500 kV Transmission Line ROW that had been recently mulched. Plants grew through the mulch layer and were still present onsite during a follow-up survey three years later.

Chipping in place allows natural decomposition, nutrient recycling, erosion control, retains moisture, and may facilitate seedling establishment. Operating heavy equipment can damage soils and non-target species. This method can also spread invasive plant seeds.

Lopping and scattering has all of the same positive and negative consequences as chipping and mulching in place. But, because this method involves mechanical equipment, it has the additional consequence of agitating soils and is less appropriate for sensitive areas.

4.3.2.4 Impacts to Threatened and Endangered Species from Restoration

4.3.2.4.1 Impacts to Threatened and Endangered Aquatic Animals from Restoration

Restoration methods of reseeding could have some short-term negative consequences for listed aquatic life, but overall long-term benefits. Reseeding involves the use of ground crews with belly-grinders, tractor seeders, aerial seeders, hydro-seeders, or drill seeders to encourage vegetation of disturbed soils. Some mechanical equipment would be used when reseeding with the potential for rutting; however, the goal is to revegetate the transmission ROW and reduce long-term erosion. Mechanical equipment could leak or spill fuel and oil, which could have minor, short-term consequences on water quality. However, standard BMPs and SMZs would minimize impacts (TVA 2017a).

4.3.2.4.2 Impacts to Threatened and Endangered Terrestrial Animals from Restoration

Reseeding disturbed areas would have beneficial effects for terrestrial animals (wildlife). Using strategic plantings as a method to maintain the transmission line ROW in the long-term would require the use of one or more other methods (manual, mechanical, or herbicide) in the short-term to clear and control target species. This method has the advantages of requiring little need for vegetation maintenance once reseeding is complete, reducing environmental consequences such as noise, soil disturbance, chemical use, etc. The main environmental drawback to this method is that it would require the use of the other control methods and their associated consequences to achieve restoration of disturbed lands. The resulting long-term habitats require little additional vegetation maintenance through manual, mechanical, or herbicide treatments and would likely provide beneficial impacts to a variety of wildlife species. All O-SAR related restrictions for use of manual, mechanical, and herbicide control would apply to the initial cover-type conversion process; thus, listed terrestrial animals would still be provided protection by using only the methods compatible with those areas.

Revegetating disturbed areas within a ROW provides both cover and food. The greater the diversity in vegetation species and structure, the more listed terrestrial animal species would benefit. Reseeding disturbed areas would result in decreased erosion, less sedimentation, and improved water quality. Some methods would involve machinery that can disturb soil in the short-term but stabilize it when vegetation is established. Revegetation with native plants can prevent establishment of invasive species. In addition, successful establishment of low-growing species would inhibit succession by undesirable trees, avoiding the need for frequent disturbance.

4.3.2.4.3 Impacts to Threatened and Endangered Plants from Restoration

Routine reseeding has little potential to negatively affect federally or state-listed plants found on transmission line ROWs because standard BMPs would dictate that revegetation efforts avoid the use of invasive weed species (TVA 2017a). While not all species used in revegetation projects are native to the TVA study area, none of the plants are invasive species. The non-native grass species Bermuda grass and tall fescue are approved for use in established pastures and developed areas (i.e. dam reservations, public use areas, and other facilities), but not in areas with naturalized vegetation that are likely to contain federally or state-listed plant species.

Revegetation of disturbed sites with native plants in ROWs, focusing on pollinator enhancement or plant community restoration, would also have little chance of negatively impacting listed plant species. If TVA implements conservation oriented restoration projects, biologists would have direct involvement and would tailor the work in cooperation with Transmission ROW staff to benefit listed species, if present onsite.

4.3.2.5 Mitigation Measures for Threatened and Endangered Species

4.3.2.5.1 Mitigation Measures for Impacts to Threatened and Endangered Aquatic Animals

The following BMP mitigation measures would be applied when working near or adjacent to water resources with listed aquatic species present.

- Species Review using O-SAR database:
    - Before scheduled vegetation maintenance occurs, TVA would review desktop level information to create aquatic sensitive areas in the O-SAR database. Class rankings would be assigned that would be used to guide management decisions for protecting listed aquatic species during vegetation maintenance activities.
- SMZs:
    - Streams that have known listed aquatic species occurrences or are known from within the watershed would receive a Category ‘B’ or ‘C’ level of protection, as outlined in TVA’s guide for environmental and best management practices (TVA 2017a).
    - Similar to Category ‘A’ (see Section 4.5), these levels are implemented to protect important permanent streams, springs, sinkholes, and unique aquatic habitats to minimize disturbance of banks and water in flowing streams where sensitive aquatic species are likely to occur.
- Herbicide Restrictions:
    - TVA only uses herbicides registered with the EPA and applicators must follow manufacturers’ label instructions, EPA guidelines, and respective state regulations and laws.
    - Herbicides used within stream side management zones would be approved for use within aquatic environments by the EPA.
    - Ground-based or aerial broadcast application of herbicides within any SMZ adjacent to perennial streams, ponds, or other water sources is not permitted.
    - Aerial application of liquid herbicide is not permitted when weather conditions exist that are outside the limits as described on the label. For example, pellet application would not be permitted when surface wind speeds exceed 10 miles per hour or on frozen or water-saturated soils.

4.3.2.5.2 Mitigation Measures for Impacts to Threatened and Endangered Terrestrial Animals

TVA would employ a number of mitigation measures for specific animals and habitats. These would include:

- Species Review using O-SAR database. Before scheduled vegetation maintenance occurs, TVA would review desktop level information to create sensitive areas in the O-SAR database. Class rankings would be assigned that would be used to guide management decisions for protecting listed terrestrial animal species during vegetation maintenance activities.
- Placing buffers around sensitive resources.
- Enforcing seasonal or permanent restrictions on clearing, spraying, access, and disturbance.
- Conducting field surveys for sensitive resources.
- Preventing cave access except by authorized personnel.
- When feasible, TVA biologists conduct site assessments to determine if trees in need of clearing are suitable habitat for protected species. If assessments cannot be performed, trees are assumed to be suitable summer roost trees for bats. As part of TVA's ESA programmatic biological assessment for bats, TVA will track and document removal of potentially suitable summer roost trees and include in annual reporting in accordance with Section 7(a)(2) consultation.
- Conservation funding may be required under the Bat Programmatic Consultation depending on location and season of clearing.
- TVA would also require use of BMPs for clearing, herbicide use, SMZs, rare plants, wetlands, and restoration.

Clearing of trees that may be suitable for summer roosting by Indiana and northern long-eared bats is governed by TVA's Bat Programmatic Consultation and is primarily scheduled for winter months when bats would be hibernating in caves. TVA would avoid clearing during pup season (June and July), only rarely cutting trees during this period.

Mechanical clearing is prohibited near nest sites for colonial wading birds and ospreys during nesting season (February 1 to July 15). Mowing and brush-hogging are permitted. No vegetation clearing is permitted within 660 feet of known bald eagle nests from December 1 to July 1. In rare circumstances in which clearing needs to take place during these time frames, TVA would coordinate with USDA Wildlife Services to ensure any actions are covered under USDA's Take permit.

To minimize impacts to ground nesting birds, mowing should be avoided during the height of the breeding season (May 1 to July 15) (Vickery et al. 2000) and should ideally occur before mid-March and after August. Heavy equipment is seasonally excluded from certain habitats, for example emergent wetlands within the range of Mitchell's satyr butterfly. Large equipment is prohibited within 200 feet of cave openings unless on an access road. Clearing around caves is limited to small machinery such as chainsaws, brush hogs, and mowers.

Herbicides are never applied to waterbodies, wetlands, or groundwater infiltration zones unless specifically labeled for aquatic use (TVA 2017a). TVA prohibits the use of herbicides within 200 feet of caves. Active osprey and wading bird nests are protected with buffers that restrict spraying to selective treatments between February 1 and July 15. Spraying is prohibited within 660 feet of active eagle nests from December 1 to July 1.

4.3.2.5.3 Mitigation Measures for Impacts to Threatened and Endangered Plants
Ground based and aerial broadcast herbicide usage have the greatest potential to negatively affect important listed plants occurring on TVA transmission line ROWs because these application methods could fundamentally degrade quality habitats. TVA uses the O-SAR process to avoid impacts to federally and state-listed plants on transmission ROWs by limiting the use of these methods to areas unlikely to contain herbaceous habitats dominated by native plant species. Currently, broadcast and aerial herbicide is restricted from use on about 17 percent (about 41,000 acres) of TVA transmission line ROWs likely to contain important habitat. This level of O-SAR guidance is referred to as a Class 1 area (see Section 3.1.2) and would generally be used in areas where rare species may be present but have not been field verified. Manual, mechanical, and localized herbicide methods could be used in these areas. These methods may serve to perpetuate populations of listed plant species adapted to open habitats found in the ROW by eliminating trees that would rapidly encroach into these areas in lieu of disturbance.

Slightly less than 1 percent (about 2,000 acres) of TVA transmission ROW is known to contain populations of rare plant species. These areas are denoted as Class 2 sites in the O-SAR database and when vegetation management is scheduled to occur there, TVA biologists and Transmission ROW operations staff work together to ensure the habitats are protected. Sometimes the proposed work would not affect the listed plants found in the ROW, but sometimes operations staff augments the timing or method of proposed work to protect sensitive resources. The following are representative examples of how O-SAR is used to avoid negative impacts to rare plants.

- *Timing* – Spring Creek Bladderpod. This federally endangered species is known to occur at several locations on TVA transmission line ROW near Lebanon, Tennessee. This species grows in rocky, sometimes disturbed habitats and is a winter annual, meaning seeds germinate in the autumn, plants persist through the winter and flower in the early spring of the subsequent year. Since the species sets seed and dies by early summer, TVA would avoid spraying herbicide from May through mid-June in areas the species may occur. TVA would then apply herbicide as normal after the species has completed its life cycle for the year.
- *Flagging* – Sun-facing coneflower. This globally-rare, state-listed plant occurs at several locations along TVA transmission line ROWs in northeastern Alabama. This plant prefers sunny conditions and relatively moist soils, which are ideal conditions for encroachment of woody vegetation into the ROW. Before localized herbicide application, typically low volume foliar, TVA botanists would perform field surveys to delineate specific areas where the sun-facing coneflower occurs. Sites would be marked in the field with flagging tape and maps are provided to the herbicide contractor, along with instructions on how work be conducted in these spans. Typically, foliar herbicide would not be applied within flagged areas and any woody vegetation within the relatively small areas would be removed with machetes or spot application of herbicide.

- *Conservation Spray* – White fringeless orchid. Some of the largest known populations of this federally threatened orchid occur along TVA transmission line ROWs on the Cumberland Plateau of Tennessee. Thorough documentation at these sites indicates targeted, low-volume foliar application of herbicide to woody plants along the ROW does not appear to negatively impact orchid populations (USFWS 2015). This "conservation spray" differs from standard foliar application of herbicide because of extensive communication between TVA staff and herbicide applicators on the sensitive nature of the site. In addition, there is direct TVA oversight during the application, which leads to extra caution and large reductions in damage to non-target vegetation like the white fringeless orchid.
- *Natural Area Cooperation* – Tall larkspur. Large populations of this state-listed, globally rare plant occur on TVA transmission line ROW situated on Oak Ridge National Laboratory property in east Tennessee. Recently, TVA has worked with resource managers at the lab, who have coordinated with a third party to use herbicides to control woody plants in the sensitive areas on ROW containing tall larkspur. Agreements with land management agencies are made on a case-by-case basis.

4.4 Surface Water

4.4.1 Affected Environment

The quality of the region's water is critical to protection of human health and aquatic life. Water resources provide habitat for aquatic life, recreation, domestic and industrial water supplies and other benefits. Major watersheds in the TVA study area (Figure 4-4) include most of the Tennessee River, the Cumberland River basins, portions of the lower Mississippi, Green, Pearl, Tombigbee, and Alabama/Coosa River basins, and a small portion of the lower Ohio River basin.

Fresh water abounds in much of this area and generally supports most beneficial uses, including fish and aquatic life, public and industrial water supply, waste assimilation, agriculture, and water-contact recreation, such as swimming. Water quality in the TVA region is generally good. The following Regulatory Framework for Surface Water (Section 4.4.1.1) provides a high-level overview of the surface water quality in the seven States within the TVA PSA. This section is followed by Section 4.4.1.2 with more detailed information on the regional surface water basins, especially the Tennessee River basin.

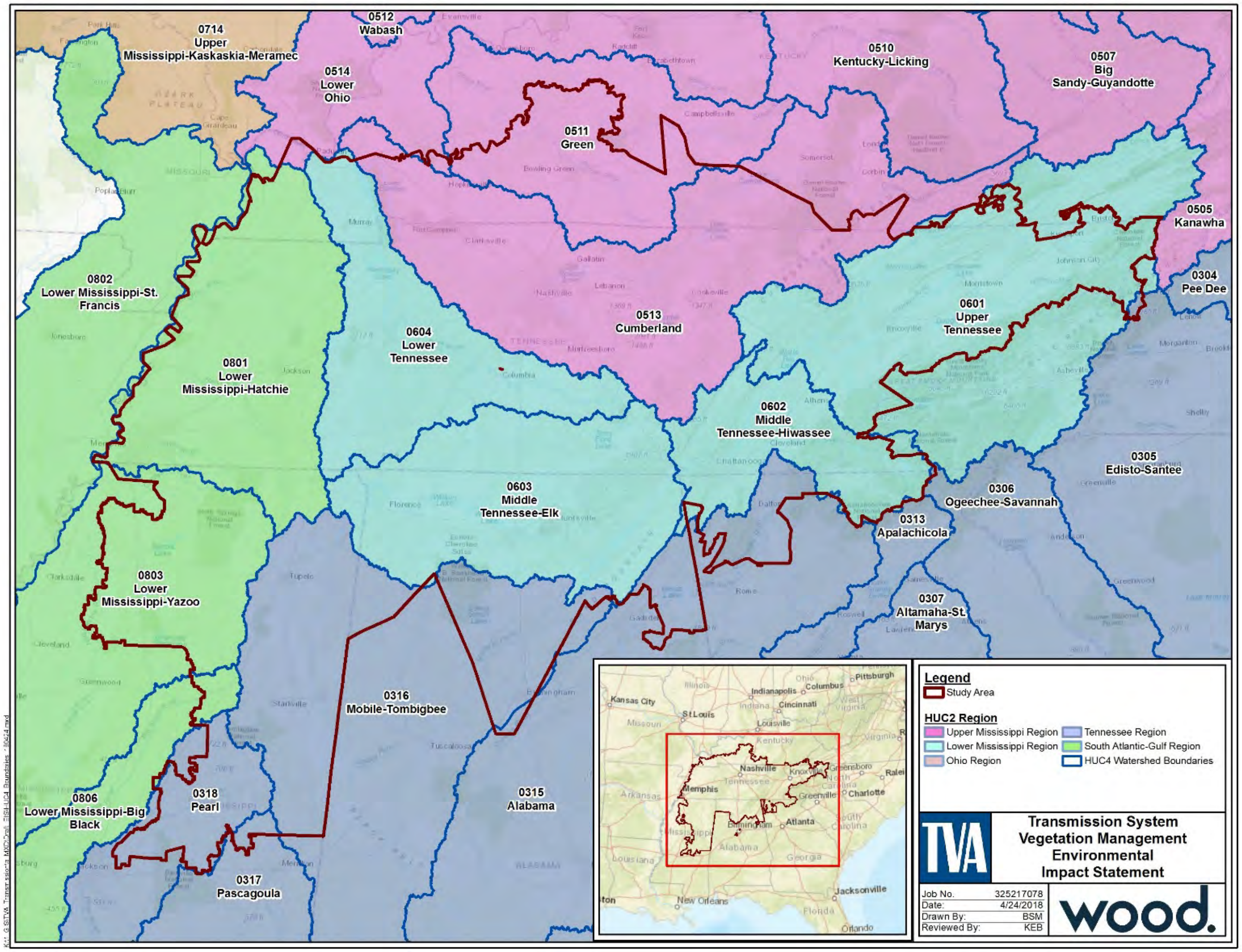


Figure 4-4. Major Watersheds of the TVA Study Area

4.4.1.1 Regulatory Framework for Surface Water

The federal Water Pollution Control Act, commonly known as the CWA, is the primary law that affects water quality. It establishes standards for the quality of surface waters and prohibits the discharge of pollutants from point sources unless a National Pollutant Discharge Elimination (NPDES) permit is obtained. NPDES permits also address CWA Section 316(b) requirements for the design, location, construction and capacity of cooling water intakes to reflect the best technology available for minimizing environmental impact. Section 404 of the CWA further prohibits the discharge of dredge and fill material to waters of the United States, which include most wetlands, unless authorized by a permit issued by the U.S. Army Corps of Engineers (USACE).

Several other environmental laws contain provisions aimed at protecting surface water, including the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation and Liability Act and the federal Insecticide, Fungicide, and Rodenticide Act.

The seven states in the TVA PSA have enacted laws regulating water quality and implementing the CWA. As part of this implementation, the states classify water bodies according to their uses and establish water quality criteria specific to these uses. Each state has also issued an anti-degradation statement containing specific conditions for regulated actions and designed to maintain and protect current uses and water quality conditions.

Alabama’s surface water is of generally high quality. Statewide the total mileage for rivers and streams not supporting designated uses is 3,352 miles. This total is 15 percent of the almost 14,000 river and stream miles which have been assessed. Approximately 53 percent of Alabama’s publicly accessible lakes and reservoirs are fully supporting their designated uses (Alabama Department of Environmental Management [ADEM] 2016).

Much of the non-support acreage is related to historic as well as recent polychlorinated biphenyl (PCB) contamination and eutrophic conditions in the Coosa River Basin reservoirs. Naturally higher nutrients in the soils of the Coosa River Basin, to a large extent, dictate its reservoirs’ eutrophic conditions. In an effort to manage eutrophic conditions more directly, the Department has developed nutrient criteria for 29 reservoirs. Ten of these reservoirs are located within the TVA PSA (Weiss Lake, Lake Guntersville, Wheeler Lake, Wilson Lake, Pickwick Lake, Little Bear Creek Lake, Cedar Creek Lake, Bankhead Lake, Lewis Smith Lake, and Inland Lake) (ADEM 2016).

Georgia is rich in water resources, with approximately 44,056 miles of perennial streams, 23,906 miles of intermittent streams, and 603 miles of ditches and canals, for a total of 70,150 stream miles. The state also has 4.8 million acres of wetlands (9 percent tidally affected), 425,582 acres of public lakes and reservoirs, 854 square miles of estuaries, and 100 miles of coastline (Georgia Department of Natural Resources 2013).

Statewide in 2014 in Kentucky there were (Kentucky Energy and Environment Cabinet 2015):

- 3,981 miles of streams (33 percent) supporting use(s).
- 7,087 miles of streams (58 percent) not supporting use(s) and requiring a Total Maximum Daily Load (TMDL) (category 5).
- 929 miles of streams (8 percent) not supporting use(s) with a TMDL (category 4A).
- 22 miles of streams (0.2 percent) not supporting uses(s) due to pollution (category 4C; no TMDL required).

The Mississippi Department of Environmental Quality assessed approximately 11 percent (2,793 miles) of Mississippi's 26,379 total miles of perennial streams and rivers for one or more uses. The status of water quality on the remaining 89 percent (23,586 miles) of the state’s perennial rivers and streams is unknown (MDEQ 2016). Table 4-11 summarizes the length of impaired streams throughout Mississippi based on the category of impairment.

Table 4-11. Summary of Causes of Use Support Impairment in Mississippi

Categories	Length of Stream Resource (miles)
Biological Impairment*	818
Nutrients	441
Sedimentation/Siltation	391
Pathogens	316
Organic Enrichment/Low Dissolved Oxygen	201
pH	134
Total**	**2,301**

* Definitive cause identification is not possible at the time of assessment. Designation used to report on waters where biological indicators (macroinvertebrates) were used and impairment was indicated but further investigation needed to identify the cause of the impairment.
** Total exceeds number of actual impaired miles due to presence of multiple impairment causes per assessed waterbody.

Across the TVA region potential causes of degraded water quality include (TVA 2015):

- *Wastewater discharges* – Municipal sewage treatment systems, industrial facilities, concentrated animal feeding operations and other sources discharge waste into streams and reservoirs. These discharges are controlled through state-issued NPDES permits issued under the authority of the federal CWA. NPDES permits regulate the amounts of various pollutants in the discharges (including heat) and establish monitoring and reporting requirements.
- *Runoff discharges* – Runoff from agriculture, forest management (silviculture) activities, urban uses and mined land can transport sediment and other pollutants into streams and reservoirs. Runoff from some commercial and industrial facilities and some construction sites is regulated through state NPDES stormwater permitting programs. Runoff from agriculture, silviculture and other sources not regulated under the NPDES program is referred to as “nonpoint source” runoff.
- *Cooling systems* – Electricity generating plants and other industrial facilities withdraw water from streams or reservoirs, use it to cool facility operations, and discharge heated water back into streams or reservoirs. The aquatic community may be impacted due to temperature changes in the receiving waters and from fish

and other organisms being trapped against the intake screens or sucked into the facility cooling system. These water intakes and discharges are controlled through state-issued NPDES permits.

- *Air pollution* – Airborne pollutants (e.g., mercury) reach the ground from the atmosphere as dust fall or are carried to the ground by precipitation and can affect surface waters through rainout and deposition.
- *Runoff* – Many nonpoint sources of water pollution are not subject to government regulations or control. Principal causes of non-point source pollution are agriculture; including runoff from fertilizer; silvicultural activities; pesticide applications; erosion and animal wastes; mining, including erosion and acid drainage; and urban runoff.
- *Low dissolved oxygen levels and low flow downstream of dams* – A major water quality concern is low dissolved oxygen levels in reservoirs and in the tailwaters downstream of dams. Long stretches of river can be affected, especially in areas where pollution further depletes DO. In addition, flow in these tailwaters is heavily influenced by the amount of water released from the upstream dams; in the past, some of the tailwaters were subject to periods of little or no flow. Since the early 1990s, TVA has addressed these issues in the Tennessee River system by installing equipment and making operational changes to increase DO concentrations below 16 dams and to maintain minimum flows in tailwaters (TVA 2015).

4.4.1.2 Regional Surface Waters

4.4.1.2.1 The Tennessee River System

The Tennessee River basin makes up a large centralized portion of the TVA study area (see Figure 4-4). The Tennessee River begins where the Holston and French Broad Rivers join in Knoxville, Tennessee, 652 river miles from where it empties into the Ohio River near Paducah, Kentucky.

A series of nine locks and dams built mostly in the 1930s and 1940s regulates the entire length of the Tennessee River and allows navigation from the Ohio River upstream to Knoxville (TVA 2004b). Almost all the major tributaries have at least one dam, creating 14 multi-purpose storage reservoirs and seven single-purpose power reservoirs. The construction of the TVA dam and reservoir system fundamentally altered both the water quality and physical environment of the Tennessee River and its tributaries. While dams promote navigation, flood control, power generation and river-based recreation by moderating the flow effects of floods and droughts throughout the year, they also disrupt the daily, seasonal and annual flow patterns characteristic of a river (TVA 2004a).

This system of dams and their operation is the most significant factor affecting water quality and aquatic habitats in the Tennessee River and its major tributaries. Portions of several rivers downstream of dams are included on state CWA Section 303(d) lists of impaired waters (Tennessee Department of Environmental Conservation 2014) due to low DO levels, flow modifications and thermal modifications resulting from impoundment. As mentioned above, TVA is working to reduce these impacts (TVA 2004a).

Major water quality concerns within the Tennessee River drainage basin include point and nonpoint sources of pollution that degrade water quality at several locations on main stream reservoirs and tributary rivers and reservoirs. TVA regularly evaluates several water quality indicators as well as the overall ecological health of reservoirs through its Ecological Health Monitoring Program. This program evaluates five metrics: chlorophyll concentration, fish community health, bottom life, sediment contamination and DO (TVA 2004b). Scores for each metric from monitoring sites in the deep area near the dam (forebay), mid-reservoir (transition zone), and at the upstream end of the reservoir (inflow) are combined for a summary score and rating. Ecological Health ratings, major areas of concern, and fish consumption advisories are listed in Table 4-12. The information in Table 4-12 utilizes previously reported ratings from TVA's IRP FEIS (TVA 2015) and includes updated data from each of the TVA Valley States' Water Quality Monitoring websites and TVA's Ecological Health Monitoring Program website.

Table 4-12. Ecological Health Ratings, Major Water Quality Concerns, and Fish Consumption Advisories for TVA Reservoirs

Reservoir	Ecological Health Rating – Score	Latest Survey Date	Concerns	Fish Consumption Advisories
Apalachia	Good – 75	2015	--	Mercury (NC statewide)
Bear Creek	Poor – 54	2017	DO[1], chlorophyll, bottom life	Mercury (dam forebay area)
Beech	Fair – 66	2015	DO, chlorophyll	Mercury
Blue Ridge	Good – 84	2017	--	Mercury
Boone	Fair – 63	2016	DO, chlorophyll, bottom life, sediments	PCBs[2], chlordane
Cedar Creek	Fair – 69	2017	DO	Mercury (dam forebay to 1 mile upstream of dam
Chatuge	Fair – 62	2015	DO, chlorophyll	Mercury
Cherokee	Poor – 56	2015	DO, chlorophyll, bottom life	None
Chickamauga	Good – 83	2017	--	Mercury (Hiwassee River from Hwy 58 (river mile 7.4) upstream to river mile 18.9.
Douglas	Poor – 63	2016	DO, chlorophyll	None
Fontana	Fair – 67	2016	DO, bottom life	Mercury
Fort Loudoun	Fair – 60	2017	DO, chlorophyll, bottom life	PCBs, mercury (upstream US 129)
Fort Patrick Henry	Fair – 69	2016	Chlorophyll	None
Guntersville	Fair – 72	2016	Chlorophyll	Mercury (Vicinity of Tennessee River mile 408, just downstream of Widows Creek; Sequatchie River)
Hiwassee	Fair – 67	2015	DO	Mercury (Statewide advisory)
Kentucky	Good – 75	2017	Chlorophyll (Big Sandy only - DO, bottom life)	Mercury (State of Kentucky statewide advisory; State of Tennessee, Big Sandy River and embayment)
Little Bear Creek	Fair – 69	2017	DO	Mercury

Reservoir	Ecological Health Rating – Score	Latest Survey Date	Concerns	Fish Consumption Advisories
Melton Hill	Good – 80	2016	Sediments	PCBs, mercury (Poplar Creek embayment)
Nickajack	Good – 84	2016	--	PCBs, chlordane (Chattanooga Creek)
Normandy	Poor – 40	2016	DO, chlorophyll, bottom life	None
Norris	Fair – 69	2014	DO	Mercury (Clinch River portion)
Nottely	Poor – 47	2014	DO, chlorophyll, bottom life	Mercury
Parksville	Fair – 66	2017	Sediments	None
Pickwick	Fair – 59	2016	DO, chlorophyll, bottom life	None
South Holston	Fair - 67	2015	DO	Mercury (Tennessee portion)
Tellico	Fair – 63	2015	DO, bottom life	PCBs
Tims Ford	Poor – 52	2016	DO, chlorophyll, bottom life	None
Watauga	Good - 77	2015	DO	Mercury
Watts Bar	Fair - 62	2016	DO, chlorophyll, bottom life	PCBs
Wheeler	Fair - 68	2015	DO, chlorophyll, bottom life	Mercury (Limestone Creek, Round Island Creek embayments); PFOS[3] (Baker Creek embayment, river miles 296 to 303)
Wilson	Poor - 57	2016	DO, chlorophyll, bottom life	Mercury (Big Nance Creek embayment)

Sources: TVA 2018, ADEM 2016, Georgia Department of Natural Resources 2013, Kentucky Energy and Environment Cabinet 2015, Mississippi Department of Environmental Quality 2016, North Carolina Department of Environmental Quality 2014, Tennessee Department of Environment and Conservation 2014, Tennessee Wildlife Resources Agency 2018, Virginia Department of Environmental Quality 2014.

[1] DO = Dissolved Oxygen

[2] PCB = Polychlorinated biphenyls

[3] PFOS = Perfluorooctane sulfonate

4.4.1.2.2 Other Major River Systems

The Cumberland River is formed by the junction of the Poor and Clover Forks in Harlan County, Kentucky, about 693 miles above its confluence with the Ohio River near Smithland, Kentucky. The drainage area of the Cumberland is 17,598 square miles. A system of locks and dams makes the Cumberland commercially navigable from the Ohio to mile 381.0 at Celina, Tennessee. Most of the Cumberland basin is comprised of limestone and dolomitic bedrock which tends to produce moderate to high concentrations of calcium and magnesium and a slightly alkaline pH in the surface waters (TVA 2004a).

The lower Ohio River receives drainage from a 204,000-square mile watershed, including 33,000 square miles in Kentucky. The upper Ohio Valley is highly industrialized. The Ohio River is regulated by a series of locks and dams from the Mississippi River to Pittsburg, Pennsylvania (981 miles) (TVA 2004a).

The lower Mississippi River in the reach that borders west Tennessee is one of the largest rivers in the world. Its drainage basin is 1,247,000 square miles and includes nearly all of the United States between the Rocky Mountains and the Appalachian Mountains. The Mississippi River has an average daily discharge of 312,000 million gallons per day at Memphis, Tennessee. In general, the quality of water in the Mississippi is suitable for most uses (TVA 2004a).

The Green River Basin is located in south central Kentucky and north central Tennessee. The drainage area is 9,273 square miles, of which 377 are in Tennessee. The Green River flows generally westward to the Ohio River upstream of Henderson, Kentucky. A system of seven locks and dams enables navigation on the lower portion of the Green River (TVA 2004a).

4.4.2 Surface Water Use

As stated in TVA's IRP 2015 Supplemental FEIS:

> "The TVA PSA (see Figure 1-1) contains most of the Tennessee River Basin, one of the most water-rich basins in the U.S. The Tennessee River Basin, which is about half of the TVA PSA, has been described as the most intensively used basin in the conterminous U.S. as measured by intensity of freshwater withdrawals in gallons per day per square mile (Hutson et al. 2004). Conversely, the basin has the lowest consumptive use in the nation by returning about 96 percent of the withdrawals back for downstream use (Bohac and Bowen 2012).
>
> In 2010, estimated average daily water withdrawals in the TVA PSA totaled 16,395 million gallons per day (Bohac and Bowen 2012; Bradley 2014). About 5.2 percent of these water withdrawals were groundwater and the remainder was surface water. The largest water use (84.4 percent of all withdrawals) was for thermoelectric generation (TVA 2015)."

4.4.3 Environmental Consequences for Surface Water

4.4.3.1 General Impacts to Surface Water

The evaluation of potential impacts to surface water resources centers on the evaluation of alterations to surface water quality. The clearing of vegetative cover within the study area has the potential to cause minor and temporary effects on surface water quality, regardless of the methods used for clearing. These alterations could be caused by small increases in sediment laden stormwater runoff, small increases in stream temperatures and decreases of dissolved oxygen from the loss of tree cover; the alteration of nutrient levels; small increases of pollutants, such as solid wastes from litter and chemical pollutants from leaking vehicles and heavy equipment; and the minor increase of concentrated stormwater flows from reduced vegetation cover. The evaluation of the surface water resources including the designated use of these resources and whether they are high quality or impaired (listed on the State 303(d) list) is considered to determine the appropriate control measures. Compliance with all applicable federal, state and local environmental laws and regulations as mentioned in Section 4.1 Affected Environment would be followed including State

Regulatory Stormwater Construction Permits, USACE 404/401 permitting, and Water Quality Certifications. A State-specific Stormwater BMP Plan, if required, would be drafted and would identify specific BMPs to address vegetation maintenance-related activities that would be adopted to minimize stormwater impacts per state guidelines. Additionally, BMP practices (TVA 2017a) would be used to avoid contamination of surface water in the project area. Appropriate BMPs would be followed, and all proposed project activities would be conducted in a manner to ensure that waste materials are contained, and the introduction of pollutants to the receiving waters would be minimized.

In addition to the removal of vegetative cover, the use of herbicides for the control of vegetation has the potential to affect the water quality of streams. Therefore, any pesticide/herbicide use as part of vegetation maintenance activities would have to comply with the General Permit for Application of Pesticides, which also requires a pesticide discharge management plan if certain thresholds are met. In areas requiring chemical treatment, only EPA-registered and TVA approved herbicides would be used in accordance with label directions designed in part to restrict applications near receiving waters and to prevent unacceptable aquatic impacts. Proper implementation and application of these products would be expected to have no significant impacts to surface waters. No cumulative impacts are anticipated.

4.4.3.2 Impacts to Surface Water from Vegetation Control Methods

4.4.3.2.1 Impacts to Surface Water from Manual Methods

Manual vegetation control methods use hand-operated tools (ANSI 2012). Equipment used includes chainsaws, machetes, brush hooks, axes, and brush blades, among others. Manual removal with chainsaws does not use the quantity of chemicals or fuels required by mechanical removal. Manual removal with other hand tools does not use chemicals or fuels. Pulling and cutting are the primary activities for this control method. Manual control methods are more suitable for smaller project areas which could include sensitive resource areas and/or very steep, rough terrain. With these control methods the impacts to surface water quality would potentially include the general impacts mentioned in Section 4.4.3.1. However, these tools may be used in a more targeted manner and would be expected to be less severe than impacts from vegetation control methods that include heavy equipment. This type of control method would be unlikely to require permitting. With the implementation of appropriate standard BMPs (TVA 2017a) only temporary, minor impacts to surrounding surface waters would be expected.

4.4.3.2.2 Impacts to Surface Water from Mechanical Methods

Mechanical tools require the use of fuels and lubricants. Consequently, there is a potential for impacts to water quality from leaks and spills that enter nearby surface waters. Additionally, heavy equipment has the ability to increase sediment laden stormwater flows by creating rills or ruts or areas of exposed soil. This can potentially alter the natural drainage course of stormwater and cause temporary and/or permanent impairment to surface water quality. Compaction of adjacent soils resulting from heavy equipment access can negatively impact a soil's water holding capacity and increase stormwater runoff. However, given intermittent access to these areas, impacts to the soils are expected to be temporary as the compaction would lessen over time and normal sediment retention function would be restored.

These types of activities may require a State Construction Stormwater permit depending on the area of the disturbance. Additional permitting may be required depending on the scope of the work, such as if stream crossings were required. Protective buffer zones would need to be determined and observed during work of this nature. Additionally, BMP practices employed by TVA (TVA 2017a) and/or any applicable State Regulated Stormwater BMP Plan would be used to avoid contamination of surface water in the project area. With the implementation of appropriate BMPs, only temporary, minor impacts to surrounding surface waters would be expected.

4.4.3.2.3 Impacts to Surface Water from Herbicide Application Methods

Herbicide application control techniques involve establishing the desirable application method determined after considering the impacts on public safety, environmental safety, and the site characteristics of the area to be treated. The application techniques include a range of tools that vary in the volume and type of herbicide used and in the intensity of their application. Herbicides used by TVA can be liquid, granular, pellets, or powder; can be applied aerially or by ground equipment; and may be selectively applied or broadcast depending on the site requirements, species present, and condition of the vegetation (TVA 2017a).

Runoff of herbicides could occur with any of the herbicide application techniques listed above; however, it would be minimized with limited application, such as spot, localized and human broadcast application, and the adherence to buffer or SMZ requirements.

Drift of herbicides could occur when spray or pellets are carried offsite by unforeseen weather or wind conditions into adjacent streams. Herbicide drift also would be minimized with limited application, such as spot, localized and human broadcast application, and the adherence to buffer or SMZ requirements.

The aerial broadcast herbicide application method is done either by fixed-wing aircraft or by helicopter and has a greater potential to impact water quality as a result of herbicide transport to non-targeted receiving streams and waterbodies. This method currently is not used, and if it is used in the future, is expected to be infrequent to rare.

Mechanical equipment is used in some cases for herbicide application. This equipment requires the use of fuels and lubricants; therefore, there is a potential for impacts to water quality from leaks and spills that can enter nearby surface waters. However, TVA has BMPs in place that actively minimize the chance that spilled or leaked petroleum products could enter streams (TVA 2017a). Additionally, heavy equipment has the ability to increase sediment laden stormwater flows by creating rills or ruts, denuded soil, or areas of exposed soil. This can potentially alter the natural drainage course of stormwater and cause temporary and/or permanent impairment to surface water quality. Heavy equipment can also compact soil which can increase concentrated flows and make it more difficult to implement permanent stabilization. However, this action is performed very infrequently; therefore, potential impacts would be minor and temporary.

Any pesticide/herbicide used as part of vegetation maintenance activities would comply with the General Permit for Application of Pesticides, which requires a pesticide discharge management plan if certain thresholds are met. In areas requiring chemical treatment, only EPA-registered herbicides would be used in accordance with label directions designed in part to restrict applications near receiving waters and to prevent unacceptable aquatic impacts. Proper implementation and application of these products would be expected to have no significant impacts to surface waters. No cumulative impacts are anticipated.

4.4.3.3 Impacts to Surface Water from Debris Management

Chipping in place, mulching in place, and cut and leave debris management methods keep debris in the project area. Chips and vegetation could potentially enter surface waters through stormwater runoff and obstruct water flows. However, TVA actively manages debris such that it is not placed in proximity to stream channels or other aquatic environments within the ROW. As such, impacts from debris management would be minor. Mechanical equipment is used in some cases for debris management. This equipment requires the use of fuels and lubricants, and it has the same potential for effects on quality for mechanical control methods above as described.

Offsite debris management methods remove the majority of debris from the work area. However, these methods also require heavy equipment that disturb the soil and require petroleum products that can leak or spill.

Burning methods have no direct or indirect impacts to the surface water quality within the study area.

Protective buffer zones would be determined and observed during debris management activities and BMPs (TVA 2017a) and/or any applicable State Regulated Stormwater BMP Plan would be used to avoid contamination of surface water in the project area. With the implementation of appropriate BMPs only temporary, minor impacts to surrounding surface waters would be expected.

4.4.3.4 Impacts to Surface Water from Restoration

Restoration measures entail the use of either manual or mechanical tools to seed disturbed areas. The reseeding method may require the use of heavy equipment and could have similar potential for impacts to water quality as described above. Over the long-term however, restoration measures would reduce erosion and sedimentation in receiving streams and would therefore be beneficial to water quality.

4.5 Aquatic Ecology

4.5.1 Affected Environment

The TVA study area encompasses portions of several major watersheds that support high aquatic biotic diversity (see Figure 4-4). The study area is recognized as a globally important area for freshwater biodiversity due to the number of major river systems, lack of historic glaciation, and high geologic diversity (Stein et al. 2000). Tennessee is reported to support approximately 319 fish species, including native and introduced species (Etnier and Starnes 1993) and 132 freshwater mussels (Parmalee and Bogan 1998). The Tennessee and Cumberland rivers have the highest number of endemic fish, mussel, and crayfish species in North America (Schilling and Williams 2002). The other major drainages within the TVA region share a diversity of aquatic life equal to or greater than the Tennessee River drainage (TVA 2015).

This section focuses on the aquatic biota characteristic of two distinct categories of waterbodies—lotic systems (i.e., streams and rivers) and lentic systems (i.e., lakes and reservoirs). There are approximately 42,000 miles of perennial streams and 46 TVA managed reservoirs in the study area (TVA 2011b and 2017; see Section 4.4). Most beneficial uses (as designated by the states) are supported in most water bodies in the study area including for fish and aquatic life support (see Section 4.4). Aquatic resources highlighted in this section represent a broad spectrum of important resources found in the study area including: fish (recreational and commercial fisheries), aquatic macroinvertebrates, aquatic plants, and rare species.

4.5.1.1 TVA Dam and Reservoir System

The construction of the TVA dam and reservoir system fundamentally altered the aquatic habitat of the major rivers and tributaries in the study area. Dams and their associated reservoirs have benefits for power generation, navigation, flood control, and recreation; however, they also disrupt the daily, seasonal, and annual flow patterns that are essential characteristics of the impounded waterway. Dams modify the natural hydroperiod by converting free-flowing lotic ecosystems into lake-like lentic ecosystems. For example, high flows are captured and stored by reservoirs upstream of dams, whereas flows fluctuate rapidly downstream of the dams due to hydropower peaking or flood-control releases.

Dams have shaped the composition of the aquatic communities above and below impoundments throughout the study area. Reservoirs and smaller impoundments have expanded species' ranges in the system, primarily shad and sunfishes, creating popular sport fisheries. Conversely, the undammed sections within the Tennessee River Valley hold a much higher diversity of aquatic life (including federally and state-listed species) than is found in the TVA reservoir system. For example, the Clinch River and Duck River in Tennessee and Virginia are recognized as global hotspots for freshwater biodiversity (Schilling and Williams 2002) partly due to their longer, unimpounded reaches.

4.5.1.1.1 Fish

Because the state of Tennessee encompasses a full range of physiographic provinces and ecoregions that are also represented in adjoining states within the study area, fishes within Tennessee (based on Etnier and Starnes 1993) are also generally representative of other states. Fishes within the study area are represented by approximately 30 families—the largest being the perch family (>90 species, most of which are darters), followed by the minnows (>80 species), catfishes (>20 species), suckers (21 species), and sunfishes (>20 species). Undammed streams and tributaries in the study area typically have a fish community that follows this same structure (i.e., high numbers of minnows and darters). Some of these species are common and may be found throughout the study area, whereas others are more limited in their distribution to certain watersheds. For example, more than 90 species are confined to the Tennessee River and Cumberland River watersheds, and approximately 25 species are confined to the Mississippi River watershed. The most diverse watershed is the Tennessee River with an estimated 205 native species, followed by the Cumberland River watershed with 161 species, and the Mississippi River watershed with 136 species (Etnier and Starnes 1993).

TVA has used a Reservoir Ecological Health monitoring program since 1990 to evaluate ecological conditions in major reservoirs in the Tennessee River system. A component of this monitoring program is a multi-metric approach to data evaluation for fish communities known as the Reservoir Fish Assemblage Index. Samples of fish communities are used to evaluate ecological conditions because of their importance in the aquatic food web and because fish life cycles are long enough to integrate conditions over time. Though altered from human activity, main stream reservoirs support healthy fish communities and generally rate good or fair based on attained Reservoir Fish Assemblage Index scores (McDonough and Hickman 1999). The number of species ranged from around 50 to 90 species per reservoir (TVA 2004b). Table 4-13 lists the number of species by family from seven representative reservoirs. Four families make up two-thirds of the total diversity. Minnows are the largest portion of total diversity at 24 percent (22 species), followed by sunfish at 15 percent (14 species), then suckers at 14 percent (13 species), and perch 13 percent (12 species). The other one-third of the total diversity is made up of 15 other families (30 species). Table 4-14 lists the most common species caught in the representative reservoirs. Six sunfish species were collected in every reservoir including: largemouth bass, smallmouth bass, spotted bass, redear sunfish, warmouth, and white crappie. Three suckers (black redhorse, golden redhorse, and spotted sucker); three minnows (common carp, golden shiner, and spotfin shiner); and three catfish (blue catfish, channel catfish, and flathead catfish) were commonly collected. Two herring (gizzard shad and threadfin shad) and two perch (logperch and yellow perch) were common. Additionally, longnose gar and white bass are commonly collected.

Table 4-13. Number of Species by Family from Representative[1] TVA Reservoirs

Family Common Name	Family	Number of Species
Bowfin	*Amiidae*	1
Catfish	*Ictaluridae*	5
Drum	*Sciaenidae*	1
Eel	*Anguillidae*	1
Gar	*Lepisosteidae*	2
Herring	*Clupeidae*	4
Lamprey	*Petromyzontidae*	2
Minnow	*Cyprinidae*	22
Mosquitofish	*Poeciliidae*	1
Needlefish	*Belonidae*	1
Perch	*Percidae*	12
Pikes	*Esocidae*	1
Sculpin	*Cottidae*	1
Silverside	*Atherinidae*	2
Sturgeon	*Acipenseridae*	1
Sucker	*Catastomidae*	13
Sunfish	*Centrachidae*	14
Temperate Bass	*Moronidae*	5
Topminnow	*Fundulidae*	2

Source: TVA 2004b

[1]Representative reservoirs included Chickamauga, Fort Loudoun, Kentucky, Nickajack, Normandy, Wheeler, and Wilson.

Table 4-14. Common Fish Species Found in TVA Reservoirs

Common Name	Family	Scientific Name
Black redhorse	Catastomidae	*Moxostoma duquesni*
Blue catfish	Ictaluridae	*Ictalurus furcatus*
Channel catfish	Ictaluridae	*Ictalurus punctatus*
Common carp	Cyprinidae	*Cyprinus carpio*
Flathead catfish	Ictaluridae	*Pylodictis olivaris*
Gizzard shad	Clupeidae	*Dorosoma cepedianum*
Golden redhorse	Catastomidae	*Moxostoma erythrurum*
Golden shiner	Cyprinidae	*Notemigonus crysoleucas*
Largemouth bass	Centrachidae	*Micropterus salmoides*
Logperch	Percidae	*Percina caprodes*
Longnose gar	Lepisosteidae	*Lepisosteus osseus*
Redear sunfish	Centrachidae	*Lepomis microlophus*
Smallmouth bass	Centrachidae	*Micropterus dolomieu*
Spotfin shiner	Cyprinidae	*Cyprinella spiloptera*
Spotted bass	Centrachidae	*Micropterus punctulatus*
Spotted sucker	Catastomidae	*Minytrema melanops*
Threadfin shad	Clupeidae	*Dorosoma petenense*
Warmouth	Centrachidae	*Lepomis gulosus*
White bass	Moronidae	*Morone chrysops*
White crappie	Centrachidae	*Pomoxis annularis*
Yellow perch	Percidae	*Perca flavescens*

Source: TVA 2004b

According to the Reservoir Operation Study (TVA 2004b), good to excellent sport fisheries exist in reservoirs, primarily for black bass, crappie, sauger, temperate bass, sunfish, and catfish. Additionally, year-long coldwater discharges below seven TVA impoundments have allowed for a productive trout Salmonidae fishery including rainbow trout and brown trout. The primary commercial species are channel catfish, blue catfish, and buffalo.

Stream habitats in the study area include very large rivers (e.g., Mississippi and lower Tennessee), large rivers (e.g., lower Cumberland and upper Tennessee), medium rivers (e.g., lower Duck and Clinch), small rivers (e.g., Little, Buffalo), and numerous perennial, intermittent, and ephemeral streams (Meyer et al. 2007). Each of these stream habitat types have a characteristic fish composition with diversity generally increasing downstream along a gradient of increasing stream size, habitat heterogeneity, and habitat availability (Schlosser 1987). Therefore, larger streams and rivers are the most diverse systems in the study area. However, smaller streams (e.g., headwater streams and tributaries) are the most likely to be encountered during TVA vegetation maintenance activities due to their abundance throughout the study area. Smaller streams are characterized by small-bodied species such as small minnows, madtom catfishes, darters, and sculpins (Schlosser 1987). Darter species contribute heavily to the overall fish diversity in headwater streams in the study area with 73 species found in smaller reaches (Meyer et al. 2007). Some fish species found in the study area only use headwater streams for spawning and nursery areas. For example, the federally threatened slackwater darter lives in pools of perennial streams, but it migrates upstream to spawn in "slack water" formed by shallow springs, seeps, or flooded fields that slowly run off into adjacent headwater streams (Etnier and Starnes 1993).

4.5.1.1.2 Macroinvertebrates

Benthic (bottom dwelling) macroinvertebrate populations of TVA's reservoir system are assessed using the Reservoir Benthic Index methodology. Because benthic macroinvertebrates are relatively immobile, negative impacts to aquatic ecosystems can be detected earlier in benthic macroinvertebrate communities than in fish communities. A component of the Reservoir Health Ecological Monitoring Program includes sampling the benthic macroinvertebrate community. Benthic life includes worms, aquatic insects, crayfish (which spend all of their lives in or on the stream beds), snails, mussels and clams. Benthic invertebrates are a vital part of the food chain of aquatic ecosystems. Benthic invertebrate communities are strongly affected by seasonal thermal stratification, varying dissolved oxygen concentrations and large water level fluctuations in reservoirs. Poor benthic community ratings are typical of tributary reservoirs. Macroinvertebrate communities of reservoirs are generally low in diversity and comprised of tolerant taxa. This trend is typical of most reservoir systems, as few macroinvertebrates tolerate conditions in the deeper waters that are characterized as having lower dissolved oxygen concentrations, reduced habitat variability, and limited food resources (Thorp and Covich 2001). Overall, aquatic insect communities were fair according to index ratings from representative reservoirs (TVA 2004b).

In contrast, benthic macroinvertebrate populations in non-reservoir aquatic environments are often comprised of assemblages that are representative of lotic habitats. Composition and quality of such communities are often correlated with such factors as stream size and placement within the watershed, surrounding land uses and proximity to point source and non-point source discharges. Within rural portions of TVA's transmission line ROW, smaller streams may be expected to be composed of benthic invertebrates that are less tolerant of low dissolved oxygen levels and representative of a wide range of sub-habitats. For example, higher gradient riffle environments may be expected to support greater abundances of organisms that are clingers or swimmers. Such communities are often characterized as having increased abundances of insects such as mayflies, stoneflies, and caddisflies. In contrast, slower gradient deposition reaches of these smaller streams may be variously composed of biota that are burrowers, shredders or collectors. Groups common to such environments include worms, midges, scuds and isopods. Smaller headwater streams within ROW may be dominated by only a few species, though all classes of invertebrates may be found. Crustaceans, caddisflies, leeches, mollusks, flatworms and blackflies tend to be found in such environments (North Carolina State University Water Quality Group 1976).

Freshwater mussels are excellent indicators of water quality and habitat stability. Mussels provide many other important ecosystem services including filtering large quantities of water. Mussel communities in reservoirs are generally poor (TVA 2004b). Native mussels that are adapted to the natural warmwater conditions cannot maintain diverse populations in reservoirs. However, the statuses of individual populations vary by species. For example, mussel species adapted to pool conditions have been doing better in reservoirs, including: mapleleaf, bankclimber, and threeridge in Kentucky Lake (Sickel et al. 2007). Though, the overall native mussel community has decreased from 42 species to 21 species (four of which invaded post-dam construction) due to loss of flow-sensitive species (Sickel et al. 2007). Main stream tailwaters, like those off Kentucky Lake, are areas of highest mussel diversity in the regulated TVA system. Remaining riverine mussel species reach greater abundance and diversity in flowing main stream reaches, but their status remains only fair due to overall low diversity, low abundances, and low reproductive success for some species (TVA 2004b). In cool to warm tailwaters, the status of mussel communities is rated poor (TVA 2004b).

In the Tennessee River watershed, the 91 taxa of mussels belonging to Unionidae were widespread from headwater streams to the mainstem of the Tennessee River. Currently, of these original 91 native mussels, 10 are extinct, 20 are extirpated, 24 are endangered (see Section 4.3), nine are relic, and 28 are stable (Neves 1999). Dennis (1984) provided a detailed account of the distribution of mussels by stream size throughout the Tennessee River watershed (see Table I-19 in Dennis 1984). The greatest number of mussels (approximately 70 percent of species) are found in medium to large streams. Only six species were common to all stream sizes and found throughout the study area including: threeridge, purple wartyback, deertoe, mucket, pocketbook, and kidneyshell.

4.5.1.1.3 Aquatic Macrophytes

Aquatic plants are often referred to as aquatic macrophytes and include aquatic vascular plants, a few mosses, and macroscopic algae. Aquatic plants benefit water quality and provide habitat to wildlife, waterfowl, and fisheries. Floating-leaved plants and submersed vegetation provide sediment stabilization and food, shelter, and reproductive habitat for fish, insects, and other aquatic fauna. Riverine aquatic plants in the Tennessee River watershed are mostly rooted species that occur on gravel shoals. Plant communities are dominated by native species; however, Eurasian watermilfoil, hydrilla, and coontail are common invasive species.

4.5.2 Environmental Consequences for Aquatic Ecology

4.5.2.1 General Impacts to Aquatic Ecology

Transmission line vegetation management activities have little potential to directly and indirectly affect the aquatic ecology of waterways within the study area, regardless of the methods used. Potential for effects include: ground disturbing activities such as the removal of riparian vegetation that could result in minor and temporary erosion, sedimentation, and increased water temperatures; overspray or spills of non-aquatic rated herbicides into aquatic environments; and leaks of oil or fuel that could alter water quality. However, these impacts are expected to be rare and effects minimal because TVA employs a host of BMPs that are designed to minimize environmental impacts like soil disturbance/erosion, stream bank destabilization, in stream deposition of woody debris, damage to in steam habitats (vehicle/equipment traffic), and inadvertent discharge of herbicides or other petrochemical to aquatic environments. With correct implementation of BMPs, SOPs, the O-SAR database, and any site-specific conservation measures, ROW vegetation management activities are not likely to adversely affect aquatic environments.

> **What are "streamside management zones (SMZs)"?**
>
> A Streamside Management Zone is an area or zone, covered with vegetation on both sides of perennial and intermittent streams and along the margins of bodies of open water, where extra precaution is used in carrying out construction activities to protect stream banks, instream aquatic habitat, and water quality. The zone also functions as a buffer when herbicides and other chemicals are applied to adjacent lands.

TVA's routine integration of O-SAR database reviews, adherence to BMPs related to SMZs (see Appendix E) protocols and procedures, coupled with strict adherence to proper selection and use of herbicides in proximity to surface water minimizes potential impacts to aquatic ecosystems. Proper application of BMPs, including effective SMZs, would reduce direct and indirect effects to aquatic ecosystems in the transmission ROW. SMZs promote a vegetated riparian area that stabilizes stream banks, moderates water temperature, filters nutrients and sediments, and strongly influences energy pathways by controlling light penetration and inputs of organic material (Gregory et al. 1991; Allan and Castillo 2007). When properly using forestry BMPs, streams in the Southeast have shown little change in aquatic macroinvertebrate community diversity following timber harvesting (Warrington et al. 2017). Where changes occurred, they reflected a temporary (less than 5 year) shift in food resources from that based on detritus to one based on primary productivity (algal growth). This makes sense for a section of stream with a temporary reduction in leaf inputs, but an increased solar exposure that promotes photosynthesis. Vegetation control methods that included properly used herbicide applications showed no significant differences in macroinvertebrate indices from reference streams (Warrington et al. 2017). Forestry BMPs that include SMZs would effectively mitigate consequences of TVA's vegetation management program, even in small headwater streams.

4.5.2.2 Impacts to Aquatic Ecology from Vegetation Control Methods

4.5.2.2.1 Impacts to Aquatic Ecology from Manual Methods

Manual vegetation control methods have limited impacts to aquatic ecosystems due to their precision and lighter footprint. Such methods have a negligible potential for erosion and secondary sedimentation effects in the aquatic environment. Chainsaws and other powered hand tools that require gasoline, engine oil, and bar (blade) lubricants have the potential to leak or spill. However, spills would be rare due to adherence to TVA BMPs and SOPs and limited due to the small engine sizes found on hand tools.

4.5.2.2.2 Impacts to Aquatic Ecology from Mechanical Methods

Mechanical vegetation control has the potential to impact aquatic ecosystems more than manual methods due to use of heavy equipment that can cause ground disturbance that increases the potential for soil erosion. Adherence to TVA BMPs regarding riparian buffers (i.e., SMZs) reduces the potential for mechanical methods to impact waterbodies. Methods that may cause ground disturbance but leave behind a base of vegetation and vegetative debris, can further reduce the potential for erosion and result in reduced impacts on aquatic environments. Aerial side-wall trimming avoids all ground disturbances and associated erosion issues and therefore has no impact on aquatic resources.

Other potential effects of mechanical clearing include possible oil leaks or spills from equipment or vehicles that may reach adjacent waterbodies. Hydrocarbons leaked or spilled in waterbodies can have multiple detrimental effects to aquatic species as indicated above. However, TVA has BMPs in place that actively minimize the chance that spilled or leaked petroleum products could enter streams (TVA 2017a). These processes ensure equipment is in good working order and machinery found to be leaking oil or other fluids would be immediately removed from service until repaired. Repairs would occur off ROW except under emergency situations, when ground cloths, matting, or plastic sheeting would be used to prevent releases of oil, fuel, or grease into the environment. Given standard BMPs, any effects of fluids leaking from machinery on aquatic ecology are expected to temporary and minor, if they occur at all.

Compaction of adjacent soils resulting from heavy equipment access can negatively impact soil water holding capacity, resulting in increased stormwater runoff. However, given intermittent access to these areas, and infrequent use of heavy equipment, impacts to the soils are expected to be temporary as the compaction would lessen over time and normal sediment retention function would be restored.

Operation of mechanized equipment near streams has the potential to destabilize small sections of streambank, but TVA BMPs generally prohibit the use of machinery in SMZs (TVA 2017a). Typically, trees are removed in SMZs using chainsaw. Feller-bunchers are permitted, but they are rarely used for routine vegetation management. If a feller-buncher were used in an SMZ, the operator would position the equipment as far as possible from the streambank, reaching toward the tree with the cutting attachment. This would keep the equipment away from stream bank and reduce the potential for bank sloughing and associated sedimentation.

When used on a broader scale as part of vegetation removal activities, mechanized equipment would result in the loss of a small amount of riparian forest cover along streams. Removal of forested riparian zone vegetation can increase stream temperatures (Gordon et al. 2004), which may locally alter instream light and temperature characteristics. Riparian vegetation also acts as filters for sediments, nutrients, and other pollutants (Allan and Castillo 2007). Runoff is physically slowed by the tangle of trunks and stems, so soil and roots can actively uptake excess nutrients otherwise destined for the stream. However, since the amount of forest cover that would be removed along any one stream is very small, amounting to a fraction of an acre at any one stream crossing, any potential effects of tree removal are expected to be minor.

4.5.2.2.3 Impacts to Aquatic Ecology from Herbicide Application Methods

Herbicide application has the potential to impact water quality via inadvertent application to stream channels, excess surface runoff, spray drift, and leaching through the soil profile (Annett et al. 2014; Tatum et al. 2017), however TVA employs SOPs (e.g., label-directed use) and BMPs specifically designed to eliminate these risks. For example, overspray has the highest potential to acutely affect aquatic organisms (Rolando et al. 2017). Algae, microorganisms, macroinvertebrates, amphibians, and fish are affected by exposure to consistently elevated levels of herbicide (Warren et al. 2003; Warrington et al. 2017), but, in the environment, organism exposure would fluctuate due to varying physical and climatic conditions. Field measures for concentration and durations of exposure to herbicides are typically well below standard toxicity endpoints (Scarbrough et al. 2015; Rolando et al. 2017). For example, glyphosate-based herbicides have a low-runoff risk and rapidly dissipate when introduced to aquatic environments (Rolando et al. 2017). Acute and chronic toxicity of herbicides to aquatic organisms is dependent on herbicide type, concentration, exposure time, and varies by species; but, overall risks of aquatic ecosystem exposure to herbicides are low when used within legal label recommendations and applied by trained applicators.

Spot and localized herbicide applications have little chance of impacting aquatic systems when applied correctly. Spot application is intended to use the least amount of herbicide possible to treat individual plants. Similarly, localized herbicide application consists of treating individual or small groupings of plants via basal, low-volume foliar, granular, and bare-ground treatments to minimize any overspray or excess runoff. Heavy rains could carry herbicides (e.g., granular pellets) offsite and into adjacent streams; however, rain would also serve to dilute any excess herbicide and limit any acute or chronic effects (Scarbrough et al. 2015). Additionally, broadcast application methods using mechanized equipment also have the potential for ground-disturbing impacts (as described above). Inadvertent application to aquatic environments via overspray and drift are most likely with broadcast and aerial application methods. Drift is the airborne movement of herbicides through wind or evaporation to non-target areas. Because TVA uses BMPs (i.e., SMZs), prior planning, proper herbicide mixtures, and advanced technologies to reduce or eliminate drift during application (see Section 2.1.3), herbicide toxicity to aquatic ecosystems is unlikely under TVA's standard procedures.

4.5.2.3 Impacts to Aquatic Ecology from Debris Management

Cut debris from mechanical methods also has the potential to cause excess debris loading into waterways. Such debris deposition in aquatic environments has the potential to alter localized habitat characteristics and lower dissolved oxygen levels (Allan and Castillo 2007) that may stress or result in the mortality of aquatic biota. Additionally, debris from riparian vegetation removal could enter the channel and form debris jams that continue to exacerbate streambank erosion (Stott et al. 2001). However, TVA actively manages debris such that it is not placed in proximity to stream channels or other aquatic environments within the transmission ROW. As such, impacts from debris management would be minor.

Leaving standing snags in place following herbicide treatments would have negligible impacts to aquatic organisms. Initial impacts would be similar to those discussed in the Herbicides discussion in Section 4.3.2.2.3. Minor positive impacts may occur as a result of increased food source due to potential increased insect usage of dead and decomposing trees located near streams.

4.5.2.4 Impacts to Aquatic Ecology from Restoration

Restoration methods of reseeding have the potential for some minor and localized short-term negative consequences for aquatic environments, but overall would have long-term benefits. Reseeding involves the use of ground crews with belly-grinders, tractor seeders, aerial seeders, hydro-seeders, or drill seeders to encourage vegetation of disturbed soils. Impacts from the use of such equipment would be similar to that described above for mechanical methods.

4.5.2.5 Mitigation Measures for Impacts to Aquatic Ecology

The following BMP mitigation measures would be applied when working near or adjacent to water resources to limit adverse impacts including: riparian buffers (i.e., SMZs), limits to the amount of exposed ground, and specific herbicide restrictions.

- SMZs:
  - At a minimum, all streams would receive the standard Category ‘A’ level of protection (TVA 2017a).
  - Category ‘A’ protection restricts the use of heavy equipment operated within the SMZ in accordance with permit requirements and such that only equipment with minimal soil disturbance and minimal damage to low-lying vegetation is used.
  - Wheel- or track-type equipment should not operate within these zones.
  - Stumps can be cut close to the ground but must not be removed or uprooted.
  - If sensitive aquatic species are present, more restrictive SMZs (e.g., Category ‘B’ or ‘C’) would be applied (see Section 4.3.2.1.3).
- Disturbed Ground Limits:
  - Along perennial streams, no more than 20 percent bare disturbed ground, evenly distributed, is allowed to result from vegetation maintenance activities.
  - Along intermittent streams, no more that 40 percent bare disturbed ground, evenly distributed, is allowed.
  - On those areas where bare, disturbed ground should exceed the 20 or 40 percent limit, a groundcover must be provided.
- Herbicide Restrictions:
  - TVA only uses herbicides registered with the EPA and applicators must follow manufacturers’ label instructions, EPA guidelines, and respective state regulations and laws.
  - Herbicides used within SMZs would be approved for use within aquatic environments by the EPA.
  - Ground-based or aerial broadcast application of herbicides within any SMZ adjacent to perennial streams, ponds, or other water sources is not permitted.
  - Aerial application of liquid herbicide is not permitted when weather conditions exist that are outside the limits described on the label. For example, pellet application would not be permitted when surface wind speeds exceed 10 miles per hour or on frozen or water-saturated soils.
  - An NPDES permit would be obtained for aquatic herbicide use. TVA would adhere to requirements established by each permit. Permit requirements vary by state.

4.6 Wetlands

4.6.1 Affected Environment

Wetlands are those areas inundated or saturated by surface or groundwater such that vegetation adapted to saturated soil conditions is generally prevalent (USACE 33 Code of Federal Regulations [CFR] § 328(b); EPA 40 CFR § 230.3(t); TVA 1983). In the TVA region, examples typically include bottomland forests, swamps, wet meadows, and fringe wetland along the edges of watercourses and impoundments. On TVA transmission ROWs where conductor clearance is necessary, low-stature or ROW compatible wetland habitat persists where naturally present. Routine vegetation maintenance activities conducted on a three-year rotation ensure low-stature wetland habitat is sustained where woody wetland saplings become established and have potential to threaten conductor clearance. Forested wetlands would persist on transmission ROW areas not subject to three-year cyclical vegetation maintenance activities, such as along ROW borders or in spanned valleys.

Wetlands are ecologically important because of their beneficial effect on water quality, their moderation of flow regimes by retaining and gradually releasing water, their value as wildlife habitat, and as areas of botanical diversity. Wetland habitat provides valuable public benefits including flood storage, erosion control, water quality improvement, wildlife habitat and recreation opportunities. Because of this, wetlands are protected under Federal and State laws that mandate wetland avoidance, minimization, and compensation for loss of wetland function resulting from regulated activities.

Wetlands in the study area consist of two main systems: palustrine wetlands, such as non-tidal marshes, swamps and bottomland forests dominated by trees, shrubs, and persistent emergent vegetation, and lacustrine wetlands associated with lakes such as aquatic bed wetlands (Cowardin et al. 1979). Overall, palustrine wetlands are the predominant wetlands in the study area. These wetlands include bottomland hardwood forests (forested wetlands), scrub-shrub wetlands, beaver ponds (aquatic-bed or emergent wetlands), wet meadows and marshes (emergent wetlands), and highland bogs (forested, scrub-shrub, or emergent wetlands that have organic soils). Lacustrine (i.e., related to a lake) and riverine (i.e., related to a river) systems are also wetland types found within the region and are discussed in Section 4.4.

Wetlands occur across the TVA region and are most extensive in the south and west (TVA 2015). In these areas the topography levels out, and broad, flat floodplain areas are common features. For this section, the type and extent of wetlands within the study area and TVA transmission corridors have been derived from the NWI database (USFWS 1977-2017). The use of national data sets such as NWI is appropriate and effective for a broad study area; however, the dataset is outdated and often doesn't reflect existing land uses or conditions. This is particularly problematic in non-agricultural lands and undeveloped lands, such as floodplains of large rivers, where use of NWI produces false overestimations of forested wetland areas by not eliminating the portion within the existing transmission corridor. Therefore, based on derived forested landcover quantities developed for TVA's ESA Section 7 Programmatic BA developed by TVA, the acreage of forested wetland within the transmission ROW presented by NWI has been modified to better represent the existing condition within the transmission ROW. The difference in forested landcover between the BA and NLCD data was used as a guide to apply an equivalent adjustment to the NWI forested quantities. The difference in forested wetland acreage was then applied to the total emergent acreage as this represents areas that have been cleared for the existing transmission corridors. Therefore, the acreage of forested wetland within the transmission

ROW presented by NWI has been modified to better represent the existing condition within the ROW. Table 4-15 summarizes the acreage of each vegetated wetland category that occurs within the TVA transmission ROW and overall study area.

According to NWI maps, a total of 6,751 acres of wetland are mapped within existing transmission ROWs, covering approximately 2.8 percent of TVA's transmission ROW system. Because the tools used to develop NWI do not easily allow for identification of small and/or saturated wetlands, TVA conducts an O-SAR review with better imagery and updated materials to supplement the NWI. For wetlands, this includes potential wetlands identified by TVA using topographic features, water bodies, soils boundaries, and proximity to NWI. Some field verified wetlands delineated during TVA field surveys of transmission ROW may be incorporated, but these are limited relative to the entire ROW system. The office-level review has identified 13,597 acres of potential wetland in addition to NWI wetlands. Therefore, NWI and O-SAR together map 20,348 acres of potential wetlands, comprising 8.5 percent of TVA's transmission ROW system. As described in Section 3.1.2, TVA uses this information to guide decisions regarding vegetation maintenance activities in the vicinity of recorded or potential wetland features.

Overall, within the transmission line ROW, palustrine emergent wetlands are the most abundant type and constitute approximately 2.1 percent of the transmission line areas (see Table 4-15). Forested wetlands are the least abundant (0.3 percent of the area), which is consistent with the existing vegetative cover within the transmission ROWs as most of the wetland areas are maintained as either scrub-shrub or emergent wetlands to ensure safety and reliability of the TVA system. The relatively small amount of forested wetland acreage includes those areas that are not maintained within the entire corridor and forest lands that are spanned by the line and are not cleared (i.e., deep ravines). While vegetation maintenance is not being proposed within the spanned valleys and deep ravines, the 627 acres of forested wetlands within the existing corridors is used as a bounding value within this assessment. Within the study area, forested wetlands are the most abundant and comprise the large majority (87 percent) of the wetland resources and approximately 3.6 percent of the study area.

Emergent wetlands often occur along streams in poorly drained depressions and along the edges of water bodies, and they have water depths that vary between a few inches to a few feet (EPA 2017e). Within the transmission ROW and study area, the greatest acreage of emergent wetlands occurs in the Southeastern Plains and Interior Plateau ecoregions (Table 4-15). However, as a percentage of the total area, they are the most prevalent in the Mississippi Alluvial Plain and Southeastern Plains ecoregions. These wetlands areas are characterized by emergent plants (erect, rooted, or floating herbaceous hydrophytes) that include water lilies, cattails, rushes, sedges, reeds and other species. A more detailed list of emergent species typically found in poorly-drained soils can be found in Section 4.1 (Vegetation). Perennial plants typically dominate the landscape and remain present for most of the growing season, which can lead to a similar appearance of these wetlands year after year in areas with relatively stable climatic conditions (Federal Geographic Data Committee [FGDC] 2013).

Table 4-15. National Wetland Inventory Data within TVA Transmission Line Rights-of-Way and TVA Study Area

	TVA Transmission ROW						Study Area					
	Emergent		Forested[1]		Scrub Shrub		Emergent		Forested		Scrub Shrub	
Level III Ecoregion	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**
Blue Ridge	6	0.1%	1	0.01%	5	0.1%	658	0.03%	2,413	0.1%	1,484	0.1%
Central Appalachians	6	0.3%	1	0.03%	1	0.1%	210	0.03%	1,595	0.2%	297	0.04%
Interior Plateau	1,391	1.7%	169	0.2%	247	0.3%	35,904	0.2%	313,600	2.0%	21,036	0.1%
Interior River Valleys and Hills	65	1.6%	8	0.2%	22	0.5%	886	0.1%	16,010	1.6%	1,864	0.2%
Mississippi Alluvial Plain	48	6.7%	6	0.9%	0	0%	8,104	0.9%	158,595	17.6%	4,484	0.5%
Mississippi Valley Loess Plains	913	3.9%	122	0.5%	163	0.7%	17,224	0.3%	325,796	6.2%	19,587	0.4%
Ridge and Valley	137	0.3%	16	0.03%	56	0.1%	6,202	0.1%	27,683	0.4%	6,197	0.1%
Southeastern Plains	2,288	5.2%	283	0.6%	611	1.4%	67,791	0.5%	982,014	7.7%	81,029	0.6%
Southwestern Appalachians	147	0.5%	21	0.1%	18	0.1%	4,074	0.1%	43,933	0.6%	1,980	0.03%
Total by Type	**5,001**	**2.1%**	**627**	**0.3%**	**1,123**	**0.5%**	**141,053**	**0.3%**	**1,871,639**	**3.6%**	**137,958**	**0.3%**

Source: USFWS 1977-2017

[1]Forested wetland acreage modified to develop a more accurate estimate of forested wetland within the transmission ROW due to coarseness of NWI scale and inability to map emergent wetland in narrow transmission ROW corridors through forest and/or where NWI preceded transmission ROW construction.

Forested wetlands are found throughout the United States and occur where moisture is relatively abundant, particularly along rivers and in the mountains. Within the transmission ROW and study area, the greatest acreage of forested wetlands occurs in the Southeastern Plains, Interior Plateau, and Mississippi Valley Loess Plains ecoregions (see Table 4-15). As a percentage of the total area, they are the most prevalent in the Mississippi Alluvial Plain and Southeastern Plains ecoregions. They are typically characterized by an overstory of trees with species including red maple, oaks, willows, and cypress; an understory of young trees or shrubs; and an herbaceous layer.

Scrub-shrub wetlands are dominated by woody plants less than 20 feet tall and sometimes represent a successional area leading to forested wetland, but they may be relatively stable communities as well (FGDC 2013). Within the transmission ROW and study area, the greatest acreage of scrub shrub wetlands occurs in the Southeastern Plains and Interior Plateau ecoregions (see Table 4-15). However, as a percentage of the total area, they are the most prevalent in the Mississippi Valley Loess Plains and Southeastern Plains ecoregions. Since shrubs can include true shrubs, young specimens of tree species that have not yet reached 6 meters in height, and woody plants (including tree species) that are stunted because of adverse environmental conditions, this wetland type commonly occurs adjacent to forested wetlands, but may also contain shrubby vegetation such as buttonbush, willow, dogwood, and swamp rose (EPA 2017c).

4.6.2 Environmental Consequences for Wetlands

4.6.2.1 General Impacts to Wetlands

Activities in wetlands are regulated by state and federal agencies to ensure no more than minimal impacts to the aquatic environment and no net loss of wetland resources. Under CWA §404, activities resulting in the discharge of dredge or fill material in jurisdictional wetlands, and any secondary wetland impacts, must be authorized by the USACE through a Nationwide, Regional, or Individual Permit. CWA §401 mandates state water quality certification for projects requiring USACE approval and permitting. Lastly, EO 11990 requires federal agencies such as TVA to minimize wetland destruction, loss, or degradation, and preserve and enhance natural and beneficial wetland values, while carrying out agency responsibilities. Compliance with USACE permitting is required for regulated activities within jurisdictional waters of the U.S., which could include mitigation based on their review of TVA’s proposed impacts.

As described in Section 4.6.1, wetland identification for the purpose of TVA’s transmission ROW vegetation management program is conducted utilizing NWI data and supplemented with an O-SAR review that incorporates higher quality imagery and overlays indicative of wetland presence. The use of office-level materials for wetland identification runs the inherent risk of inaccuracies (Tiner 1997); therefore, limitations of this data must be considered. For example, there may be wetlands present for which no mapped evidence or other data currently exists and are, therefore, undetectable via office-level review. The presence or absence of these wetland resources could only be verified through field surveys to accurately determine the extent and condition. Wetland delineations are not performed for the purpose of planning transmission ROW vegetation maintenance activities; however, some ground surveyed wetland boundaries may be incorporated into the O-SAR dataset. Because most of the wetland areas have only been identified through desktop resources, potential impacts due to transmission ROW vegetation maintenance activities may occur at wetlands not previously identified. Therefore, to ensure compliance with wetland regulations, wetland O-SAR data is only applicable to vegetation management activities occurring within the routinely cleared (three-year cycle) ROW corridor and associated access road work resulting in less than 0.1 acre of permanent disturbance. Impacts over 0.1 acre commonly require agency notification and potential mitigation to ensure no more than minimal impacts to the aquatic environment, in accordance with state and federal wetland regulations. Thus, an environmental review separate from O-SAR is conducted for vegetation management outside of the routinely cleared (three-year cycle) ROW corridor and associated access road work where greater than 0.1 acre of permanent impact is proposed. In addition, as a general practice, vegetation maintenance crews remain alert to wetland "indicators" such as standing water, soil saturation, etc., and work accordingly to protect and identify previously unmapped wetland resources.

Transmission ROW vegetation maintenance in wetlands consists of completely removing or limiting woody wetland vegetation in order to accommodate conductor clearance for safe and reliable transmission line operation. The initial conversion of forested wetlands due to the construction of the transmission line ROW into a low-growing, meadow-like wetland habitat has resulted in the decrease of wetland functions for those portions of the wetland within the ROW. Lower growing emergent wetlands lack the deeper root systems and greater above ground biomass (quantity of living matter) that is present in forested wetlands. Without these forested wetland attributes, wetland functions are provided at a reduced level due to the lower functional capacity or ability of emergent wetland habitat to impede and store stormwater, improve water quality through toxin absorption, and reduce siltation by erosion control (Ainslie et al. 1999; Scott et al. 1990, Wilder and Roberts 2002). Therefore, any conversion of a forested wetland and subsequent long-term management as emergent meadow-like wetland results in sustained loss of wetland function, regardless of the technique used to convert and maintain the desired low stature wetland habitat. The methods available to TVA for transmission ROW vegetation management result in a range of direct and indirect wetland impacts, and they are coupled with practices for avoiding or minimizing wetland impacts to the extent practicable.

4.6.2.2 Impacts to Wetlands from Vegetation Control Methods

4.6.2.2.1 Impacts to Wetlands from Manual Methods

Manual control is the most common practice for transmission ROW vegetation maintenance in wetlands. Removal of woody vegetation in wetlands using hand-held tools is generally conducted on foot or ATV, with nominal access impacts, and it results in immediate removal of only target vegetation by hand pulling or cutting.

Pulling (or hoeing) is not typically used by TVA in wetlands because only small, shallow rooted wetland plants can be removed. There are no foreseeable wetland impacts from transmission ROW maintenance accomplished by pulling/hoeing due to the relatively unobtrusive nature and small scale applicability.

Cutting using hand held shears, clippers, brush saws, axes, and chainsaws to sever above ground vegetation of shrubs or saplings would maintain existing wetland function by promoting long-term emergent meadow-like wetland habitat. If tree removal is the primary objective, cutting can result in forested wetland conversion and associated reduction in wetland function.

Manual clearing with hand tools can be used where inundated and saturated wetland soils constrain access precluding the use of other vegetation management strategies. Resprouting of manually cut or pulled woody wetland plants can ultimately lead to increased stem density, especially for invasive species that tend to resprout more aggressively. Seasonal timing of manual clearing and herbicide application to cut stems can help to reduce resprouting (Kays and Canham 1991; Wegner 1953). Therefore, the manual removal method is most effective when conducted during the appropriate season and/or in combination with herbicide. As described in Subsection 4.6.2.1 (General Impacts), there is potential for this method to affect wetlands not identified during the O-SAR process or apparent to line crews.

4.6.2.2.2 Impacts to Wetlands from Mechanical Methods

Saturated and inundated wetland soils often prevent heavy equipment access, unless matting, low ground pressure equipment, dry season work, or other BMPs can be used to accommodate large vehicular traffic. However, transmission ROW vegetation maintenance needs may, at times, require the use of mechanical removal to ensure woody wetland vegetation does not interfere with conductor clearance.

Clearing trees via mechanical means in wetlands may be necessary where 1) forested wetland habitat has encroached on transmission ROWs, 2) along transmission ROW borders where historic and routine vegetation maintenance has not included the entire transmission ROW width, or 3) where natural establishment and growth of wetland saplings pose a threat to safe conductor clearance and transmission line operation. Mechanical clearing of wetlands trees and large saplings may be conducted through the use of above ground shears (e.g. feller-bunchers). This method allows stumps and root balls to remain intact and avoids tip over or grubbing and associated ground disturbance. Similarly, to minimize soil compaction, only low ground pressure equipment is permitted and any soil rutting must be less than 12 inches. Clearing of trees within wetlands results in conversion of forested wetland and degradation to the functions and values forested wetlands provide. Forested wetland clearing via mechanized equipment may be subject to USACE/State regulatory permitting and compensatory mitigation requirements. In those circumstances, coordination with the regulatory agencies is necessary to ensure compliance with wetland mandates and no net loss of wetland resources.

Mowing using brush hogs or large mowers may accommodate floor work to maintain a meadow-like habitat. However, access to wetlands with inundated or saturated soils with mechanical equipment is limited due to the unstable substrate. Therefore, mowing in wetlands may only be conducted under dry conditions, such as the dry-season during which time soil saturation would be reduced. Under these conditions, mowers and brush hogs may be used to clear briars and/or small saplings within wetlands with minimal impacts. Additionally, it is anticipated that the existing wetland function would not change.

Side-wall trimming (aerial or ground) may be conducted in wetlands to clear or trim tree branches and reduce encroachment from the transmission ROW border. If this mechanical clearing method is conducted by helicopter tree saws, no direct impacts to wetlands would result from equipment access due to the nature of an aerial approach. Hydro-axes, line trimmers, and aerial lifts may be used in wetlands during dry seasons when soils are sufficiently stable to accommodate the weight of machinery through the use of BMPs to reduce rutting and soil compaction (TVA 2017a).

Other potential effects of mechanical clearing include possible oil leaks or spills from equipment or vehicles that may reach adjacent waterbodies. Compaction of wetland soils resulting from heavy equipment access can negatively impact a wetland’s ability to hold, impede, and transpire stormwater. Siltation resulting from removal of wetland vegetation via mechanical clearing can negatively impact water quality and affect hydrologic dynamics and downstream biota. However, given intermittent access to these areas, impacts to the soils are expected to be temporary as the compaction would lessen over time and normal sediment retention function would be restored. As with manual clearing, resprouting of mechanically cut woody wetland plants can ultimately lead to increased stem density. Therefore, mechanical removal methods are most effective and least intrusive when used in combination with appropriate seasonal timing and herbicide application (Kays and Canham 1991; Wegner 1953). As described in Section 4.6.2.1 (General Impacts), there is potential for this method to affect wetlands not identified during the O-SAR process or apparent to line crews.

4.6.2.2.3 Impacts to Wetlands from Herbicide Application Methods

Herbicide application is a common and effective method used to limit or deter woody vegetation growth on transmission ROWs both in wetlands and adjacent upland areas. Only aquatic approved herbicides are allowed to be used in wetlands and application must be conducted in accordance with label specifications. However, wetlands can be indirectly impacted by herbicides due to runoff, leach or drift into untargeted areas. The inundated and saturated conditions of wetlands elevate the risk of herbicide runoff or leaching through surface and groundwater transport. Likewise, wetlands are typically located at topographic low spots, which make them more susceptible to receiving runoff and leaching from upland herbicide application. In addition, herbicide drift into non-target wetland habitat can result from airborne application in upland transmission ROW areas or adjacent off-ROW areas. To reduce indirect, unintended impacts to wetlands, herbicide treatment type, method, and dose (concentration/dilution per area) may then be selected for site specific use in or near wetlands to achieve the desired goals of TVA's transmission ROW vegetation management program. Several techniques for herbicide application are available and selection is dependent on management need, potential non-target risks, and accessibility.

Spot herbicide application may be used to treat woody wetland plants by direct application of herbicide to stumps or girdled trees, saplings, and shrubs. This can be an effective method for eliminating resprouts, young saplings, and otherwise unwanted target plants, without impacting adjacent desirable wetland vegetation. This application method in or near wetlands is accomplished generally on foot or ATV with a backpack sprayer, resulting in nominal wetland impacts from access.

Localized herbicide application may be used to treat small populations or clumps of woody vegetation within the transmission ROW system that pose a threat to overhead transmission clearance. Basal, low-volume foliar herbicide application in or adjacent to wetlands would generally be conducted on foot or ATV if stability of wetland soils can accommodate traffic. Therefore, wetland impacts from access would be nominal. Under this method there is potential for unintended impacts to wetlands due to the transport of herbicide pellets offsite or spray drift. A site-specific determination would be necessary to ascertain whether this method is appropriate for woody vegetation control in or near wetlands.

Broadcast herbicide application may be conducted through a variety of methods, all of which have a greater potential for runoff and drift and associated impacts to non-target wetland habitat. Herbicide application to non-targeted wetland area results in unintended loss of wetland vegetation and microbial biota that support wetland function. If mechanical equipment is used for broadcast herbicide treatment in wetlands, wetland disturbance associated with access may occur, as described in Mechanical Methods Section 4.6.2.2.2.

Large scale broadcast herbicide application of wetland vegetation would result in loss of wetland function.

Aerial herbicide application may be conducted by fixed-wing aircraft or helicopter over or near wetland areas. Since no ground entry is required under this method, there would be no impacts as a result of equipment access. However, aerial herbicide application has the greatest potential to impact wetlands relative to other herbicide treatment methods due to its higher potential for drift into non-target wetland habitat. This could result from aerial application of non-aquatic-approved herbicide drifting from upland target areas into wetland habitats, or from aquatic-approved herbicide drifting and impacting offsite wetland area, though TVA has BMPs in place to prevent these scenarios from occurring (TVA 2017a).

Consideration of site specific characteristics ensures potential herbicide runoff, leaching, or drift is contained when applied in or near wetland areas. Tree removal and the resulting forested wetland conversion to emergent meadow-like wetland habitat would result in a reduction of forested wetland function and associated value. Most often, however, herbicide application in wetlands within transmission ROWs is applied to target woody wetland vegetation of smaller stature in order to prevent tree growth on the open ROW floor. Therefore, there would not be a reduction or change in the wetland function or value. In combination with manual clearing, mechanical clearing or reseeding practices, herbicide application can extend the necessary routine vegetation maintenance cycles due to its effectiveness for woody vegetation control. As described in Section 4.6.2.1, there is potential for this method to affect wetlands not identified during the O-SAR process or apparent to management crews.

4.6.2.3 Impacts to Wetlands from Debris Management

Although management of woody debris on transmission ROWs may be accomplished via several methods, few are allowable in wetlands without regulatory oversight. Debris left in wetlands may be considered a regulated fill by wetland regulatory agencies. Therefore, in accordance with standard BMPs, debris would not be left in NWI/O-SAR identified wetland areas. Downed woody material would be removed from those locations and disposed of at least 50 feet outside the desktop mapped wetland boundaries (TVA 2017a).There is potential for this method to affect wetlands not identifiable by NWI or during the O-SAR process or apparent to line crews. Therefore, any mulched, chipped or cut woody debris in excess of 0.1 acre would require a site visit in order to field delineate wetland boundaries and ensure compliance with CWA regulations. If site characteristics necessitate woody material be left inside wetland areas, appropriate consultation with regulatory agencies and compliance with wetland permits would be necessary to ensure no more than minimal wetland impacts are incurred.

Heavy equipment access (e.g., mulcher, chipper, loader) in wetlands may be required to facilitate debris removal. BMPs would be in place to minimize rutting and associated soil compaction that could otherwise result in wetland disturbance and loss of function (TVA 2017a).

In the application of herbicides, treated woody stems in wetlands may be left standing, to fall and decompose naturally, after herbicide is applied (unless safety or environmental concerns are present). This debris management method is least likely to result in direct or indirect impacts to the wetland functions on transmission ROWs due to the natural weathering and decay of above-ground material. Additionally, there would be no heavy equipment access necessary to remove dead or downed vegetation after the initial herbicide treatment.

4.6.2.4 Impacts to Wetlands from Restoration

Wetland restoration can help to stabilize disturbed soil and establish desirable vegetation in areas where bare ground has been exposed from transmission ROW maintenance activities in wetlands. Restoration would also prevent the spread of invasive weeds within the wetlands, promote the establishment of low-growing vegetation, and promote wildlife habitat.

Reseeding desirable wetland species helps to establish low-growing vegetation and prevents the establishment of invasive weeds and is therefore beneficial to promoting wetland functions. Broadcast seeding may be done on foot (throwing seed onto the ground, using a hand-crank container for dispersal), or from a truck-mounted broadcast/hydro seeder, drill seeding by tractor, or via aerial application from a helicopter.

4.6.2.5 Mitigation Measures for Impacts to Wetlands

Wetland avoidance, minimization, and mitigation measures are conducted in accordance with BMPs (TVA 2017a) and applicable wetland regulations. The most desirable BMP for wetlands is avoidance. Where avoidance of wetlands cannot be accommodated, minimization of wetland impacts is necessary. Lastly, after wetland avoidance and minimization strategies have been implemented to the fullest extent practicable, unavoidable wetland impacts that result in long-term wetland degradation may require compensatory mitigation to off-set loss of wetland function.

Avoidance strategies take into consideration wetlands identified using desktop resources, including NWI data and O-SAR. If vehicular traffic on these areas can be avoided, if they already contain vegetation compatible with transmission ROW clearance, or if they are otherwise not in need of maintenance, no action would be taken.

Minimization strategies are applied within the NWI/O-SAR mapped wetlands. Where vegetation maintenance activities are required, the following minimization efforts would be incorporated to reduce impacts:

- Adherence to dry season schedule (September to mid-November) when practicable for increased soil stability and decreased soil disturbance.
- Cut and cross-lay (poles), wood mats, pipe mats, panels, pallets, metal grating, or similar materials may be used or installed for wetland crossing to minimize rutting and soil compaction that may otherwise result from vehicular traffic across wetlands; these crossings are temporary and removed after use.
- Soils ruts not to exceed 12 inches.
- Only low ground pressure equipment, such as rubberized tracks, wide tires, or lightweight ATVs are used.
- Any storage of oil/fuel is placed outside of wetland areas and all equipment refueling is done away from wetlands or streams.
- Woody wetland vegetation is severed within 12 inches from ground level.
- Woody debris removed outside identified wetland area.
- Stumps are left intact, no grubbing.

- Only aquatic approved herbicide is permissible; herbicides are registered with EPA and applicators follow manufacturer's label instructions, EPA guidelines, and respective state regulations and laws.
- Water flow is maintained.
- Erosion control techniques are implemented within 50 feet of identified wetland areas where soil disturbance is proposed.
- Existing contours are restored as necessary.
- Disturbed and exposed soils are seeded upon completion of work (or within 14 days, whichever comes first).

Mitigation strategies are required to compensate for impacts to wetlands that result in the permanent decrease or loss of wetland function. Transmission ROW vegetation maintenance activities that would require wetland mitigation are typically related to the conversion of forested wetland and the subsequent long-term vegetation maintenance of emergent, meadow-like wetland habitat for compatible transmission line clearance. Compensatory mitigation requirements are based on consultation with the appropriate agencies and are generally accomplished through purchase of wetland credits from an approved wetland mitigation bank.

4.7 Floodplains

4.7.1 Affected Environment

A floodplain is the relatively level land area along a stream or river that is subjected to periodic flooding. The area subject to a 1 percent chance of flooding in any given year is normally called the 100-year floodplain. The area subject to a 0.2 percent chance of flooding in any given year is normally called the 500-year floodplain. When the Federal Emergency Management Agency (FEMA) develops detailed floodplain maps for a stream, a "regulatory floodway" is often also defined by hydraulic modeling. A regulatory floodway is the channel of a river or other watercourse and the adjacent floodplain that must be reserved in order to discharge the 100-year, or base, flood without cumulatively increasing the water surface elevation more than a designated height. Communities participating in the National Flood Insurance Program must regulate development in floodplains, and especially in floodways, to ensure that proposed encroachments would not cause an increase in flood elevations in the community.

Floodplains in their natural or relatively undisturbed state provide numerous benefits to both society and the natural ecosystem. For example, floodplains reduce the frequency and severity of floods, maintain water quality by filtering out excess sediments and nutrients, and contribute to groundwater recharge by promoting infiltration. Biological resources (e.g., fish, wildlife, and vegetation) benefit from floodplains for the food and habitat they provide and rely on them for important life-history events. Society also draws important cultural resource values (e.g., open space, recreation) and cultivated resource values (e.g., agriculture, aquaculture and forestry) from floodplains.

As a federal agency, TVA adheres to the requirements of EO 11988, Floodplain Management. The objective of EO 11988 is "to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative…" (42 Federal Register 26951 [25 May 1977]).

The transmission line ROWs cross floodplains mapped by FEMA under the National Flood Insurance Program at approximately 6,318 separate locations (Figure 4-5). With this number of crossings, the condition of stream and floodplain size and type, vegetation type, and topographic setting is highly variable.

According to currently effective county FEMA floodplain maps, TVA transmission line crossings encompass a total FEMA-mapped 100-year floodplain area of 40,910 acres. The transmission line ROW area that is mapped as 100-year floodplain is therefore approximately 0.08 percent of the study area. The floodplain areas and lengths at individual crossings vary widely within the study area.

4.7.2 Environmental Consequences for Floodplains

The evaluation of potential floodplain impacts typically is centered on the assessment of effects on flood flow rates, floodplain boundary or flood storage changes (e.g., earthwork topographic changes), or physical obstructions to flow. Vegetation control measures (manual, mechanical, herbicides) and site restoration measures do not involve actions that would alter or modify floodplains other than changing the resistance to floodplain flow associated with changes in vegetation density or vegetation types. As such, potential floodplain impacts associated with vegetation control are generally limited and more closely associated with the resulting change in vegetation type(s) and densities than with the method of vegetation management.

The influence of the change in vegetation type(s) and densities on a specific floodplain location depends on the relative scale of the transmission ROW area to the watershed area and floodplain size. In most cases, the effect of vegetation control within the transmission line ROW on total watershed runoff is small or negligible due to the transmission line ROW being a small portion of the total watershed with a FEMA-mapped floodplain.

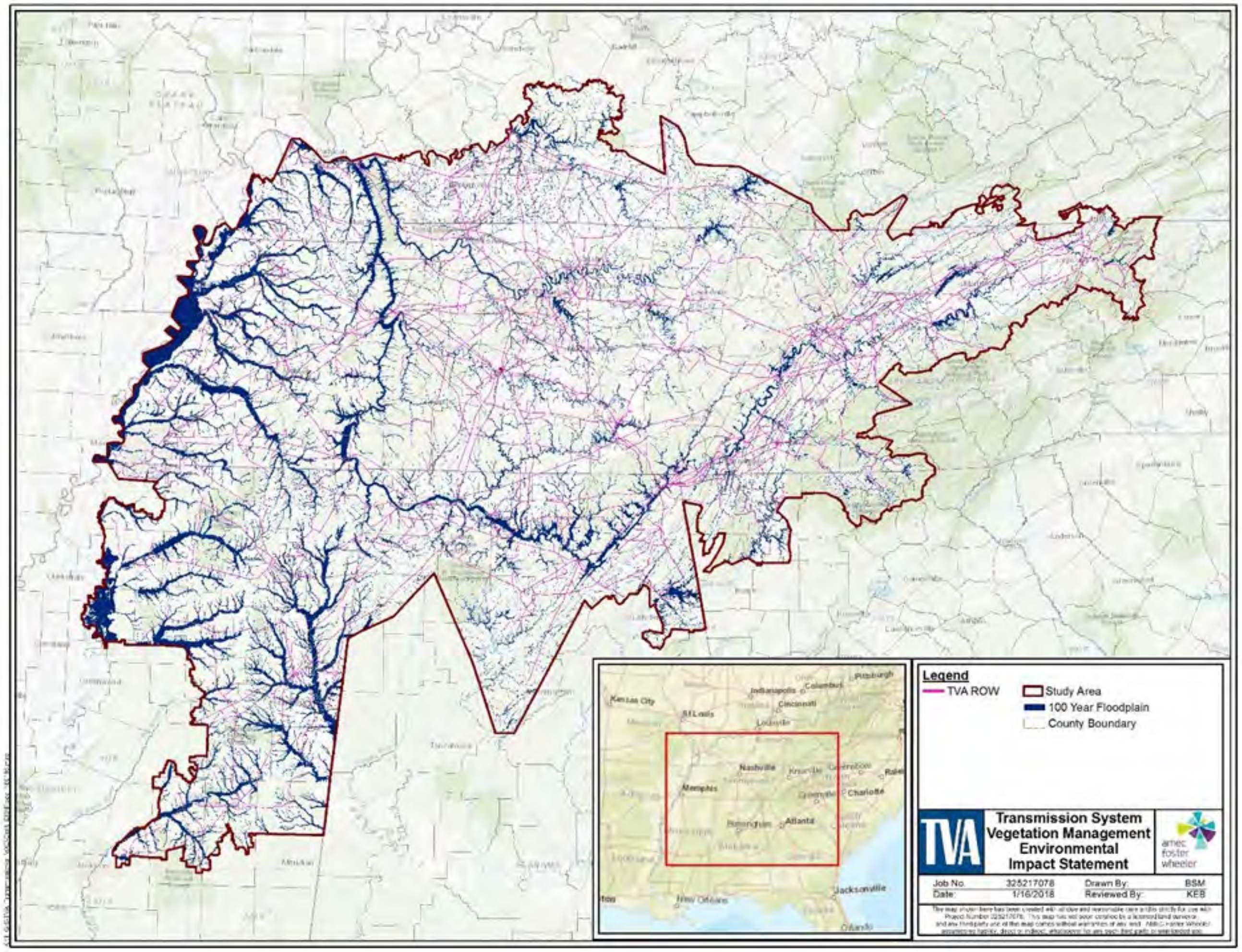


Figure 4-5. Floodplains Within the TVA Study Area

However, FEMA regulates floodways, which may include portions of the floodplain in addition to the channel, such that “development” within a floodway does not cause a rise in the floodway. An unacceptable rise is 0.01 foot or more. A “development” is defined as any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations or storage of equipment or materials (40 CFR 59.1). States may adopt additional more stringent criteria (e.g., use of a floodway surcharge of less than 1.0 foot, which would expand the floodway farther into floodplains) and may adopt certain other policies such as exempting certain activities from floodway review (such as clearing of brush, most typically related to removal from streams, often referred to as “snagging”). Consequently, it is possible that, based on the location and the state in which it is located, a major vegetation control project could be considered as an activity subject to floodway impact review and permitting and a change in vegetation type could potentially cause 0.01 foot or more of increase. However, vegetation control methods and conditions would not normally be a regulated activity.

Vegetation management includes the treatment or disposal of vegetative debris generated when vegetation is cut. Larger pieces of vegetative debris, particularly woody pieces, left in place in floodplain areas or in areas of concentrated flow are susceptible to dislodging and being carried downstream during high flow periods. This material has potential for contributing to debris jams at downstream sharp bends in the stream or at culverts. Mechanical control methods may have the potential to generate the largest amount of vegetative debris followed by manual cutting, with the follow-up debris collection and disposal method determining the risk of contributing to downstream debris jams. Notably, TVA’s BMPs require that all debris resulting from vegetation maintenance of transmission ROW be removed from SMZs, stream channels and wetlands. These BMPs would also be effective in reducing the amount of debris in floodplains such that the impact of debris management on floodplains and flow alteration would be minor.

4.8 Geology and Soils

4.8.1 Affected Environment

The footprint of TVA’s transmission sector boundary overlies portions of seven states and five physiographic provinces (Coastal Plans, Blue Ridge, Valley and Ridge, Appalachian Plateaus, and Interior Low Plateaus). Physiographic provinces are geographic regions with distinct landscape characteristics (specific subsurface rock type or structural elements) resulting from similar geologic history. These physiographic provinces are then subdivided into eight smaller physiographic sections as shown on Figure 4-6. Physiographic divisions are provided in Table 4-16. Vegetation control within TVA power transmission lines ROW, and access roads leading to the ROW, would be based on the physical characteristics of each province within the PSA as provided below.

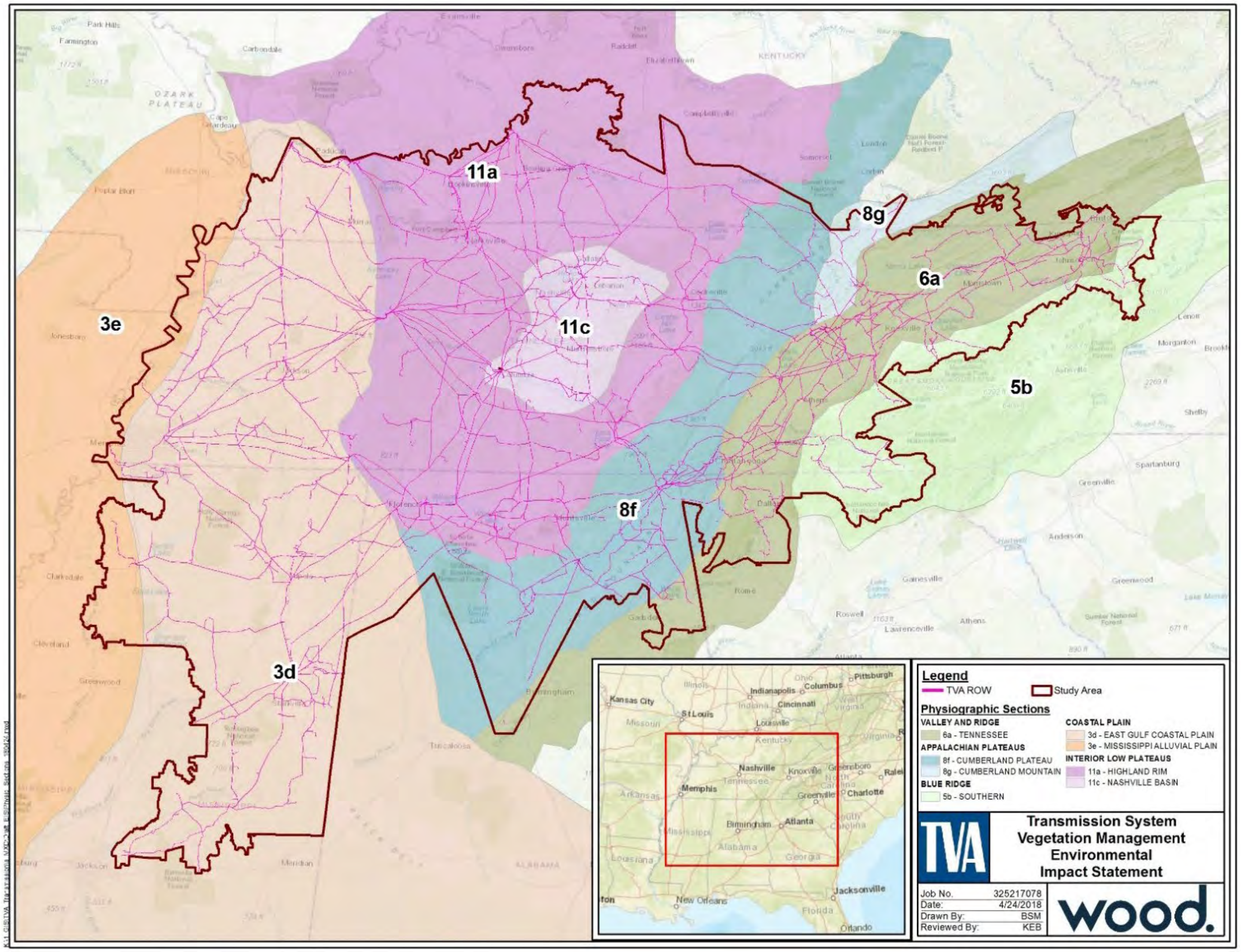


Figure 4-6. Physiographic Sections of the TVA Study Area

(Adapted from Fenneman 1938)

Table 4-16. Physiographic Provinces and Sections within the TVA Study Area

Province		Section
Coastal Plain	3d	East Gulf Coast Plain
	3e	Mississippi Alluvial Plain
Blue Ridge	5b	Southern
Ridge and Valley	6a	Tennessee
Appalachian Plateaus	8f	Cumberland Plateau
	8g	Cumberland Mountain
Interior Low Plateaus	11a	Highland Rim
	11c	Nashville Basin

Coastal Plain Province: The Coastal Plain province encompasses much of west Tennessee and most of the Coastal Plain portion of the TVA region is in the extensive East Gulf Coastal Plain section (3d). The underlying geology is a mix of poorly consolidated gravels, sands, silts and clays. Soils are primarily of windblown (loess) and alluvial (deposited by water) origin, low to moderate fertility and easily eroded. The terrain varies from hilly to flat in broad river bottoms.

Blue Ridge Province: The easternmost part of the PSA is in the Blue Ridge physiographic province (5b-Southern section), an area composed of the remnants of an ancient mountain chain. This province has the greatest variation in terrain in the TVA region. Terrain ranges from nearly level along floodplains at elevations of about 1,000 feet to rugged mountains with elevations of more than 6,000 feet. The rocks of the Blue Ridge have been subjected too much folding and faulting and are mostly shales, sandstones, conglomerates, and slate (sedimentary and metamorphic rocks of Precambrian and Cambrian age).

Valley and Ridge Province: The Valley and Ridge province (6a-Tennessee section) is located west of the Blue Ridge province and includes lands containing complex folds and faults with alternating valleys and ridges trending northeast to southwest. Ridges have elevations of up to 3,000 feet and are generally capped by dolomites and resistant sandstones, while valleys have developed in more soluble limestones and dolomites. The dominant soils in this province are residual clays and silts derived from *in-situ* weathering. Karst features such as sinkholes and springs are numerous in the Valley and Ridge province. “Karst” refers to a type of topography that is formed when rocks with a high carbonate content, such as limestone and dolomite, are dissolved by groundwater to form sink holes, caves, springs and underground drainage systems.

Appalachian Plateau Province: The Appalachian Plateau province is an elevated area west of the Valley and Ridge province and is comprised of the extensive Cumberland Plateau section (8f) and the smaller Cumberland Mountain section (8g). The Cumberland Plateau rises about 1,000 to 1,500 feet above the adjacent provinces and is formed by layers of near horizontal Pennsylvanian sandstones, shales, conglomerates and coals, underlain by Mississippian and older shale and limestones. The sandstones are resistant to erosion and have produced a relatively flat landscape broken by stream valleys. Toward the northeast, the Cumberland Mountain section is more rugged due to extensive faulting and has several peaks that exceed 3,000 feet in elevation.

Interior Low Plateau Province: Two sections of the Interior Low Plateau province occur in the TVA PSA. The Highland Rim section (11a) is a plateau that occupies much of central Tennessee and parts of Kentucky and northern Alabama. The bedrock of the Highland Rim is Mississippian limestones, chert, shale, and sandstone. The terrain varies from hilly to rolling to extensive, relatively flat areas in the northwest and southeast. The southern end of the Illinois Basin coal region (USGS 1996) overlaps the Highland Rim in northwest Kentucky and includes part of the TVA PSA. The Nashville Basin (11c-also known as the Central Basin) section is an oval area in middle Tennessee with an elevation about 200 feet below the surrounding Highland Rim. The bedrock is generally flat-lying limestones. Soil cover is usually thin and surface streams cut into bedrock. Karst is well developed in parts of both the Highland Rim and the Nashville Basin.

Mississippi Alluvial Plain (Delta): The Mississippi Alluvial Plain section (3e) occupies the western edge of the TVA region and much of the historic floodplain of the Mississippi River. Soils are deep and often poorly drained. The New Madrid Seismic Zone, an area of large prehistoric and historic earthquakes, is in the northern portion of the section.

4.8.2 Environmental Consequences for Geology and Soils

Proposed vegetation control methods include manual, mechanical, and herbicide application techniques. While there are no impacts of tool use on geology, the varying geologic and topographic characteristics of the study area may be important in decisions regarding tool use. There are appropriate uses for each control method based on the geologic settings within the TVA transmission footprint. For example, transmission ROWs within the Valley and Ridge province (east Tennessee) may be difficult to access with machinery due to significant and abrupt changes in elevation while areas in west Tennessee (Coastal Plains province) are characterized by gentle rolling hills promoting easier access for mechanical methods.

Herbicide applications can be effective in a broad range of geologic settings. However, herbicides may not be an appropriate tool for selection in areas of karst environments or high recharge zones such as those that may occur in the Highland Rim and Nashville Basin (Interior Low Plateau province). Treatments within karst areas have the potential to result in herbicide leaching that could infiltrate crevices and fractured bedrock or be transported by surface water to sinkholes, resulting in indirect groundwater impacts. However, TVA's routine integration of O-SAR database reviews and the diligent care in selection and use of herbicides in proximity to surface waters minimize potential concerns in these more vulnerable geologic settings (see Section 4.9).

4.9 Groundwater

4.9.1 Affected Environment

4.9.1.1 Regulatory Framework for Groundwater

The Safe Drinking Water Act of 1974 established the sole source aquifer protection program which regulates certain activities in areas where the aquifer (water-bearing geologic formations) provides at least half of the drinking water consumed in the overlying area. No sole source aquifers exist in the TVA study area (EPA 2018).

This act also established the Wellhead Protection Program, a pollution prevention and management program implemented by each state, used to protect underground sources of drinking water and the Underground Injection Control Program to protect underground sources of drinking water from contamination by fluids injected into wells. Several other environmental laws contain provisions aimed at protecting groundwater, including RCRA, the Comprehensive Environmental Response, Compensation and Liability Act and the Federal Insecticide, Fungicide, and Rodenticide Act.

4.9.1.2 Regional Aquifers

Three basic types of aquifers occur in the TVA region:

- Unconsolidated sedimentary sand
- Carbonate rocks
- Fractured non-carbonate rocks

Unconsolidated sedimentary sand formations, composed primarily of sand with lesser amounts of gravel, clay and silt, constitute some of the most productive aquifers. Groundwater movement in sand aquifers occurs through the pore spaces between sediment particles.

Carbonate rocks are another important class of aquifers. Carbonate rocks, such as limestone and dolomite, contain a high percentage of carbonate minerals (e.g., calcite) in the rock matrix. Carbonate rocks in some parts of the region readily transmit groundwater through enlarged fractures (cracks) and cavities created by dissolution of carbonate minerals by acidic groundwater, also known as karst topography.

Fractured non-carbonate rocks represent the third type of aquifer found in the region. These aquifers include sedimentary and metamorphic rocks (e.g., sandstone and granite gneiss), which transmit groundwater through fractures and openings in the bedrock.

In the TVA region, groundwater derived from carbonate rocks of the Valley and Ridge, Highland Rim and Nashville Basin provinces (see Section 4.8) is generally slightly alkaline and high in dissolved solids and hardness. Groundwater from mainly noncarbonated rocks of the Blue Ridge, Appalachian Plateaus and Coastal Plain provinces typically exhibits lower concentrations of dissolved solids compared to carbonate rocks. However, sandstones interbedded with pyritic shales often produce acidic groundwater high in dissolved solids, iron and hydrogen sulfide. These conditions are commonly found on the Appalachian Plateaus and in some parts of the Highland Rim and Valley and Ridge (Zurawski 1978). The chemical quality of most groundwater in the region is within health-based limits established by the EPA for drinking water.

The term “potentiometric surface” is often used to describe the elevation of the groundwater table. However, local site-specific hydrogeologic conditions or other factors within the aquifer system may cause the potentiometric surface to vary.

For the purpose of the programmatic approach, the assumption can be made that groundwater flow direction is reflective of site topography and local geology and is anticipated to discharge to the adjacent river systems.

4.9.1.3 Groundwater Use

Groundwater data are compiled by the USGS and cooperating state agencies in connection with the national public water use inventory conducted every 5 years (Bohac and Bowen 2012). The largest use of groundwater is for public water supply. Almost all of the water used for domestic supply and 66 percent of water used for irrigation in the TVA region is groundwater. Groundwater is also used for industrial and mining purposes. The use of groundwater to meet public water supply needs varies across the TVA region and is the greatest in West Tennessee (TVA 2015).

Six major aquifers occur in the TVA region (Table 4-17). These aquifers generally align with the major physiographic divisions of the region. The aquifers include (in order of increasing geologic age):

- Quaternary age alluvium occupying the floodplains of major rivers, notably the Mississippi River.
- Tertiary and Cretaceous age sand aquifers of the Coastal Plain Province.
- Pennsylvanian sandstone units found mainly in the Cumberland Plateau section Carbonate rocks of Mississippian, Silurian and Devonian age of the Highland Rim section.
- Ordovician age carbonate rocks of the Nashville Basin section.
- Cambrian-Ordovician age carbonate rocks within the Valley and Ridge Province.
- Cambrian-Precambrian metamorphic and igneous crystalline rocks of the Blue Ridge Province.

Approximately 60 percent of all groundwater withdrawals in 2010 were supplied by sand aquifers in West Tennessee and North Mississippi. Shelby County, Tennessee (Memphis, Tennessee) accounted for about 38 percent of the total public water supply regional pumping. The dominance of groundwater use over surface water in the western portion of the TVA region is due to the availability of prolific aquifers and the absence of adequate water resources in some areas.

This variation of groundwater use across the region is the result of several factors including groundwater availability and quality, surface water availability and quality, determination of which water source can be developed most economically and public water demand, which is largely a function of population. There are numerous sparsely populated, rural counties in the region with no public water systems. Residents in these areas are self-served by individual wells or springs.

Table 4-17. Aquifer, Well and Water Quality Characteristics within the TVA Region

Aquifer Description	Well Characteristics (common range, maximum) Depth (feet)	Yield (gallons/ minute)	Water Quality Characteristics
Quaternary alluvium: Sand, gravel and clay. Unconfined.	10 to 75, 100	20 to 50, 1,500	High iron concentrations in some areas.
Tertiary sand: Multi-aquifer unit of sand, clay, silt and some gravel and lignite. Confined; unconfined in the outcrop area.	100 to 1,300, 1,500	200 to 1,000, 2,000	Problems with high iron concentrations in some places.
Cretaceous sand: Multi-aquifer unit of interbedded sand, marl and gravel. Confined; unconfined in the outcrop area.	100 to 1,500, 2,500	50 to 500, 1,000	High iron concentrations in some areas.
Pennsylvanian sandstone: Multi-aquifer unit, primarily sandstone and conglomerate, interbedded shale and some coal. Unconfined near land surface, confined at depth.	100 to 200, 250	5 to 50, 200	High iron concentrations are a problem; high dissolved solids, sulfide or sulfate are problems in some areas.
Mississippian carbonate rock: Multi-aquifer unit of limestone, dolomite and some shale. Water occurs in solution and bedding-plan openings. Unconfined or partly confined near land surface; may be confined at depth.	50 to 200, 250	5 to 50, 400	Generally hard; high iron, sulfide, or sulfate concentrations are a problem in some areas.
Ordovician carbonate rock: Multi-aquifer unit of limestone, dolomite and shale. Partly confined to unconfined near land surface.	50 to 150, 200	5 to 20, 300	Generally hard; some high sulfide or sulfate concentrations in places.

In 2010, estimated average daily water withdrawals in the TVA service area totaled 16,395 million gallons per day (Bohac and Bowen 2012). About 5.2 percent of these water withdrawals were groundwater and the remainder were surface water. Since 1950, groundwater and surface water withdrawals by public supply systems in Tennessee have greatly increased. The magnitude and rate of growth of withdrawals of surface water has exceeded groundwater. The annual increase in groundwater withdrawals for public supply in Tennessee averaged about 2.5 percent. Although these data are for Tennessee public water supplies, they are representative of the overall growth in water use for the TVA region (TVA 2015).

The quality of groundwater in the TVA region largely depends on the chemical composition of the aquifer in which the water occurs (see Table 4-17). The chemical quality of most groundwater in the region is within health-based limits established by the EPA for drinking water. Pathogenic microorganisms are generally absent, except in areas underlain by shallow carbonate aquifers susceptible to contamination by direct recharge through open sinkholes (Zurawski 1978).

Groundwater use in the TVA Region is variable, typically characterized by municipal public supply wells in urban densely populated areas, and generally limited to private domestic water supply wells in rural areas.

4.9.2 Environmental Consequences for Groundwater

4.9.2.1 General Impacts to Groundwater

The evaluation of potential impacts to groundwater resources typically is centered on the assessment of project related alterations to groundwater quantity and/or quality. Vegetation control measures do not rely on groundwater use and do not involve actions that would alter or modify groundwater flow patterns. Therefore, none of the vegetation control measures would affect groundwater quantity.

As described above, lands throughout the study area are highly variable in terms of groundwater characteristics of depth, flow patterns, and associated geologic formation. Groundwater resources that are deep and isolated from the surface by confining layers or aquitards are not vulnerable to groundwater quality impacts from tool use. However, potential effects on groundwater quality may occur where aquifers are shallow or in high groundwater recharge zones (e.g., karst topography, coarse alluvial recharge zones). The following subsections consider potential effects on groundwater quality in these more vulnerable environmental settings.

4.9.2.2 Impacts to Groundwater from Vegetation Control Methods

4.9.2.2.1 Impacts to Groundwater from Manual Methods

Manual control methods are defined as control of vegetation using hand-operated tools (ANSI 2012). Equipment used includes chainsaws, machetes, brush hooks, axes, and brush blades, among others. Most manual removal methods do not use chemicals or fuels. Chainsaws use fuel and release small amounts of oil into the environment under normal operations. However, the quantity of fuel and lubricants used and released by such methods is typically very small. Consequently, manual removal techniques would not result in impacts to groundwater quality.

4.9.2.2.2 Impacts to Groundwater from Mechanical Methods

Mechanical control methods are defined as vegetation control using equipment-mounted saws, mowers, grinders, and other devices (ANSI 2012). Mechanical methods include clearing, mowing, and side-wall trimming using machinery. As such mechanical tools require the use of fuels and lubricants. Equipment refueling and vegetation maintenance operations would be carried out by TVA contractors using BMPs. Additionally, appropriate care would be taken to immediately contain and clean up any accidentally releases remove from the ground surface. Therefore, impacts to groundwater quality from mechanical tool use are minor and mitigated by BMPs.

4.9.2.2.3 Impacts to Groundwater from Herbicide Application Methods

Herbicide application techniques include a range of tools that vary in the volume and type of herbicide used and in the intensity of their application. Potential effects to groundwater quality are limited to indirect effects arising from the transport of herbicide constituents in stormwater or surface waters draining a given project site. For example, treatments in certain areas may result in potential herbicide drift or leaching that could be transported via surface waters. Specialized environments where groundwater resources are closely associated with surface water are particularly vulnerable to surface water-groundwater interactions (i.e., karst topography, or shallow aquifer zones). In karst terrain the presence of fractures, cracks, and cavities can provide a conduit for rapid vertical migration of the herbicides. Similarly, shallow groundwater areas where the groundwater surface (potentiometric surface) is close to ground surface may also be vulnerable areas where constituents associated with herbicides may be transported to associated groundwater.

However, TVA integrates several practices that are effective in avoiding and minimizing potential effects on groundwater. First, TVA routinely conducts a review of its O-SAR database to identify the occurrence of geologic and groundwater features that may be associated with karst terrain (i.e., caves), which are used to make decisions regarding method use in sensitive environments. Second, TVA is diligent about the selection and use of herbicides in proximity to surface waters so as to avoid transport of potentially detrimental herbicide constituents to receiving waters, including groundwater. Therefore, as a result of TVA's O-SAR database review of sensitive features coupled with the selection of tools in proximity to surface water resources that are not impactful, environmental effects on groundwater from herbicide use are considered to be low potential for adverse effects and minor.

4.9.2.3 Impacts to Groundwater from Debris Management

Methods to accomplish debris management include left in place, lopping and scattering, chipping in place, mulching in place, offsite debris disposal, pile burning, container burning, and landowner use. Risks of debris management to groundwater quality are similar to mechanical control methods in that machinery requires the use of fuels and lubricants. Impacts to groundwater quality from debris management methods would be mitigated by BMPs and are anticipated to be minor.

4.9.2.4 Impacts to Groundwater from Restoration

Restoration measures entail the use of either manual or mechanical tools to reseed disturbed areas. Such measures entail minimal site disturbance and impacts to groundwater quality are similar to those described for manual and mechanical control methods. Therefore, impacts to groundwater from restoration measures are minor and mitigated by BMPs.

4.10 Land Use

4.10.1 Affected Environment

4.10.1.1 Primary Land Uses

Land use within the study area is dominated by forest land and agriculture followed by developed lands (Table 4-18). Approximately 51 percent of the study area is classified as forest land. According to the TVA Integrated Resource Plan (TVA 2015), approximately 97 percent of the forest land in the TVA study area is classified as timber land. Other forest lands within the study area are characterized as consisting of both recreational and low density rural residential uses.

Table 4-18. Land Use of the TVA Study Area

Land Use Category	Study Area (acres)	Percent of Study Area
Forest	26,976,751	51.2%
Agricultural Lands	15,351,751	29.1%
Developed	4,597,806	8.7%
Other	4,423,684	8.4%
Open Water	1,273,718	2.4%
Barren Land	95,606	0.2%
Total	**52,719,317**	**100%**

Source: Homer et al. 2015

Approximately 29 percent of the study area is agricultural land. Agricultural land in the study area is primarily comprised of haylands and pasture land. Predominant cultivated crops within the study area include corn, soybeans, cotton, vegetables, and orchards. Vegetation within such lands are maintained as low growing, generally herbaceous plant species. As such these are considered to be “lands managed by others” and are generally considered to only entail TVA vegetation maintenance activities where danger trees or incompatible vegetation has been identified.

Developed lands account for approximately 9 percent of the study area, and include areas used for residential, commercial, and industrial development. In developed areas, houses and businesses are commonly found adjacent to transmission line ROWs and may have lawns, playgrounds, and parking lots which extend into the ROW. Vegetation within such land uses are also typically managed by others and consist of lawns and ornamental trees and shrubs. Such lands are generally considered to only entail TVA vegetation maintenance activities where danger trees or incompatible vegetation has been identified.

4.10.1.2 Land Ownership

The majority of lands crossed by TVA transmission line ROWs are held in private ownership. TVA holds easements which include rights to maintain the transmission line within the ROW. In most cases, the fee simple ownership of the land within the transmission ROW remains with the landowner, and many land uses could continue to occur on the property. However, the terms of the easement prohibit certain activities, such as construction of buildings and any other activities within the ROW that could interfere with the operation or maintenance of the transmission line or violates the terms of the easement.

Table 4-19 identifies state and federal agencies whose land is crossed by TVA transmission line ROWs. TVA transmission line ROWs cross lands owned by various federal agencies, with the largest acreage of crossings (5,642 acres) occurring on USFS land. TVA transmission line ROWs cross NPS lands 97 times, which is greater than any other agency. The USFS and NPS are included as a cooperating agency on this PEIS to coordinate vegetation management efforts. Federal lands may have additional plans and /or permits governing their use that would need to be considered when planning for transmission line ROW vegetation maintenance activities.

Table 4-19. Transmission Line Crossings on State and Federal Lands

Agency	Number of Crossings	Acreage
U.S. Forest Service†	18	5,642
Tennessee Wildlife Resources Agency	65	5,519
Kentucky Department of Fish and Wildlife	5	1,401
Alabama Department of Conservation and Natural Resources	12	1,082
Tennessee Department of Environment and Conservation	36	854
U.S. Air Force	1	768
National Park Service	97	710
Tennessee Department of Agriculture	6	637
Mississippi Department of Wildlife, Fisheries and Parks	11	457
U.S. Army Corps of Engineers	5	410
North Carolina Wildlife Resources Commission	2	406
U.S. Fish and Wildlife Service	39	329
Department of Energy	1	130
Georgia Department of Natural Resources	2	108
Alabama Department of Environmental Management	1	8
Kentucky State Nature Preserve Commission	1	4

† TVA transmission line crossings in U.S. Forest Service lands are further described in Appendix K.

The Tennessee Wildlife Resources Agency is the state agency with the greatest number of TVA transmission line ROW crossings (65) and the largest acreage of crossings (5,519 acres). Other state agencies with large acreages of TVA transmission line ROW crossings include the Kentucky Department of Fish and Wildlife (1,401 acres) and Alabama Department of Conservation and Natural Resources (1,082 acres). Lands owned by these agencies generally consist of state parks, wildlife management areas, and other public lands. ROWs on state owned lands may be subject to various agency regulations regarding specialized vegetation management.

4.10.2 Environmental Consequences for Land Use

TVA considers land use and land ownership of the transmission ROW and surrounding lands when selecting site-specific vegetation control methods. Figure 3-4 indicates generalized proportions of vegetation control methods expected to occur in different environmental settings.

Within undeveloped lands associated with forested lands, very low density rural residential areas, croplands and similar open spaces various methods may be used as necessary to remove or maintain vegetation to a compatible form. By comparison, within developed land uses, methods and tools selected for use by TVA to manage vegetation, manage debris and undertake site restoration activities may be more limited. However, while all proposed tools and methods may represent a short-term disruption in the character of such lands, these tools would not modify the intended uses. As such, no impacts on land use is expected to occur for any of the methods under consideration.

State and federal lands often have specific policies governing land use and management by which other land users must adhere. As described in Section 3.1.2, additional reviews by appropriate agency staff are required prior to the implementation of vegetation management practices. Transmission line vegetation management on lands managed by the USFS, NPS, or other special use/conservation lands would be determined by any governing agency agreements, memoranda of agreement and applicable law.

Management of vegetation within TVA transmission line ROWs using any of the proposed methods would not alter the designated use of land within the ROW regardless of ownership. Therefore, individual vegetation control methods would not impact land use regardless of land ownership.

4.11 Prime Farmland

4.11.1 Affected Environment

The 1981 Farmland Protection Policy Act and its implementing regulations (7 CFR Part 658) recognizes the importance of prime farmland and the role that federal agencies can have in converting it to nonagricultural uses. The Act requires all federal agencies to evaluate impacts to prime and unique farmland prior to permanently converting to land use incompatible with agriculture.

Prime farmland soils have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. These characteristics allow prime farmland soils to produce the highest yields with minimal expenditure of energy and economic resources. In general, prime farmlands have an adequate and dependable water supply, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content and few or no rocks. Prime farmland soils are permeable to water and air, not excessively erodible or saturated for extended period and are protected from frequent flooding.

Approximately 22 percent of the TVA region is classified as prime farmland (NRCS 2014). An additional 4 percent of the TVA region would be classified as prime farmland if drained or protected from flooding. In areas where soils classified as prime farmland are not cultivated, they are typically associated within landscapes such as floodplains of streams and rivers and river terraces because of their improved fertility, drainage, and capacity to support agricultural production. Within mountainous physiographic provinces in the eastern portion of the study area (e.g. Blue Ridge and Ridge and Valley provinces) (see Section 4.8 Geology), prime farmland soils are expected to be limited to narrow valley floodplains where the changes in topography are more significant. In contrast, prime farmlands are more abundant in less mountainous physiographic regions on level or nearly level plateaus and alluvial plains.

4.11.2 Environmental Consequences for Prime Farmland

Management of vegetation within TVA’s transmission ROWs does not entail construction of facilities or structures and as such would not result in the conversion of prime farmland to uses that are incompatible with agriculture.

Under the proposed action TVA is using vegetation control methods to manage vegetation within the ROW along their existing transmission line. As such, the potential for disturbance or degradation of prime farmland soils exists in conjunction with the use of mechanized equipment that cause rutting and disturbance of soils. Many of the cultivated lands are also often considered prime farmland. Because these lands are managed by private landowners, the potential impact from TVA’s vegetation maintenance on prime farmlands is minimized as TVA would not conduct vegetation maintenance on these lands.

In areas where prime farmland is not actively managed by others (e.g. cultivated land, residential lands), there is potential for minor impacts to prime farmland due from vegetation maintenance activities. Methods consisting of low or zero ground impact (i.e., manual control methods, aerial mechanical and herbicide methods) would not disturb soils and would not affect prime farmlands. Lighter duty machinery including mowers, brush hogs and light duty herbicide vehicles (e.g., ATV-mounted) may be expected to result in minimal surface disturbance and negligible effects to prime farmland soils. By comparison, higher intensity mechanical methods, especially those that may entail larger removal efforts (bulldozer, track-hoe, skid steer), may result in localized rutting and erosion. Such impacts however, would be localized and limited to particular tools and minimized by the use of BMPs. Overall, individual vegetation control methods would have minor localized impacts on prime farmland.

4.12 Natural Areas

4.12.1 Affected Environment

Numerous natural areas occur throughout the study area (Figure 4-7). Natural areas include ecologically significant sites and managed areas. Managed areas encompass a broad range of lands and typically include federal, state, or local park lands, national or state forests, wilderness areas, scenic areas, conservation easements, wildlife management areas, recreational areas, greenways, trails, Nationwide Rivers Inventory (NRI) streams, and designated Wild and Scenic Rivers. These areas consist of lands held in public ownership that are managed by an entity (e.g., TVA, NPS, USFS, state or county, or land trust) to protect and maintain certain ecological, cultural and/or recreational features. TVA transmission line ROWs cross through seven NPS units, nine USFS areas, six National Wildlife Refuges, and numerous state wildlife management areas, state parks, and local parks. National Parks with the largest acreage of TVA transmission line crossings include Great Smoky Mountains National Park, Big South Fork River and Recreation Area, and Natchez Trace National Parkway. TVA transmission line ROWs within federal or state parks may be subject to various agency or local government regulations and policies regarding specialized vegetation control methods. Natural areas, in the study area are shown on Figure 4-7.

A management plan or similar document defines what types of activities are compatible with the intended use of the managed area. Ecologically significant sites are either tracts of privately owned land that are recognized by resource biologists as having important environmental resources or are identified tracts of lands that are ecologically distinct in attributes or character but are not specifically managed by a public or private entity. NRI streams are free-flowing segments of river recognized by the NPS as possessing remarkable natural or cultural values that may potentially qualify them as part of the National Wild and Scenic River System.

Some of the largest publicly managed areas crossed by TVA transmission ROWs include the Cherokee (south) National Forest and State Wildlife Management Area, the Nantahala National Forest, Holly Springs National Forest, and Land Between the Lakes National Recreation Area and adjoining state management areas (see Figure 4-7). The Department of Energy’s Oak Ridge National Laboratory Reservation is also a large area crossed by the TVA transmission ROW. The reservation includes several areas that are managed by various agencies including the Tennessee Department of Environment and Conservation and the TWRA to support conservation and recreation. Additionally, 86 NRI streams are crossed by TVA’s transmission ROW (see Figure 4-7).

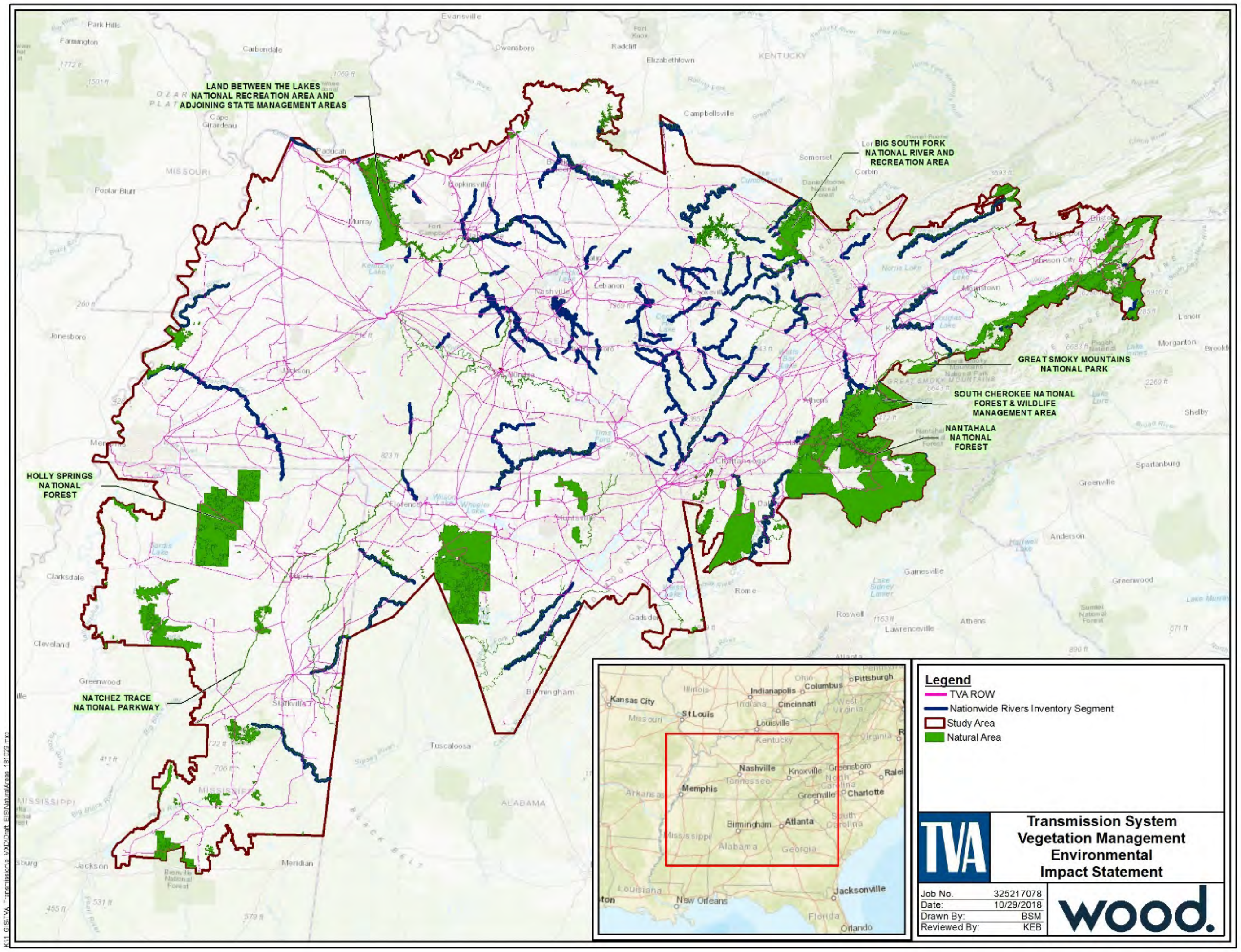


Figure 4-7. Natural Areas Located Within the TVA Study Area

A review of the TVA Regional Natural Heritage database indicated that there are approximately 704 instances where the TVA transmission lines cross natural areas; 29 of them are managed by TVA and the remaining 675 are managed by other entities and private landowners. As described in Section 3.1.2 (O-SAR Process), natural areas identified in areas subject to vegetation maintenance along existing transmission line ROW within the study area are included within the O-SAR database. TVA uses this information to guide decisions regarding vegetation maintenance activities within natural areas.

4.12.2 Environmental Consequences for Natural Areas

4.12.2.1 General Impacts to Natural Areas

Natural areas consist of land held in public or private ownership that are managed to protect and maintain certain ecological and/or recreational features. Because many natural areas were established to protect or enhance the environment and often exhibit high ecological quality, sensitive plants, animals, and their associated habitats (including high quality rivers and streams) and cultural resources are often abundant.

The management of vegetation within TVA's transmission ROWs does not include a conversion of these natural ecologically significant sites into any other land use types. However, some of the specific vegetation maintenance methods used by TVA to control vegetation throughout their transmission ROW have the potential to negatively impact non-targeted sensitive resources and cause short-term disruptions in the character of these natural areas (e.g., noise levels).

4.12.2.2 Impacts to Natural Areas from Vegetation Control Methods

4.12.2.2.1 Impacts to Natural Areas from Manual Methods

Manual cutting is often an appropriate method of vegetation control within natural areas because it selectively targets vegetation by hand pulling or cutting and has minimal potential to affect non-targeted sensitive resources. Short-term impacts due to equipment noise and presence of work crews may exist; however, these impacts would be minor and temporary.

4.12.2.2.2 Impacts to Natural Areas from Mechanical Methods

In natural areas use of mechanical methods vary by type. For example, mowing methods are allowable for routine maintenance practices. In contrast, larger mechanized equipment that has potentially large ground disturbing effects (e.g., bulldozers) are not typically used in natural areas. Short-term impacts may result from equipment noise and presence of work crews. However, these impacts would be minor and temporary. In areas that are not as easily accessible, mechanical removal can result in longer-term negative impacts that may include ground disturbance, localized erosion, and removal of non-targeted resources.

4.12.2.2.3 Impacts to Natural Areas from Herbicide Application Methods

Throughout natural areas, aerial herbicide application is not permissible due to the larger impact it would have on non-target, potentially sensitive plants and animals. However, selective herbicide application is frequently allowed because it targets specific vegetation species and only applies a low volume of herbicide to the plant. These herbicides are selected from a pre-approved list for use on the transmission ROWs and TVA determines which herbicides, if any, would be appropriate for site-specific use. By minimizing undesirable vegetation with herbicide application, native vegetation growth is promoted, and increased plant diversity is possible within the transmission ROW. The increased plant diversity provides wildlife with more food and cover options and promotes higher quality native vegetation communities throughout natural areas. Additionally, selective herbicide application reduces damage to nesting and tunneling wildlife that may be impacted by other methods such as mechanical removal.

4.12.2.3 Impacts to Natural Areas from Debris Management

Vegetation debris that is managed by mechanical means such as being chipped or mulched within a natural area has the potential to retard herbaceous plant growth for some amount of time depending on the depth of chipped or mulched material. Typically, after less than one growing season grasses and forbs begin to regrow through the chips. Conversely, offsite debris disposal of cut vegetation and chip and haul methods could allow for immediate regrowth of herbaceous plants, but they may result in more soil disturbance than chipping and mulching in place because of additional equipment traffic on site.

4.12.2.4 Impacts to Natural Areas from Restoration

Restoration techniques that include reseeding can increase wildlife habitat and create a more natural vegetation community within the transmission ROW, creating an overall enhancement to natural areas. While some impacts to natural areas due to pedestrian traffic and noise may occur, these impacts are minor and would be short-term. The long-term benefits of ecological restoration would outweigh these minimal impacts and promote the development of more native vegetation and their associated habitats.

4.12.2.5 Mitigation Measures for Impacts to Natural Areas

Mitigation measures are conducted in accordance with TVA’s O-SAR process. The O-SAR process has identified natural areas along the transmission ROW and provides site-specific guidance for minimizing impacts to natural areas. This guidance may include the following:

- Contact the appropriate land manager before implementing vegetation maintenance activities and determine the appropriate actions.
- Seek opportunities to partner with natural area managers to plan and conduct vegetation management.
- Where available, utilize existing site-specific vegetation management plans for transmission ROWs that cross managed lands.

4.13 Parks and Recreation

4.13.1 Affected Environment

Lands within the study area provide a high-quality and diverse array of developed and dispersed recreation opportunities. Developed recreation includes campgrounds, picnic areas, scenic overlooks, playgrounds, sports fields, lodges, marinas, boat launching ramps, swimming pools and beaches, visitor buildings and other day use facilities, and golf courses. Dispersed recreation occurs in an undeveloped setting and includes informal activities such as hunting, hiking, nature observation, primitive camping, backpacking, horseback riding, cycling, whitewater rafting, canoeing, fishing, rock climbing, off-road ATV use, and driving for pleasure.

Recreation areas within the study area include public and private recreation areas. Public facilities are owned and/or operated by TVA or other government agencies. TVA manages approximately 293,000 acres of land within the study area, of which approximately

175,000 acres is open for hunting (TVA 2017a, 2017c). In addition, TVA operates approximately 80 developed public recreation areas throughout the study area, primarily located near and associated with TVA managed reservoirs (TVA 2017b). Other public recreation areas within the study area include federal, state, and local parks.

TVA transmission line ROWs cross numerous private recreational lands. Private recreation facilities are commercial areas operated for profit and occur on private lands, on TVA land with land right agreements, or on combinations of private and public lands under agreement. Many private landowners offer short-term, seasonal, or annual leases to individuals and hunting clubs for access and hunting rights. In addition, concessionaires provide for-profit campgrounds, horseback riding stables, whitewater rafting trips, marinas, golf courses, and other recreational activities on federal, state, and local government land.

4.13.2 Environmental Consequences for Parks and Recreation

4.13.2.1 General Impacts to Parks and Recreation

TVA managed transmission lines cross a variety of lands, both public and private that receive outdoor recreation use. This includes transmission ROWs that pass through developed outdoor recreation areas and those that cross expanses of primarily undeveloped forested or semi-forested lands which may provide opportunities for dispersed outdoor recreation. While publicly owned lands managed by federal, state, and local agencies generally offer the most opportunity for dispersed recreation, many privately owned lands crossed by TVA transmission ROWs receive dispersed recreation use by landowners and, in some cases, members of the public. Maintenance of these corridors by TVA and/or others can be conducive to dispersed outdoor recreation activities such as nature observation, hunting, walking, and hiking and can also result in maintenance of a stable vegetation environment in developed recreation areas located within TVA transmission ROWs.

It should be noted that TVA transmission line ROWs within parks and open space areas are sometimes managed by local entities. This allows for expansion of parks and facilities such as trails within the transmission ROW and provides local agencies some flexibility to manage vegetation to maximize recreation benefits. This approach requires communication between TVA and local entities and compliance with TVA safety regulations.

While the existence of transmission ROWs may offer some recreation related benefits, activities associated with vegetation maintenance can potentially have some disruptive effect on dispersed recreation use and on developed recreation areas.

4.13.2.2 Impacts to Parks and Recreation from Vegetation Control Methods

4.13.2.2.1 Impacts to Parks and Recreation from Manual Methods

The lighter footprint and selective targeting associated with this method may make this approach appropriate for transmission ROWs that pass through developed recreation areas. However, equipment noise and other vegetation maintenance activities could have short-term negative impacts on recreation users.

Manual vegetation maintenance activities could also have minor short-term impacts on recreation use patterns within transmission ROWs that receive dispersed recreation use due to the presence of work crews and equipment noise.

4.13.2.2.2 Impacts to Parks and Recreation from Mechanical Methods

In general, use of mowers and brush hogs would have the least impact on recreation within developed recreation areas and within transmission ROWs that receive dispersed recreation use. Because side-wall trimming would be limited to the fringes of the ROW, this activity would also have a small short-term impact on recreation. Mechanical clearing activity could have a greater impact on existing transmission ROW conditions if this treatment is applied to areas where vegetation has not been controlled over extended periods. In such cases, clearing could substantially change the character of the vegetation within the transmission ROW and impacts related to recreation would be slightly greater than those associated with other mechanical activities.

4.13.2.2.3 Impacts to Parks and Recreation from Herbicide Application Methods

Selective targeting of herbicides that retain some ground cover would generally have a small impact on recreation due to noise and possibly odors associated with this method. However, erosion protection, enhanced wildlife food and cover, and a greater diversity of flowering plants and shrubs that can be associated with this activity would be beneficial to recreation. Application of herbicides by aerial sprayers could have a more negative temporary impact on recreational use due to a larger impact area and indiscriminate removal of vegetation within the treated corridor. Also, there is some risk that a recreation user within the transmission ROW could be accidentally sprayed during application.

4.13.2.3 Impacts to Parks and Recreation from Debris Management

Debris that is left in place could physically inhibit or alter the visual experience of some dispersed recreation activities such as hiking, mountain biking, or walking. These impacts would likely be minor. Debris that provides wildlife habitat could be beneficial to some dispersed recreation such as wildlife viewing or hunting. Debris left in place within developed recreation areas could have a detrimental effect as it could interfere with normal recreation use of the area.

The use of lopping and scattering includes cutting branches to relatively short lengths. As such, this approach would generally have less impact on hiking and walking activities compared to left in place option. Enhancements to wildlife habitat could be beneficial to wildlife viewing and hunting activity. Debris left in place within developed recreation areas could have a detrimental effect as it could interfere with normal recreation activities within the area.

Most recreational activities such as walking and hiking within the transmission ROW would not be inhibited by chipping in place, mulching in place, and offsite debris disposal methods. When conducted within developed recreation areas, chipping in place would be more visually appealing than debris managed by the left in place or lopping and scattering methods. Similarly, the relatively small size of mulched material would have less effect on activities such as hiking or walking. Offsite debris disposal of vegetation debris or chips would also be appropriate in developed recreation areas.

Pile burning as a disposal technique could have some short-term impacts on recreation activities within undeveloped areas due to the presence of smoke and work crews. Recreation users within developed recreation areas could be similarly impacted. Similarly, container burning would result in similar effects. However, due to lower smoke emission and reduced ash mass associated with container burning, this approach would have less impact on recreation than pile burning.

4.13.2.4 Impacts to Parks and Recreation from Restoration

Because reseeding can have a positive impact on wildlife habitat as well as provide a more natural setting within the transmission ROW, dispersed recreation activity generally would be enhanced. Restoration in the immediate vicinity of developed recreation areas also would be beneficial due to the creation of a more natural setting.

4.13.2.5 Mitigation Measures for Impacts to Parks and Recreation

A number of mitigation measures are available to TVA to minimize impacts to the recreation activities. These include:

- Follow procedures outlined in TVA's A Guide for Environmental Protection and Best Management Practices for Tennessee Valley Authority Construction and Maintenance Activities Revision 3-2017 (TVA 2017a).
- Communicate with recreation area management prior to undertaking vegetative maintenance activities within developed recreation areas (public and private).
- To the extent practical, identify recreation use patterns, if any, within undeveloped transmission ROWs to determine any constraints, including those related to public safety that should be considered prior to initiation of vegetation control actions.
- In cases where transmission ROWs cross developed or undeveloped recreation areas, seek additional opportunities to partner with recreation area managers to plan and conduct vegetation control activities.

4.14 Archaeological and Historic Resources

4.14.1 Affected Environment

4.14.1.1 Regulatory Framework

Federal agencies, including TVA, are required by the NHPA (16 USC 470) and by NEPA to consider the possible effects of their undertakings on historic properties. Additional cultural resource laws that protect historic resources include the Archaeological and Historic Preservation Act (16 USC 469-469c), Archaeological Resources Protection Act (16 USC 470aa-470mm) and the Native American Graves Protection and Repatriation Act 925 USC 3001-3013).

TVA is in the process of finalizing a PA in consultation with the Advisory Council on Historic Preservation, seven SHPOs and all federally recognized Indian tribes with an interest in the region. The purpose of the PA was to establish a program alternative for compliance with Section 106 of the NHPA that would allow compliance to be achieved more efficiently through consultation at the programmatic level. The PA would set forth procedures and criteria for an alternative process for all existing TVA operation and maintenance activities that are similar and repetitive in nature. The majority of the activities associated with transmission ROW vegetation management are covered within this PA. For States with which TVA does not have an executed PA in place, or for activities which are not covered by the PA, TVA would conduct an individual site specific assessment of effects to historic properties under Section 106.

4.14.1.2 Archaeological Resources

4.14.1.2.1 Background

The history of human activity throughout the study area spans thousands of years. The earliest groups to leave a definitive material record of their presence were early Paleoindians who entered the region during the Late Pleistocene glacial epoch at least 12,000 years ago. Their descendants and the descendants of other Native American groups who migrated to the area occupied the region for the next 11 millennia. This long prehistoric era lasted until the arrival of Europeans explorers in the sixteenth and seventeenth centuries. Cultural change is a slow and continual process. Archaeological researchers divide the prehistoric human history of the study area into six distinct cultural periods; Paleoindian (10,000-8000 B.C.), Archaic (8000-1000 B.C.), Gulf Formational/Early Woodland (1000-100 B.C.), Middle-Late Woodland (100 B.C.-A.D. 900), Mississippian (A.D. 900-1540), and Contact/Protohistoric period (A.D. 1540-1672) (Anderson and Sullivan 2013; Hudson 2002). The modern historic era includes activities taking place from the eighteenth, nineteenth, and early twentieth centuries.

The Paleoindian period is characterized by small nomadic groups who exploited a variety of resources across the landscape including the hunting of now extinct mega-fauna. Artifacts attributed to this period often include large fluted stone projectiles of the Clovis tradition. The Archaic period spans approximately seven millennia in which many cultural changes occurred. The early part of the Archaic period was much like that of the Paleoindian; mobile groups exploiting an increasing number of new environmental niches as the climate began to warm at the end of the ice age. Then the archaeological record became more diverse. Lithic projectile point forms recovered include those of the Eva, Morrow Mountain, White Springs, and Benton clusters (Justice 1987). Groundstone tools became more complex with the development of grooved axes, bannerstones and netsinkers during the Middle Archaic period. The first evidence of the spear thrower also appeared in the form of atlatl weights (Sassaman 1996). Deep storage pits, post molds (structures), and burials as well as evidence of the collection of arboreal nut crops and other cultigens, such as hickory nuts and wild plant remains such as goosefoot, maygrass, and knotweed are present at later Archaic sites (Gremillion 1996).

A main attribute that separates the Gulf Formational/Early Woodland period from the Archaic is the introduction of ceramics or pottery. The first pottery appeared in the western portion of the Middle Tennessee Valley between 1,000 and 800 B.C. largely in the form of undecorated fiber- and sand-tempered wares. Smaller lanceolate shaped, notched, and stemmed projectile of the Adena Stemmed, Gary Contracting Stemmed, Motley, and Wade types have been recovered from Early and Middle Woodland period sites (Justice 1987). Later Woodland period sites include undecorated and decorated chert-, quartz-, and more prominently grog- and limestone-tempered pottery (Faulkner 2002). More complex varieties of structural and storage features indicating increased emphasis on horticulture of native plants and sedentary lifeways also are evident at later Woodland sites. Small triangular Hamilton and small notched projectile types occur and mark the introduction of bow and arrow technology, a key cultural marker throughout the Tennessee Valley.

The Mississippian period throughout the TVA study area was dominated by chiefdom level societies, which influenced the surrounding tribal groups, arguably the most radical shift in social organization in the prehistoric era (Harle et al. 2013). Elaborate mortuary practices involving burial pits, mounds, and more extravagant grave goods evolved during this time. Large planned villages are often fortified. The villages contain extensive midden deposits and a high density of features. Rectangular, wall trenched dwellings with raised clay fire basins are also evident. In addition, many inhabitants were dispersed into farming hamlets throughout the landscape.

The beginning of the Contact/Protohistoric period in the Southeast is commonly marked by the de Soto expeditions deep into interior portions of the Southeast (A.D.1544-1543). Though de Soto did not venture extensively into the Tennessee Valley, his and subsequent explorations and colonization impacted the region. From the period of initial European contact to the Historic period, the archaeological and ethnohistoric record indicates a steady decline of the Native American population and extensive movement of many tribes. Introduced disease, especially smallpox, may have been a major catalyst for this decline (Smith 2002). The Mississippian pattern of large towns surrounded by smaller hamlets continued to operate in some areas even during the latter part of the Protohistoric when there were influxes of Native Americans from outside groups who were displaced by Euroamerican encroachment (Davis 1990). Eventually, these villages declined in number, population, and overall size and were ultimately abandoned.

European influx only increased throughout the eighteenth century, and following the Revolutionary War, settlement further west beyond the Appalachian Mountains began in earnest. This resulted in the forced cessation of Native American lands throughout the Tennessee River Valley, including those belonging to the Chickasaw, Choctaw, Muscogee-Creek, Seminole, and Cherokee to name a few. In 1830, Congress passed the Indian Removal Act resulting in the forced removal of tens of thousands of Native Americans westward, known as the ‘Trail of Tears.’ The American Industrial Revolution occurred within subsequent decades, resulting in marked growth of urban centers, large plantations, and smaller subsistence farming homesteads throughout the study area. The construction of railroads furthered the growth of industry in the Valley. The Civil War played a significant role in the development of the region. The Reconstruction Era of the late nineteenth century and the influx of European immigrants during the turn of the nineteenth and early twentieth century also had a major impact to settlement and the economy of the Valley.

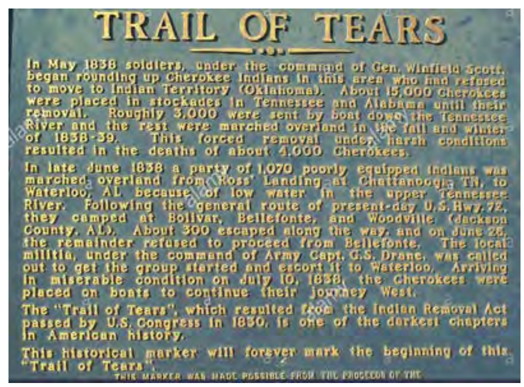
4.14.1.2.2 Archaeological Sites

Archaeological investigations in the study area began in the early 19th century with the explorations of Cyrus Thomas, C.B. Moore, and the Smithsonian Institute. These early investigations focused on larger sites such as mound complexes. The earliest TVA related archaeological surveys occurred in the 1930s and 1940s, prior to inundation of Norris, Wheeler, Guntersville, Chickamauga, Douglas, Pickwick, and Kentucky Reservoirs among others (Webb 1939; Lewis and Kneberg 1995). These surveys, staffed by New Deal public works programs, were opportunistic in nature focusing on the excavation of large village sites. Following the passage of the NHPA in 1966 TVA has implemented numerous archaeological investigations throughout the study area as they consider effects to cultural resources by their undertakings in compliance with Sections 106 and 110.

The transmission system ROWs encompass more than 16,000 miles. The transmission ROWs have undergone systematic Phase I archaeological surveys since the mid-1990s in association with compliance with Section 106. As a result, numerous archaeological sites within the transmission ROWs have been identified and evaluated with respect to their eligibility status for listing on the National Register of Historic Places (NRHP). Much of the survey work is conducted at the planning stages and prior to new construction of transmission lines.

Prehistoric Archaeological sites located within the TVA study area can take many forms. These can range from low-density lithic artifact scatter to extensive and complex village sites. Prehistoric sites are most often discovered within sub-surface deposits or below ground. Near surface deposits have often been previously disturbed by historic plowing activities, but intact cultural deposits can occur below what is termed the ‘plowzone.’ Earlier prehistoric sites, namely Paleoindian and earlier Archaic sites, are less common and are characterized by low density lithic artifact scatters across a variety of topographical settings; both upland and along lower elevated landforms along river drainages. In general, Middle and Late Archaic sites are more numerous across the study area landscape. Later Woodland and Mississippian period as well as Protohistoric sites are common along terrace sequences of major rivers, including the Tennessee River. These sites can represent long-term villages and contain rich archaeological deposits. Lithic resource procurement sites and rockshelter and cave sites are also prehistoric archaeological sites types that can occur within the study area. The latter can contain significant intact cultural deposits.

Historic era archaeological sites throughout the study area are predominately associated with industrial, military, and domestic activities dating to the late eighteenth, nineteenth, and early twentieth centuries. Historic sites often contain both above- and below-ground cultural remains. Above-ground remains can be represented by structural remnants, wells and cisterns, and chimney remains mainly for industrial and domestic sites and various earthwork forms associated with Civil War military sites. Below-ground deposits can be represented by structure floors and layouts, storage cellars, and privies. Examples of industrial sites within the study area can include anything business related including mill complexes, iron furnaces, plantation operations, blacksmith shops, and taverns to name a few. Worker camp complexes can also occur within the study area. These can be associated with mill operations as well as early twentieth century TVA dam construction. Civil War military historic sites involve different types of sites, including battlefields, training camps, bivouacs (encampments), earthen fortifications, masonry fortifications, and other strictly military features on the landscape. Domestic sites are the most prevalent historic site within the study area. These sites are dotted across the landscape and can occur as small communities or individual farmstead complexes. Associated out buildings can also occur. In addition, historic cemeteries have been located within transmission line corridors and can represent themselves by single or multiple grave markers that may or may not be fenced off and maintained. In many cases, only a few grave markers remain, but depressions representing unmarked graves may be present.



Commemorative marker in Chattanooga, TN for the Trail of Tears

The study area represents a diverse cultural landscape that held special meaning to its past inhabitants and to their descendants. Some of these places can be considered Traditional Cultural Properties (TCP). A TCP is defined as a property that is eligible for inclusion on the NRHP because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community (Parker and King 1998). Similarly, a cultural landscape is defined as "a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values" (Birnbaum 1996). It should be noted that TVA does not make public sensitive information regarding the location or other information regarding sacred sites or TCPs identified by consulting tribes. Some examples of TCPs within the study area include mound sites, segments of the Trail of Tears, as well as stacked stone features. The Congressionally designated Trail of Tears National Historic Trail is a prominent cultural resource within the study area. The Trail of Tears consisted of many routes and sub-routes that involved the removal of Native Americans from their ancestral homelands. Analysis indicated there are approximately 278 incidences where the Trail of Tears crosses TVA's transmission ROW. In some locations intact, original segments of this part of the trail may be present such as the Unicoi Turnpike or Overhill Path, located in southeastern Tennessee, western North Carolina, and northern Georgia. This is a transportation route of great antiquity and a landscape of historical and cultural significance to the consulting tribe. Stone stacked features often appear as single or a group of cylindrically stacked limestone. The origin and purpose of these stone features is uncertain, but a Resolution passed by the United South and Eastern Tribes, Inc. (USET) in 2007 recommended all federal agencies involved in the Section 106 process consider stacked stone features not conclusively linked to a historic origin be considered a TCP under NRHP Criterion A (USET 2007).

4.14.1.3 Historic Structures

Historic architectural resources are standing structures (e.g., houses, barns, dams, power plants) that are usually at least 50 years of age and are considered eligible for listing on the NRHP as defined by the Secretary of the Interior criteria for evaluation (36 CFR 60.4). TVA, in consultation with the various state SHPOs evaluate these for their NRHP eligibility status on an as needed basis.

4.14.2 Environmental Consequences for Archaeological and Historic Resources

4.14.2.1 General Impacts to Archaeological and Historic Resources

Vegetation maintenance activities within the TVA transmission ROW have the potential to adversely affect cultural resources. As described above a range of cultural resources have the potential to be present within the transmission line ROW including prehistoric Native American archaeological sites, historic era archaeological sites, and TCPs including intact original Unicoi Turnpike/Trail of Tears segments. Furthermore, standing or extant historic structures could also be present. Vegetation maintenance activities that have the potential to cause disturbance of soil can disturb sub-surface cultural deposits related to both prehistoric and historic era archaeological sites. Vegetation removal also has the potential to adversely affect the natural setting of a TCP. However, this potential effect would be low as vegetation maintenance activities are focused on maintaining vegetation within an established transmission ROW.

4.14.2.2 Impacts to Archaeological and Historic Resources from Vegetation Control Methods

4.14.2.2.1 Impacts to Archaeological and Historic Resources from Manual Methods

Methods involving manual vegetation activities include the use of hand tools for either pulling or cutting vegetation and have a low potential for disturbance of subsurface cultural resources given that vegetation would be cut and not actually removed from the soil. However, cutting in areas containing above-ground resources such as standing historic structures, historic foundations, privies, historic wells, remains of historic cemeteries and sacred sites, may also disturb these resources as thick vegetation can often adhere to these resources. Pulling methods that entail root removal would disturb soils and present a greater risk of adverse impacts to sub-surface cultural deposits. In such cases pulling techniques have a greater potential effect on cultural resources as compared to cutting techniques. Such techniques however, are expected to be undertaken on a very localized and limited basis. As such, potential impacts from manual methods would be minor.

4.14.2.2.2 Impacts to Archaeological and Historic Resources from Mechanical Methods

Mechanical methods for vegetation removal would involve the use of machinery such as bull dozers, track hoes, mowers, brush hogs, and tree saws that have the potential to adversely impact cultural resources by disturbing cultural deposits, compaction, displacing soils, leaving areas subject to erosion, or mixing the soil layers. These effects may be exacerbated under wet soil conditions or in fragile soils such as sandy river levees and terraces. Maneuvering machinery within the transmission line ROW has the potential to disturb sensitive above-ground historic resources if present, for example above-ground historic structural remains, cemetery components, entrenched historic trails, and stone mounds.

4.14.2.2.3 Impacts to Archaeological and Historic Resources from Herbicides

The use of spot or localized herbicides as a method to control vegetation within the study area, would not adversely affect cultural resources. However, broadcast and aerial spray, which is rarely used, and herbicide application using vehicles have the potential to affect cultural resources. This would include culturally significant and traditionally used native plants should they be present within TCPs in TVA's ROW because of the potential for ground disturbance.

4.14.2.3 Impacts to Archaeological and Historic Resources from Debris Management

The various methods of debris management proposed for the study area are unlikely to adversely impact sub-surface archaeological deposits. In some cases, the cut and leave method may have a beneficial impact by controlling erosion of sub-surface archaeological deposits. If heavy equipment is involved while employing the cut and leave method, as mitigation method would be to manage debris during dry conditions with the use of low pressure tire equipment or the use of wetland mats to avoid any rutting that may disturb below ground archaeological deposits. The cut and leave method may visually affect historic properties, but this affect would be temporary and therefore not adverse.

4.14.2.4 Impacts to Archaeological and Historic Resources from Restoration

Restoration activities associated with reseeding are unlikely to cause soil disturbance and are therefore unlikely to adversely impact cultural resources.

4.14.2.5 Mitigation Measures for Impacts to Archaeological and Historic Resources

Vegetation maintenance mitigation methods to be employed would depend upon such factors as nature and extent of prior cultural resource investigations of the area, eligibility and integrity of the resource, and potential for selective tool/method use. Such mitigation is undertaken in accordance with Section 106. TVA is in process of finalizing a PA with state SHPOs and all federally recognized Indian tribes with an interest in the region. TVA released the PA for public comment in December 2018. TVA intends to finalize the PA upon taking into account comments received from the public, individual state SHPOs and federally recognized Indian tribes with an interest in the region. The PA covers the majority of TVA vegetation management activities that are subject to this PEIS, categorizing them into Appendix A and B activities. Appendix A activities are those activities that have been determined through the PA consultation process as being unlikely to affect historic properties and are therefore excluded from further Section 106 review. Appendix B activities would be reviewed internally by TVA to verify that no cultural resources are present in the area of impact. Individual vegetation maintenance activities that fall outside of those listed in the PA would require further Section 106 review. Separately, TVA is also in discussion with USFS as well as with the consulting Tribes regarding the development of a collaborative approach for meeting TVAs ROW vegetation management obligations under Section 106 for areas located within the boundaries of the Trail of Tears. This collaboration is expected to result in safe and reliable operation of the transmission lines, while improving the visual quality of the Trail of Tears National Historic Trail, particularly the original entrenched segments that cross or underlie a TVA transmission ROW.

4.15 Visual Resources

4.15.1 Affected Environment

This assessment provides a review and classification of the visual attributes of existing scenery, along with the anticipated attributes resulting from the proposed action. The classification criteria used in this analysis are adapted from a scenic management system developed by the U.S. Forest Service and integrated with planning methods used by TVA. The classification process is also based on fundamental methodology and descriptions adapted from Landscape Aesthetics, A Handbook for Scenery Management, Agriculture Handbook Number 701 (USFS 1995).

The visual landscape of an area is formed by physical, biological, and man-made features that combine to influence both landscape identifiability and uniqueness. Scenic resources within a landscape are evaluated based on a number of factors that include scenic attractiveness, integrity and visibility. Scenic attractiveness is a measure of scenic quality based on human perceptions of intrinsic beauty as expressed in the forms, colors, textures, and visual composition of each landscape. Scenic integrity is a measure of scenic importance based on the degree of visual unity and wholeness of the natural landscape character. The varied combinations of natural features and human alterations both shape landscape character and help define their scenic importance. The subjective perceptions of a landscape's aesthetic quality and sense of place is dependent on where and how it is viewed.

Scenic visibility of a landscape may be described in terms of three distance contexts: (1) foreground, (2) middleground and (3) background. In the foreground, an area within 0.5 mile of the observer, individual details of specific objects are important and easily distinguished. In the middleground, from 0.5 to 4 miles from the observer, object characteristics are distinguishable but their details are weak and tend to merge into larger patterns. In the distant part of the landscape, the background, details and colors of objects are not normally discernible unless they are especially large, standing alone, or have a substantial color contrast. In this assessment, the background is measured as 4 to 10 miles from the observer. Visual and aesthetic impacts associated with a particular action may occur as a result of the introduction of a feature that is not consistent with the existing viewshed. Consequently, the character of an existing site is an important factor in evaluating potential visual impacts.

For this analysis, the affected environment is considered to include the existing physical and biological features of the landscape within existing TVA transmission ROWs. The terrain within the affected environment ranges from flat to slightly rolling to steep hillsides. In addition, these corridors are present in a variety of environmental settings including rural country side, forests, agricultural fields, and urban developments. Vegetation within these maintained transmission ROWs contrasts with surrounding vegetation the most when adjacent to forested areas. However, in the middleground and background these differences are less noticeable. In non-forested areas, the vegetation within the maintained corridor is often similar in appearance to that in the surrounding area and dominated by herbaceous plants and shrubs. Visibility of the towers within forested areas is greatest in the foreground, while the trees and topography can act as a buffer in both the middleground and background. In non-forested areas, the towers are visible in the foreground and possibly middleground depending on the topography and overall setting (rural vs. urban).

Example of contrasting foregrounds in developed landscapes primarily maintained by others and the undeveloped landscapes maintained exclusively by TVA

4.15.2 Environmental Consequences for Visual Resources

4.15.2.1 General Impacts to Visual Resources

The potential impacts to the visual environment from a given method are assessed by evaluating the potential for changes in the scenic value class ratings based upon landscape scenic attractiveness, integrity and visibility. Sensitivity of viewing points available to the general public, their viewing distances, and visibility of the proposed action are also considered during the analysis. These measures help identify changes in visual character based on commonly held perceptions of landscape beauty, and the aesthetic sense of place. The extent and magnitude of visual changes that could result from the proposed management tools were evaluated based on the process and criteria outlined in the scenic management system.

4.15.2.2 Impacts to Visual Resources from Vegetation Control Methods

4.15.2.2.1 Impacts to Visual Resources from Manual Methods

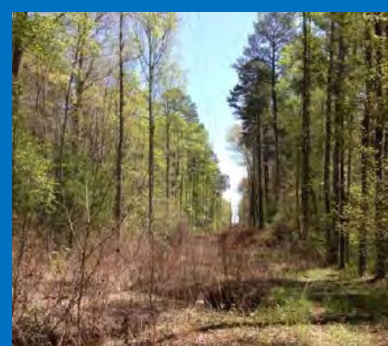
Manual removal techniques are not anticipated to result in any significant visual discord at all sight distances. Depending on the area being cleared and the intensity of efforts, there may be slight discord based on the presence of additional personnel, equipment, and vehicles. This method utilizes hand-operated tools and any visual impacts would be minor, temporary, and limited to the foreground. Hand pulling vegetation would result in minor disturbance potentially visible in the foreground. Manual cutting would not result in any ground disturbance, however, pruned trees and shrubs, exposed stumps, and the resulting debris may seem unsightly to some viewers. This would be limited to only the targeted areas and would only affect those targeted plants, leaving the surrounding vegetation intact. All impacts would be less noticeable in the middleground and background as any visual disturbance would not be discernable nor would contrast with the overall landscape.

4.15.2.2.2 Impacts to Visual Resources from Mechanical Methods

Mechanical removal techniques can potentially result in notable visual discord, depending on the method.

Methods consisting of low ground impact (i.e., lighter duty machinery including mowers, brush hogs, etc.) would result in minimal visual effects from ground disturbance, but they would have notable short-term effects on the visual environment due to changes in growth form. Mechanical methods generally achieve 90 to 100 percent stem count removal which could result in readily observable visible changes in the foreground and middleground. Mechanical methods are effective for completely removing thick stands of vegetation, resulting in areas of low-cut plants. In areas where the surrounding vegetation is taller, this would create a notable contrast with the untreated areas. However, the impact would be less if the transmission ROW is located in an area surrounding by existing low-growing vegetation. In the background these impacts would not be noticeable. Properly maintained areas that are mowed can also provide a pleasing landscape for the public.

By comparison, some mechanical methods, especially those that may entail larger vegetation removal efforts may create greater visual disruption during site activities as they have the potential to result in rutting and erosion under certain circumstances. Additionally, some mechanical equipment can mulch, lop and scatter, and stack vegetation debris as the equipment moves through an area, thus changing the visual landscape. Such impacts, however, would be localized and limited to particular tools and minimized by the use of BMPs and site restoration measures. Some mechanical methods also would result in greater visual discord due to the presence of additional personnel, equipment, and vehicles. However, any resulting visual impacts would be minor, temporary, and limited to the foreground.



Example of short-term visual discord in foreground from herbicide treatment of ROW. Source: USFS, 2017

Because of these effects, some mechanical techniques may not be appropriate for sensitive visual resource areas. In such locations mitigative measures may consist of the use of techniques that are less visually intrusive.

4.15.2.2.3 Impacts to Visual Resources from Herbicide Application Methods

Chemical vegetation control methods can potentially result in significant visual discord at foreground and middleground distances due to discolored vegetation following herbicide applications. These impacts on visual quality from herbicide application would be temporary as desirable vegetation reestablishes—reducing the color contrast between treated areas and the adjacent landscape. Aerial application of herbicides would have the largest visual impact because of the potential for large swaths of vegetation dying off at the same time. In locations that may have a particularly high visual quality, mitigation may consist of the use of other methods to control vegetation. Tree growth inhibitors would have no effect to the visual landscape as they keep trees alive that would otherwise be removed.

4.15.2.3 Impacts to Visual Resources from Debris Management

Felled logs and scattered branches can result in visual discord with the surrounding landscape. Mechanical methods to manage debris via stacking as windrows can reduce the unkempt look of the transmission ROW. Additionally, mulching and chipping can mitigate visual impacts by spreading large debris and improve the visual landscape by covering bare earth with woodchips.

Example of visual discord in foreground from scattering of woody debris. Source: USFS, 2017

4.15.2.4 Impacts to Visual Resources from Restoration

Restoration efforts typically consist of reseeding which mitigates visual impacts of cleared vegetation. Reseeding would result in temporary visual discord due to the presence of additional personnel and equipment. Due to variable germination rates and seasonality, plant establishment with reseeding may take longer. Reseeding ultimately would result in an improved aesthetic condition to viewers.

4.16 Health and Safety

This section addresses the potential health and safety effects of TVA's transmission vegetation management program on both workers who may be implementing the vegetation control measures and the general public.

4.16.1 TVA Health and Safety Culture

Workplace health and safety regulations are designed to eliminate personal injuries and illnesses from occurring in the workplace. The Occupational Safety and Health Act (OSHA) of 1970 was created by Congress to assure safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education and assistance. OSHA is the main statute protecting the health and safety of workers in the workplaces. TVA has a robust safety conscious culture that is focused on awareness and understanding of workplace hazards, prevention, intervention, and active integration of BMPs to avoid and minimize hazards. TVA's transmission ROW department has developed an *Incident, Good Catch*, and *Near Miss* reporting system for transmission ROW contractors and TVA transmission ROW personnel.

General guidelines for work place safety that are communicated to transmission ROW work crews include the following:

- *Pre-Job Brief* – allows the worker to think through a job and use that knowledge to make the job as safe as possible.
- *Two-Minute Rule* (situational awareness) – take time before starting a job to familiarize yourself with the work environment and to identify conditions that were not identified during the pre-job brief.
- *Stop When Unsure* – when confronted with a situation that creates a question and what to do is uncertain, stop and get help.

- *Self-Check* – use of “STAR” acronym to promote self-check awareness: **S**top and focus, **T**hink what will happen with right or wrong action, **A**ct correctly, **R**eview that the results are as expected.
- *Procedure Use and Adherence* – allows for proper application of procedures and work packages based on expected activities.
- *Flagging and Operational Barriers* – key to ensure control of the work zones and avoidance of exposure to work hazards by public.
- *Three-Way Communication* – essential for all job tasks to ensure they are completed safely and productively.

Vegetation maintenance activities conducted to support TVA’s transmission ROW management program reflect a safety-conscious culture and activities are performed consistent with OSHA standards and requirements and specific TVA guidance. Personnel participating in the vegetation management program are conscientious about health and safety having addressed and managed operations to reduce or eliminate occupational hazards through implementation of safety practices, training and control measures. The safety programs and processes are designed to identify actions required for the control of hazards in all activities, operations and programs. It also establishes responsibilities for implementing OSHA and state requirements.

It is TVA’s policy that contractors have a site-specific health and safety plan in place prior to conducting vegetation management activities at TVA properties. The contractor site-specific health and safety plans address the hazards and controls as well as contractor coordination for various vegetation management tasks. A health and safety plan also would be required for workers responsible for operations after vegetation management is complete.

The intent of the TVA safety program is to ensure that a safety management system is in place that provides TVA employees and contract employees the opportunity to actively participate in hazard recognition and prevention of job-related safety and health hazards. The following TVA safety expectations are provided to ensure that work is performed in a consistently safe manner. TVA contractors are required to comply with applicable OSHA regulations and TVA policies and procedures. They also are required to develop a documented Site-Specific Safety & Health Plan 30 days prior to beginning vegetation management activities.

At a minimum the Site-Specific Safety & Health Plan must address:

- Safety orientation process.
- Proactive steps to prevent injuries.
- Event reporting and documentation.
- Worksite access and control, and an emergency action plan.
- How pre-job briefs, two minutes rule cards and human performance tools will be used.
- Equipment inspection, safety inspections and safety observations are performed.
- The implementation of lessons learned.
- Working on or near asbestos, lead, PCB, silica and other health hazards.

- Critical work procedures such as Clearance/Lock Out Tag Outfall protection, confined space, hot work and high hazard lifts and use of workplace permits.
- Requirements for mobile equipment operator, if applicable.
- Fire prevention and suppression.
- Safety roles, responsibilities and expectations for your employees and subcontractors.
- Details of how medical services and first aid will be provided.
- Competent personnel roles and responsibilities.

4.16.2 Environmental Consequences for Health and Safety

4.16.2.1 General Impacts to Health and Safety

In conjunction with TVA's culture of understanding and managing hazards, TVA tracks health and safety issues across its operations. Recent trends demonstrate general characteristics regarding health and safety impacts associated with TVA's transmission ROW vegetation management program.

Lagging indicators from the three-year period from October 1, 2014 to September 30, 2017 point to the nature of hazards encountered during transmission ROW vegetation maintenance operations. During this period ROW contractors had four OSHA lost-time recordable incidents and 14 OSHA recordable incidents. The four lost-time OSHA incidents were classified into four categories:

1. Mechanical Failure.
2. Pinch Point (i.e. caught between a stationary object and moving object or between moving parts or objects.
3. Insect (i.e. insect bites or animal bites).
4. Plant (i.e. exposure to toxins in plants).

The 14 OSHA recordable incidents were classified into six categories:

- Line of Fire (5)
- Plant (3)
- Pinch Point (2)
- Slip Trip and Fall (2)
- Body Mechanics (1)
- Animal (1)

Vegetation maintenance requires work forces deployed to project work sites with a range of environmental conditions that may impact worker safety. Each of the methods used to manage vegetation has the potential to include one or more of the following categories of impacts.

- *Direct injury* – Tree clearing, mowing, and vehicle operation may cause direct injury to workers associated with equipment use or injury from falling or mobilized debris.

- *Environmental hazards* – Exposures to natural defense mechanisms of plants (thorns, spines, natural toxins) may result in a range of injuries including abrasions, cuts/lacerations and rashes.
- *Toxic chemicals* – Exposure to chemicals used in the treatment or control of vegetation may have potential effects on worker safety. Such chemicals may include herbicides, fuels, lubricants, or other mechanical fluids used in vegetation maintenance activities.

4.16.2.2 Impacts to Health and Safety from Vegetation Control Methods

4.16.2.2.1 Impacts to Health and Safety from Manual Methods

Equipment used includes: chainsaws, machetes, brush hooks, axes, and brush blades, among others. Use of these tools can result in worker injuries such as minor cuts, sprains, abrasions, bruises, muscle strains, exposure to equipment noise and air emissions, and debris mobilized by tool use (chips, branches, trees). Additionally, because these tools require workers to walk and access specific work zones by foot, they have a higher potential for resulting in injuries related to slips, trips and falls. Other worker safety issues relate to exposure to plants and insets (thorns, skin reactions to poison ivy, tick bites, etc.), lower back injuries or other effects. On a per unit area basis, these methods are expected to result in a higher injury rate as compared to mechanical and herbicide methods because manual vegetation control is more labor intensive and requires a greater number of worker man-hours.

4.16.2.2.2 Impacts to Health and Safety from Mechanical Methods

Mechanical methods include clearing, mowing, and side-wall trimming using mechanized equipment. Mechanical methods can be highly efficient on larger areas but also have the potential for worker injury as a result of equipment malfunction, loss of control, noise and air emissions, vibration, and other hazards. While use of mechanical methods present safety hazards, use of these tools allow TVA vegetation control to be accomplished rapidly and efficiently over large land areas.

Compared to the greater intensity of manpower necessary for comparable vegetation controls using manual methods, the use of mechanical tools (where appropriate) allow for greater worker safety.

4.16.2.2.3 Impacts to Health and Safety from Herbicide Application Methods

Herbicide use includes control of undesirable or invasive species and inhibition of resprouting or growth. Herbicides are routinely used during transmission ROW maintenance along with mechanical mowing and hand clearing as an integrated form of vegetation management. Herbicides used by TVA can be liquid, granular, pellets, or powder; can be applied aerially or by ground equipment; and may be selectively applied or broadcast depending on the site requirements, species present, and condition of the vegetation. Regardless of the project in which TVA uses herbicides, “applicators” must be trained, licensed, and follow manufacturers’ label instructions, EPA guidelines, and respective state regulations and laws.

Herbicide methods may require use of machinery (e.g., ATVs, tractors), which could involve the potential impacts described above for mechanical methods. The main potential risk to worker or public safety associated with the use of herbicide methods is exposure to the compounds (herbicides, carriers, dyes, and adjuvants).

The primary concern with herbicides is their potential impacts to workers or the public resulting from exposure to active ingredients, adjuvants, and carriers through the skin, by inhalation, or by swallowing. Herbicides are designed to target biochemical processes, such as photosynthesis, that are unique to plants. Thus, they typically are not acutely toxic to humans. Spills and leaks are inherent risks when using chemicals. Herbicides may drift, run-off, or leach into waterbodies or groundwater, thereby representing potential for secondary exposure to humans. TVA uses BMPs to minimize transport of herbicides to sensitive environmental resources that may represent a potential for secondary exposure pathways. For more information see mitigation measures in Section 4.6.2.5.

A description of the active ingredients of each herbicide used by TVA and their effects on public and worker safety is included below. Much of this information is derived from similar assessments of the Washington State Department of Transportation's (WSDOT) assessment of the potential risks to humans exposed to herbicides as part of their IVM program (WSDOT 2018). WSDOT evaluated risk to ROW workers applying herbicides and to the public (adults and children) who may be exposed by picking and eating drift-contaminated berries, eating drift-contaminated garden vegetables, and walking through sprayed vegetation. For each of these groups (workers and the general public) conditions of average exposure and extremely conservative conditions of maximum exposure were evaluated. Evaluating potential risks takes into account both the toxicity of a pesticide and the characteristics of possible exposure. These results are applicable to TVA use of herbicides as they reflect ROW vegetation maintenance practices and herbicides that are common in the industry. A summary of each herbicide active ingredient and their characteristics of toxicity and risk are provided below.

- *Aminopyralid* – This is a pyridine carboxylic acid herbicide used to control susceptible broadleaf weeds, including noxious and invasive weeds. Aminopyralid disrupts plant growth metabolic pathways, affecting the growth process of the plant. EPA classifies Aminopyralid as category IV (Low Toxicity). Aminopyralid has very low toxicity if individuals accidentally eat, touch, or inhale residues. Aminopyralid did not result in skin sensitization when tested on guinea pigs or skin irritation when tested on rabbits. Aminopyralid is classified by EPA as "not likely" to be carcinogenic to humans.

  In ROW applications aminopyralid is expected to pose negligible potential risks of adverse non-cancer effects to ROW workers and the public under conditions of average and maximum exposure. All hazard quotients (HQ) are below 1. Aminopyralid is not regulated as a carcinogen (WSDOT 2018).

- *Clopyralid* – This is an herbicide used for selective control of noxious and nuisance weeds. Clopyralid mimics a plant growth hormone and causes uncontrolled and disorganized plant growth that leads to plant death. EPA classifies clopyralid as toxicity class III (low toxicity). Clopyralid has low toxicity if individuals accidentally eat, touch, or inhale residues. Clopyralid vapors may irritate the eyes, and direct contact may cause very slight but temporary eye injury. It is not a skin sensitizer or irritant. Rats and mice fed moderate to high doses of clopyralid for 2 years show no increased incidence of tumors, suggesting that clopyralid is not carcinogenic. The EPA lists clopyralid as a Group E human carcinogen (no evidence of carcinogenicity). Based on exposure scenarios for similar ROW herbicide application, clopyralid is considered to pose a negligible risk to workers and the public under both average and maximum exposure conditions (WSDOT 2018).

- *Diuron* – This is a broad-spectrum herbicide used for weeds, grass, and brush control on highway shoulders. It stops photosynthesis, which in turn causes plants to stop growing. Diuron has slight toxicity if individuals accidentally eat, touch, or inhale residues and is moderately irritating to the eyes and slightly irritating to the skin. It has also been demonstrated to cause slight anemia, enlarged spleen, bone marrow changes, and abnormal blood pigments when fed to rats for 2 years at moderate doses. The EPA classifies diuron as a “known/likely” human carcinogen. Products that contain diuron pose a potential low risk of adverse non-cancer effects to the public under some of the average exposure scenarios. The HQs for these scenarios range from 1.1 to 2.7 (low risk). Hazard quotients for all other average public exposure scenarios are below 1 (WSDOT 2018).

  Workers making broadcast spray applications face potential low to moderate risks of adverse non-cancer effects from diuron under average exposure scenarios. The HQs for this scenario range from 8.6 to 12 under most conditions. Under unusual circumstances in which workers have higher exposures during broadcast applications, diuron poses moderate to high health risks. Additionally, under unusual high exposure conditions in which children are exposed by eating drift-contaminated garden vegetables the health risk may also be high.

  The estimated cancer risks are negligible for ROW workers and the public for all average exposure scenarios. Under maximum exposure conditions, cancer risk potential for ROW workers and the public are negligible, low, or moderate (WSDOT 2018).

- *Fosamine Ammonium* (*or ammonium salt of fosamine [fosamine*]) – This is an organophosphate pesticide used to control woody and leafy plants, such as maple, birch, alder, blackberry, vine maple, ash, and oak. Fosamine is a selective, post-emergent (after growth begins) herbicide that prevents dormant plant tissues from growing (WSDOT 2018).

  The EPA classifies this compound toxicity class II (moderate toxicity) because it can cause moderate eye injury or irritation. Fosamine has low to very low toxicity if individuals accidentally inhale or eat residues and has moderate toxicity if touched. It is not irritating to the eyes, but it can cause mild to moderate skin irritation. No chronic (long-term) studies are available for fosamine. Based on average exposure scenarios, fosamine poses a negligible risk of adverse non-cancer effects to workers and the public. For maximum exposure scenarios, fosamine poses a potential moderate risk to children who eat drift-contaminated garden vegetables and a negligible to low risk to the public under all other maximum exposure scenarios. Scientific evidence does not support that fosamine causes cancer (WSDOT 2018).

- *Glyphosate* – This is a broad-spectrum herbicide used to control a wide variety of weeds, brush, and plants. It interferes with cellular processes important for normal plant functioning. Only plants and microorganisms have these specific cellular processes. EPA classifies products containing glyphosate as being either toxicity class II (moderate toxicity) or toxicity class III (slight toxicity) because they are harmful if inhaled or because they may cause substantial but temporary eye injury and are harmful if swallowed or inhaled. Glyphosate has low toxicity if individuals accidentally eat or inhale residues and very low toxicity if touched. It is not a skin irritant or sensitizer but it is an eye irritant. Rats fed moderate doses of glyphosate for 2 years had no increase in the number of tumors. Mice, fed moderate doses for 2 years, developed an increase in the number of kidney tumors. The EPA lists glyphosate as a Group D human carcinogen (unclassifiable due to insufficient or conflicting data) (WSDOT 2018).

In a related analysis, several human exposure scenarios, including ROW workers applying herbicides and the public (adults and children) picking and eating drift-contaminated berries, eating drift-contaminated garden vegetables, and walking through sprayed vegetation have been evaluated. Assessments conducted by the WSDOT indicate that glyphosate poses a negligible risk of adverse non-cancer effects to ROW workers and the public under conditions of average exposure. All HQs are below 1. Glyphosate was determined to pose a low potential risk of adverse non-cancer effects to the public under two of the maximum case exposure scenarios in which adults and children ingested drift-contaminated garden vegetables. However, the study indicated that ROW workers are at potential low risk of adverse non-cancer effects from applying glyphosate under maximum case exposure assumptions. Hazard quotients for workers engaged in broadcast spray applications and directed foliar applicators exceed a value of 1 (low risk) (WSDOT 2018).

- *Imazapyr* – This is an herbicide used to control grasses, broadleaves, vines, brambles, brush, and trees. Imazapyr disrupts an enzyme (found only in plants) necessary for protein synthesis and interferes with cell growth and DNA synthesis in plants. There is a potential for short- and intermediate-term occupational handler exposure to imazapyr during mixing, loading, and applying, and for short- and intermediate-term occupational post- application exposure during post-application activities. EPA classifies products containing imazapyr as category III (Low Toxicity). Imazypyr has low toxicity if individuals get residues on their skin, and very low toxicity if it is eaten or inhaled. Imazapyr is considered not likely to be a human carcinogen by EPA. Imazapyr is expected to pose negligible potential risks of adverse non-cancer effects to ROW workers and the public under conditions of average and maximum exposure. All HQs are below 1 (WSDOT 2018). Imazapyr is not regulated as a carcinogen (WSDOT 2018).

- *Metsulfuron Methyl* – This is an herbicide used to control select broadleaf weeds, trees and brush, and some annual grasses. Its stops cell division in the shoots and roots of the plant causing plants to die. EPA classifies metsulfuron as toxicity class III (low toxicity). It has low to very low toxicity if people eat, touch, or inhale residues. Metsulfuron-methyl poses a negligible risk of adverse non-cancer effects to ROW workers and the public under conditions of average and maximum exposure. All HQs are below 1 (WSDOT 2018*).*

- *Tebuthiuron* – This is a substituted urea herbicide used for control of broadleaf and woody weeds, grasses and brush. Tebuthiuron inhibits photosynthesis in plants. The EPA classifies products containing tebuthiruron as category III (Low Toxicity) because it causes eye irritation and is harmful if inhaled, swallowed, or absorbed through the skin. Tebuthiuron is expected to pose negligible potential risks of adverse non-cancer effects to ROW workers and the public under conditions of average exposure. All hazard quotients are below 1. Under conditions of maximum exposure, Tebuthiuron poses a low potential risk of adverse non-cancer effects to workers engaged in broadcast hydraulic spray operations, adults and children ingesting drift-contaminated garden vegetables, and children coming into dermal contact with drift-contaminated berries and directly sprayed vegetation. The estimated potential risks are negligible in all other exposure scenarios. In 2-year feeding studies in rats and mice, no evidence of carcinogenicity was observed (WSDOT 2018).

- *Triclopyr* – This is an herbicide that controls woody plants and broadleaf weeds. Triclopyr mimics a plant growth hormone and causes uncontrolled and disorganized plant growth that leads to plant death. EPA classifies products containing troclopyr as toxicity class of I (high toxicity), III (low toxicity) or IV (low toxicity) depending on their characteristics. Triclopyr has low toxicity if individuals accidentally eat, touch, or inhale residues. Triclopyr is slightly irritating to the eyes, nonirritating to the skin, and causes skin sensitization. The herbicide formulation Garlon 3A may cause irreversible damage to the eyes. In ROW applications triclopyr poses a negligible risk of adverse non-cancer effects to the public under conditions of average exposure. All hazard quotients are below 1. For maximum exposure scenarios, triclopyr poses a potential low to high risk of adverse non-cancer effects in public exposure scenarios. Hazard quotients range from 1.1 (low risk) for adults who contact sprayed vegetation to 132 (moderate risk) for children who ingest drift-contaminated berries. Triclopyr poses a potential low risk to workers engaged in broadcast hydraulic spray applications under average exposure scenarios. Triclopyr poses a potential high non-cancer risk to ROW workers engaged in broadcast hydraulic spray applications under maximum exposure conditions.

EPRI also investigated the potential toxicity (including Margin of Safety—MOS) for a range of herbicides on worker safety and public health in conjunction with transmission ROW vegetation management. EPRI concluded that under normal operations the margins of safety are adequate to assure protection of the health of workers and the general public. However, in some very unusual circumstances modeled for maximum exposure for particular chemicals (e.g. excessive exposure to berries collected from recently sprayed ROWs), the margin of safety was less than adequate (EPRI 2004).

For workers, maximum exposure frequently does not provide an adequate margin of safety due to excessive deposition of chemicals on the skin. Accidental spills of chemical concentrates on the skin usually provide the lowest margin of safety and are most threatening to the health of workers. In some instances, accidental direct spray on workers or the public also results in margins of safety that are not adequate. Bar oil does not appear to pose a toxic risk to ROW workers using chainsaws if reasonable care with exposure is exercised. Available data suggest that exposures to several substances in chainsaw exhaust may reach unacceptable levels under some working conditions, constituting an elevated level of cancer risk (EPRI 2004).

4.16.2.3 Impacts to Health and Safety from Debris Management

Debris is left in place when manual control methods are used. Together with lopping and scattering this method does not represent any safety concerns for the general public, although it does have the potential for increasing safety hazards for workers who have to move through and over debris piles to treat vegetation on subsequent vegetation maintenance visits.

Chipping in place allows natural decomposition, nutrient recycling, erosion control, retains moisture, and may facilitate seedling establishment. Mulching in place entails the use of a similar piece of equipment but cuts debris into more coarse fragments. Both of these methods result in notable noise emissions that may be disturbing to nearby residents and may be a long-term hearing hazard to equipment operators. Additionally, flying debris from chipping machines may represent an additional safety hazard.

Offsite debris disposal of woody vegetation includes transporting chipped debris or entire trees offsite by truck. Each method involves mechanical equipment and the associated increased risk of vehicle operation. As such these techniques represent an incrementally greater safety risk to both workers and the public traveling on existing roadways.

Pile burning and container burning has inherent safety hazards associated with the potential for burns and smoke inhalation. Smoke emissions from a debris pile or container may be expected to reduce localized air quality or represent a health concern (especially those with respiratory problems) when conducted in close proximity to developed or residential areas. Pile and container burning is generally not used in proximity to developed areas or in close association with populated areas. Therefore, impacts of pile and container burning on public health and safety are minor.

4.16.2.4 Impacts to Health and Safety from Restoration

Reseeding has obvious benefits in restoring disturbed work sites and in promoting the development of a plant community that is compatible to transmission ROW management. Therefore, as restoration measures increase the development of an herbaceous low growing or meadow-like community, these measures increase long-term safety. However, restoration methods require a workforce that may either use manual or mechanical means for site restoration. Therefore, restoration measures represent a short-term safety risk to vegetation maintenance workforces.

4.16.2.5 Mitigation Measures for Impacts to Health and Safety

TVA employs a number of mitigation measures to protect workers and the general public to effectively minimize safety hazards associated with the above methods. These include:

- All contractors are required to use signs and barricades as needed to protect the public at all times.
- A formal pre-job meeting is conducted with the foreman and crew to discuss any environmental issues and safety requirements for the line and type of work to be completed.
- Safety and awareness training to educate workers regarding equipment, environmental and chemical hazards.
- Use of contractors trained in safety related to transmission ROW vegetation maintenance.
- Use of appropriate personal protection equipment (hard hats, safety shoes, hearing protection, face shields, gloves, clothing, etc.) in conjunction with equipment use and environmental hazards.
- Incorporation of lessons learned from prior years.
- Extensive public communication programs.

Additional BMPs and safety guidelines for herbicide application include:

- Herbicide kick-off meeting is held with all herbicide contractor applicator employees before any work is started on the TVA system to address the following topics:
    - Chain of command between TVA and applicator when problems arise.
    - Proper use of equipment and inspection of equipment to ensure proper operation.
- Distribution of an herbicide flyer is mailed to all affected property owners as a tool to communicate the upcoming application within transmission ROWs on or adjacent to their property.
- Use of selective low-volume backpack application for controlling vegetation on the transmission ROW adjacent to sensitive areas.
- Backpack applicators that target woody stems or incompatible species that endanger reliability or hamper access to the transmission lines.
- Selection of herbicides for use on each project site that are vetted by TVA transmission ROW staff to ensure that they meet the environmental requirements set by TVA transmission ROW management.
- Proper labeling of herbicide containers and availability of safety data sheets for all active chemicals used on a particular job site.
- Use of flagging to identify treated areas that are marked with the application year and the URL for the TVA transmission ROW website.
- Use of trained and licensed commercial applicators who are skilled in the use of herbicides in accordance with the label requirements and applicable state and federal laws.
- Precautions used (restrictions) in herbicide application in proximity to crops, gardens, livestock operations, and environmentally sensitive areas.
- Incorporation of random safety and equipment checks to ensure public safety.

4.17 Solid and Hazardous Waste

4.17.1 Affected Environment

4.17.1.1 Solid Waste

Solid waste consists of a broad range of materials that include refuse, sanitary wastes, contaminated environmental media, scrap metals, nonhazardous wastewater treatment plant sludge, nonhazardous air pollution control wastes, various nonhazardous industrial waste, and other materials (solid, liquid, or contained gaseous substances). Solid waste is regulated by the EPA and RCRA Subtitle D. Each state is required to ensure the federal regulations for solid waste are met and may implement more stringent requirements.

In some states, special wastes may include sludges, bulky wastes, pesticide wastes, industrial wastes, combustion wastes, friable asbestos and certain hazardous wastes exempted from RCRA Subtitle C requirements. Any of these wastes, if generated, would be disposed as required by state and federal regulations.

4.17.1.2 Hazardous Waste

Hazardous materials are regulated under a variety of federal laws including OSHA standards, Emergency Planning and Community Right to Know Act (EPCRA), the RCRA, the Comprehensive Environmental Response, Compensation and Liability Act of 1980 and the Toxic Substances Control Act.

Regulations implementing the requirements of EPCRA are codified in 40 CFR 355, 40 CFR 370 and 40 CFR 372. Under 40 CFR 355, facilities that have any extremely hazardous substances present in quantities above the threshold planning quantity are required to provide reporting information to the State Emergency Response Commission, Local Emergency Planning Committees and local fire departments. Inventory reporting to emergency response parties is required for facilities with greater than the threshold planning quantity of any extremely hazardous substances or greater than 10,000 pounds of any OSHA regulated hazardous material. EPCRA also requires inventory reporting for all releases and discharges of certain toxic chemicals. TVA applies these requirements as a matter of policy.

RCRA regulations define what constitutes a hazardous waste and establishes a “cradle to grave” system for management and disposal of hazardous wastes. Subtitle C of RCRA includes separate, less stringent regulations for certain potential hazardous wastes. Used oil, for example, is regulated as hazardous waste if it is disposed of, but it is separately regulated if it is recycled. Specific requirements are provided under RCRA for generators, transporters, processors and burners of used oil that are recycled. Universal wastes are a subset of hazardous wastes that are widely generated. Universal wastes include batteries, lamps and high intensity lights and mercury thermostats. Universal wastes may be managed in accordance with the RCRA requirements for hazardous wastes or by special, less stringent provisions.

4.17.2 Environmental Consequences of Solid and Hazardous Waste

4.17.2.1 General Impacts from Solid and Hazardous Waste

The evaluation of potential impacts from solid and hazardous wastes is dependent on the type, volume and characteristics of the waste generated. Effects may result directly from the vegetative management or inadvertently from spills/release of chemicals/petroleum.

Vegetation control activities may generate solid waste and to a lesser extent, minor amounts of hazardous waste. Solid waste includes vegetative wastes (limbs, tree trunks and resulting mulch) and domestic solid waste (trash, refuse) that may be generated while conducting clearing and vegetation management of transmission ROWs. Domestic solid waste generated by TVA during vegetation control activities would be removed from the site and disposed in an approved sanitary landfill. Materials generated (intentionally or accidentally) that are determined to be wastes would be evaluated and managed in accordance with the Solid and Hazardous Wastes Rules and Regulations of the State (Tennessee Department of Environment and Conservation Division of Solid Waste Management Rule 0400 Chapters 11 and 12, respectively) in addition to other applicable regulations (federal, state) and TVA’s BMPs.

Potential hazardous waste may be generated during the maintenance of the equipment including waste oils, coolant/anti-freeze, chemical waste from cleaning operations, parts washer liquids, and other waste petroleum products. Use of herbicides in the vegetative management plan would result in waste containers, unused herbicide products, outdated herbicides and other vegetation control chemicals requiring proper disposal. In addition, during the clearing by mechanical or chemical means, potential exists for an accidental spill or release of fuel, motor oil, herbicides and other vegetative control chemicals which may result in the generation of solid or hazardous waste based on the material released. These hazardous materials require special handling and disposal according to EPA regulations and state laws. Each state in the PSA has its own agency designated for monitoring and regulation of hazardous waste spills and disposal. Any accidental spill of hazardous waste would be reported to the landowner and the appropriate regulatory agency.

4.17.2.2 Impacts of Solid and Hazardous Waste from use of Vegetation Control Methods

4.17.2.2.1 Impacts of Solid and Hazardous Waste from use of Manual Methods

Manual control methods are defined as control of vegetation using hand-operated tools (ANSI 2012). Equipment used includes chainsaws, machetes, brush hooks, axes, and brush blades, among others. Manual removal does not generate substantial amounts of solid or hazardous waste. In more remote areas the vegetative wastes from manual removal is typically disposed of in place or gathered locally into smaller piles where it naturally degrades. Within developed lands (residential areas), vegetative wastes and other solid wastes associated with manual methods are typically removed from the site and disposed of in a landfill (unless otherwise agreed to with the landowner).

4.17.2.2.2 Impacts of Solid and Hazardous Waste from use of Mechanical Methods

Mechanical control methods are defined as vegetation control using equipment-mounted saws, mowers, grinders, and other devices (ANSI 2012). Mechanical methods include clearing, mowing, and side-wall trimming using mechanized equipment.

Vegetative wastes from mechanical methods is typically mulched or placed in windrows along the transmission ROW boundary. Solid vegetative waste may be left in place for decomposition with approval from the local land manager/owner or could be mulched and spread throughout the transmission ROW. Larger woody debris not suitable for mulching may be placed as windrows along the edge of the transmission ROW.

Mechanical tools require the use of fuels and lubricants. Equipment refueling and maintenance operations would be carried out by TVA contractors using BMPs. Additionally, in the event of an accidental release, appropriate care would be taken to immediately contain and clean up any released material from the ground surface. Any material recovered would be containerized and properly disposed as solid or hazardous waste based on the specific material spilled/released in accordance with applicable state and federal regulations.

4.17.2.2.3 Impacts of Solid and Hazardous Waste from Use of Herbicide Application Methods

The generation of solid and hazardous waste during the herbicide application would include unused herbicide and growth inhibitors, waste oil/waste fluids from maintenance of the equipment, material generated in the cleanup of minor spills/releases, and empty containers from oils/greases/herbicides/growth inhibitors. The generation of these wastes is anticipated to be minimal and would be handled and disposed of according to the appropriate state and local regulations. Typically, herbicide containers/growth inhibitor containers would be triple rinsed and the rinse water included in the spray equipment to be used. The containers can then typically be disposed as solid waste.

4.17.2.3 Impacts of Solid and Hazardous Waste from Debris Management

Methods to manage debris typically include mulching, chipping, logging and other mechanical measures. As such debris management is similar to mechanical control methods in that it requires the use of fuels and lubricants. Therefore, potential impacts from debris management are similar to manual and mechanical removal methods.

4.17.2.4 Impacts of Solid and Hazardous Waste from Restoration

Restoration measures entail the use of either manual or mechanical tools to seed disturbed areas. Such measures entail minimal site disturbance and the solid and hazardous waste generated are similar to those described for manual and mechanical control methods. The volume of solid and hazardous waste generated during this process would be expected to be minimal; therefore, the potential for impact is expected to be minimal. Disposal of any solid or hazardous waste would be handled according the appropriate local, state, and federal regulations.

4.18 Transportation

4.18.1 Affected Environment

The transportation network within the study area is extensive and contains thousands of miles of roads and bridges, rail lines, navigable waterways, and ports.

TVA's transmission infrastructure is served by both public and private roadways. Road access to this infrastructure varies from single-lane roads to four-lane divided highways and includes both paved and un-paved roads. Public road managers for this system include state departments of transportation, conservation, forestry; county highway departments; and municipal road departments.

Some roadways within TVA's transmission system are within lands managed by other Federal agencies such as the USFS or NPS and as such may require special authorization or coordination with these agencies that would occur as part of TVA's stepwise vegetation management process described in Chapter 3.1. Most of TVA's transmission system is located on private lands, which TVA would access from either existing public roadways or from private roads via access permissions and access agreements.

No access from rail or water facilities is expected to be affected as a result of vegetation maintenance activities.

4.18.2 Environmental Consequences on Transportation

Vegetation maintenance using any of the proposed methods would require moving equipment and workers to the transmission ROW to be maintained. It is expected that this would entail the use of a limited number of additional vehicles and would generally occur at the beginning and ending of the work day. Overall, the traffic volume generated by the construction workforce and the construction-related vehicles would be relatively minor. Except for the access of work crews from local roadway, it is expected that these motorists would use interstate highways or major arterial roadways as much as possible and would therefore, not result in congestion or the degradation of existing traffic patterns.

Should the management of vegetative debris require offsite disposal, work forces would require the use of additional haul trucks for removal and transport of debris. As such, this would contribute to a short-term increase in traffic volumes that would vary along the transmission ROW to be managed. Access from the work zones within transmission ROWs onto local roadways would be controlled by appropriate signage or flagmen to ensure safety. However, the number of trucks used to haul debris offsite is generally expected to be low and would be insignificant relative to existing traffic volumes. Further, the additional trucks would be distributed throughout the transportation network and would not represent a notable change in traffic conditions.

Ground vehicles would also be used when transmission ROWs are managed with aerial trimming by helicopter and aerial spraying of herbicides. For both aerial spraying and trimming by helicopter a ground "chaser" vehicle would be used. However, no additional vehicle use would be required where debris is managed onsite (for example mulching in place). For these methods, there would be no noticeable impact to traffic conditions.

In general, TVA would perform vegetation maintenance activities in a way that minimizes inconvenience and disruption to traffic and would use appropriate traffic control measures (signs and flaggers) as needed to maintain the safety and flow of public travel in the vicinity of the transmission ROW being treated. Therefore, impacts of vegetation methods on transportation and traffic conditions are negligible.

4.19 Air Quality and Climate Change

4.19.1 Affected Environment

4.19.1.1 Air Quality

Air quality is a vital resource that impacts us in many ways. Poor air quality can affect our health, ecosystem health, forest and crop productivity, economic development and our enjoyment of scenic views. The CAA is the comprehensive law that affects air quality by regulating emissions of air pollutants from stationary sources (such as power plants) and mobile sources (such as automobiles). It requires the EPA to establish National Ambient Air Quality Standards (NAAQS) and directs the states to develop State Implementation Plans to achieve these standards. This is primarily accomplished through permitting programs that establish limits for emissions of air pollutants.

NAAQS have been established to protect the public health and welfare with respect to six criteria air pollutants: carbon monoxide [CO], nitrogen dioxide [NO_2], ozone, particulate matter, sulfur dioxide [SO_2], and lead [Pb]. Primary standards protect public health, while secondary standards protect public welfare (e.g., visibility, crops, forests, soils, and materials) (Table 4-20).

Table 4-20. National Ambient Air Quality Standards

Pollutant	Type	Averaging Time	Level	Form
Carbon Monoxide (CO)	Primary	8-hour	9 ppm	Not to be exceeded more than once per year
		1-hour	35 ppm	
Lead (Pb)	Primary and secondary	Rolling 3-month average	0.15 $\mu g/m^3$[(1)]	Not to be exceeded

Pollutant		Type	Averaging Time	Level	Form
Nitrogen Dioxide (NO_2)		Primary	1-hour	100 ppb	98th Percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Primary and secondary	Annual	53 ppb(2)	Annual mean
Ozone (O_3)		Primary and secondary	8-hour	0.070 ppm(3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particulate Matter (PM)	$PM_{2.5}$	Primary	Annual	12 μg/m³	Annual mean, averaged over 3 years
		Secondary	Annual	15 μg/m³	Annual mean, averaged over 3 years
		Primary and secondary	24-hour	35 μg/m³	98th Percentile, averaged over 3 years
	PM_{10}	Primary and secondary	24-hour	150 μg/m³	Not to be exceeded more than once per year on average over 3 years
Sulfur dioxide (SO_2)		Primary	1-hour	75 ppb(4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

Source: EPA 2016a

μg/m³ = micrograms per cubic meter; ppb = parts per billion; ppm = parts per million

(1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 μg/m³ as a calendar quarter average) also remain in effect.

(2) The level of the annual NO_2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O_3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O_3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

(4) The previous SO_2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO_2 standards or is not meeting the requirements of a SIP call under the previous SO_2 standards (40 CFR 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

In accordance with the CAA Amendments of 1990, all counties are designated with respect to compliance, or degree of noncompliance, with NAAQS. These designations include:

- Attainment – Any area where air quality meets the NAAQS.
- Nonattainment – Any area with air quality worse than the NAAQS.
- Unclassified – There is not enough data to determine attainment status.

For the purpose of this PEIS, the affected environment is the study area shown in Figure 1-3. The study area consists of the 241 counties in a seven-state region and has an estimated population of 12.9 million in 2015 (Bureau of Census 2018). All counties within the study area are designated as attainment for all criteria air pollutants, except for Sullivan County, Tennessee, which has a portion of Sullivan County that is in nonattainment for SO_2 (EPA 2017b). This more than 82,000-square-mile area defines the study area for this PEIS as this area is inclusive of all areas where TVA maintains ROWs or could acquire new ROW in the future and subsequently build transmission line on the newly acquired ROW.

Prevention of significant deterioration (PSD) regulations are used to limit air pollutant emissions from new or expanding sources in attainment or unclassifiable areas. Under these regulations, some national parks and wilderness areas are designated PSD Class I air quality areas and are afforded special protection. There are eight Class I areas within the vicinity of the study area, including Sipsey Wilderness, Alabama; Mammoth Cave National Park, Kentucky; Mingo Wilderness, Missouri; Linville Gorge Wilderness Area, North Carolina; Joyce Kilmer/Slickrock Wilderness, North Carolina; Shining Rock Wilderness Area, North Carolina; the Great Smoky Mountains National Park, North Carolina/Tennessee; and Cohutta Wilderness Area, Tennessee/Georgia (Figure 4-8).

Typical emissions generated from clearing and vegetation management of TVA transmission ROWs and access roads include volatile organic compounds, nitrogen oxides, CO, SO_2, carbon dioxide (CO_2), and particulate matter from the movement and exhaust of vehicles, generators, and vegetation control equipment.

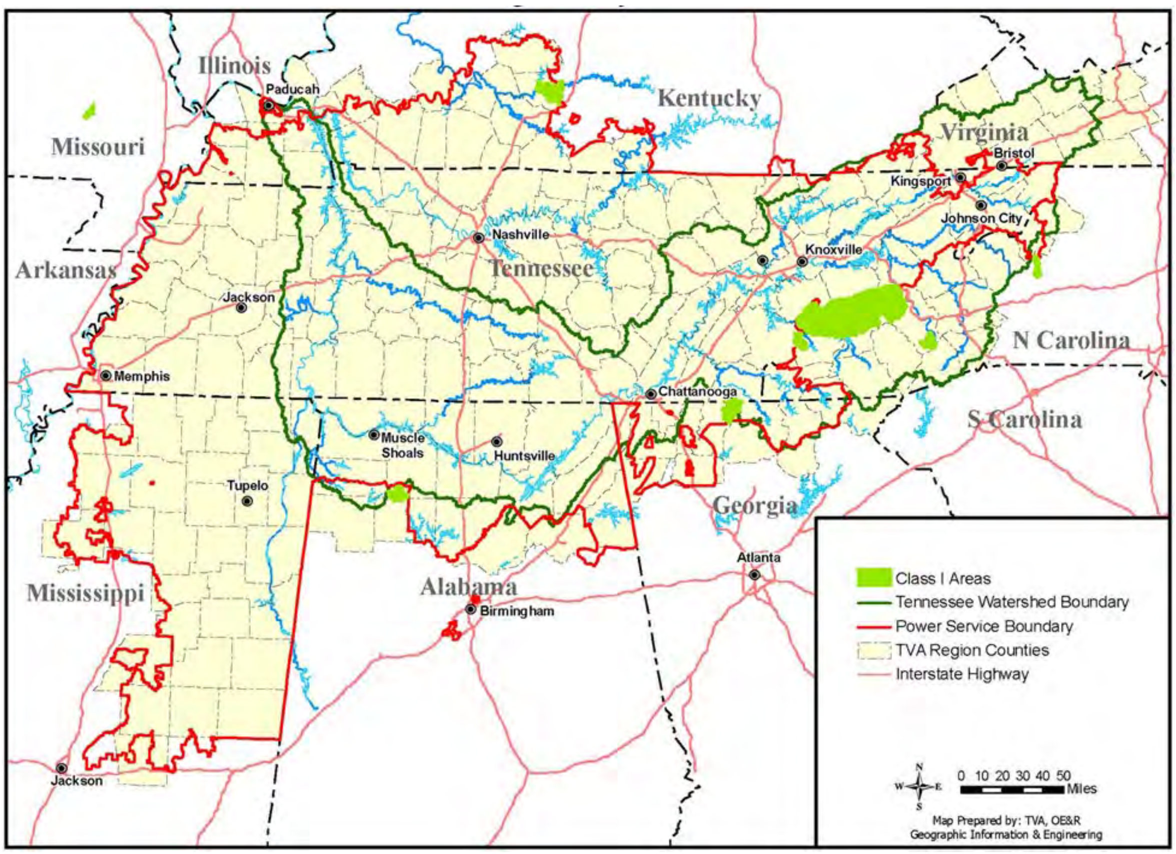


Figure 4-8. Class I Air Quality Areas In and Near the TVA Study Area

4.19.1.2 Climate Change

“Climate change” refers to any substantive change in measures of climate, such as temperature, precipitation, or wind (EPA 2016b). The 2014 National Climate Assessment concluded that global climate is projected to continue to change over this century and beyond. The amount of warming projected beyond the next few decades, by these studies, is directly linked to the cumulative global emissions of greenhouse gases (e.g., CO_2, methane) and particles. By the end of this century, the 2014 National Climate Assessment concluded a 3°F to 5°F rise can be projected under the lower emissions scenario and a 5°F to 10°F rise for a higher emissions scenario (Melillo et al. 2014).

Generally, climate change results in Earth’s lower atmosphere becoming warmer and moister, resulting in the potential for more energy for storms and certain severe weather events. TVA has adopted a climate adaptation plan that establishes adaptation planning goals and describes the challenges and opportunities a challenging climate may present to its mission and operations. The goal of TVA’s adaptation planning process is to ensure that TVA continues to achieve its mission and program goals and to operate in a secure, effective and efficient manner in a changing climate.

TVA manages the effects of climate change on its mission, programs and operations within its environmental management processes. TVA’s Environmental Policy includes the specific objective of stopping the growth in volume of emissions and reducing the rate of carbon emissions by 2020 by supporting a full slate of reliable, affordable, lower-CO_2 energy supply opportunities and energy efficiency.

Activities that contribute CO_2 emissions include industrial activities; manufacturing activities; vehicles including trucks and personal use vehicles; and other construction involving the use of fossil-fuel-powered equipment (e.g., bulldozers, loaders, haulers, trucks, generators, etc.). Generally, clearing of vegetation releases CO_2 from cleared vegetation into the atmosphere. Vegetation control activities that offset CO_2 emissions include the re-growth of low-growing vegetation and the permanent storage of carbon in any trees marketed as lumber.

4.19.2 Environmental Consequences for Air Quality

4.19.2.1 General Impacts to Air Quality

The evaluation of potential impacts to air quality resources and climate change is centered on the assessment of potential impacts of emissions. As it relates to methods to control and manage vegetation, such emissions are generally minor and are associated with the use of mechanized equipment (combustion engine use), burning of debris or fugitive dust.

Releases of CO_2 from emissions coupled with reduced carbon sequestration due to tree removal are potential mechanisms of impact on climate change. However, as it relates to climate change these emissions are considered de minimis and reductions in carbon sequestration by trees from individual method application are negligible in the context of the regional setting.

Issues related to each category of vegetation control methods are described below.

4.19.2.2 Impacts to Air Quality from Vegetation Control Methods

4.19.2.2.1 Impacts to Air Quality from Manual Methods

Manual control methods have the least potential for air quality emissions. Mobilization of work crews to and from project work sites is the only source of emissions related to use of manual methods. Because the volume of vehicles used to transport work crews is low and would represent a negligible increase relative to existing roadway traffic, the additional emissions would be negligible. Therefore, impacts of manual removal methods on air quality and climate change are negligible.

4.19.2.2.2 Impacts to Air Quality from Mechanical Methods

In addition to the air emissions associated with workforce mobilization, the use of mechanical control methods would also result in emissions. Equipment operation would produce small increases in emissions from combustion engines and particulates from mowing and localized land disturbance. Such emissions however, are localized and temporary.

This method has the potential for more widespread application for removal of standing timber in border zones. However, even for broader border zone application, reductions in carbon sequestration from individual method application are negligible in the context of the regional setting. Therefore, impacts to air quality and climate change from mechanical tools use are minor and temporary.

4.19.2.2.3 Impacts to Air Quality from Herbicide Application Methods

In addition to the air emissions associated with workforce mobilization, broadcast herbicide application methods may incrementally increase air emissions when using mechanical methods. Minor air emissions may also be expected in conjunction with the infrequent use of herbicides applied with aerial broadcast methods. Such emissions, regardless of technique however, are localized and temporary. Therefore, impacts to air quality and climate change from herbicide application are minor and temporary.

4.19.2.3 Impacts to Air Quality from Debris Management

Methods to manage debris typically entail mulching, chipping, logging and other mechanical measures. As such, debris management is similar to mechanical control methods in that it requires the use of fuels and results in air emissions. Therefore, impacts to air quality from these debris management methods are similar to those described for mechanical control methods.

In situations where large volumes of debris are generated, debris disposal may entail infrequent use of pile burning or container burning to manage debris. In such cases emissions (smoke, particulates, etc.) would be generated and would be notable locally. Such impacts however, would be short-term, temporary and minimized by the use of techniques that minimize emissions and smoke production (e.g. air curtain destroyers). Overall, impacts of debris disposal on air quality and climate change are considered to be temporary and generally minor. TVA would plan and coordinate open burning with the local and state air programs and fire control agencies before undertaking any burning activities. TVA would avoid open burning on air quality alert days.

4.19.2.4 Impacts to Air Quality from Restoration

Restoration measures entail the use of either manual or mechanical tools to seed disturbed areas. Such measures entail minor air emissions as described for mechanical methods. Therefore, impacts to air quality and climate change from restoration measures are minor and temporary.

4.20 Noise

4.20.1 Affected Environment

Noise is unwanted or unwelcome sound, usually caused by human activity and added to the natural acoustic setting of a locale. It is further defined as sound that disrupts normal activities or that diminishes the quality of the environment. Community response to noise is dependent on the intensity of the sound source, its duration, the proximity of noise-sensitive land uses and the time of day the noise occurs (i.e., higher sensitivities would be expected during the quieter overnight periods).

Sound is measured in units of decibels (dB) on a logarithmic scale. The “pitch” (high or low) of the sound is a description of frequency, which is measured in Hertz (Hz). Most common environmental sounds are a composite of sound energy at various frequencies. A normal human ear can usually detect sounds that fall within the frequencies from 20 Hz to 20,000 Hz. However, humans are most sensitive to frequencies between 500 Hz to 4,000 Hz.

Given that the human ear cannot perceive all pitches or frequencies in the sound range, sound level measurements are typically weighted to correspond to the limits of human hearing. This adjusted unit of measure is known as the A-weighted decibel (dBA). A noise change of 3 dBA or less is not normally detectable by the average human ear. An increase of 5 dBA is generally readily noticeable by anyone, and a 10-dBA increase is usually felt to be "twice as loud" as before.

To account for sound fluctuations, environmental noise is commonly described in terms of the equivalent sound level or Leq. The Leq value, expressed in dBA, is the energy-averaged, A weighted sound level for the time period of interest. The day-night sound level (Ldn), is the 24-hour equivalent sound level, which incorporates a 10-dBA correction penalty for the hours between 10 p.m. and 7 a.m., to account for the increased sensitivity of people to sounds that occur at night.

The perceived loudness or intensity between a noise source and a receptor may change as a result of distance, topography, vegetation, water bodies, and structures. The closer a receptor is to a noise source the louder the noise seems; for every doubling of distance from a source the intensity drops by about 6 dBA over land and about 5 dBA over water. Topography, vegetation, and structures can change noise intensity through reflection, absorption, or deflection. Reflection tends to increase the intensity, while absorption and deflection tend to decrease the intensity.

Common indoor and outdoor sound levels are listed in Table 4-21.

Table 4-21. Common Indoor and Outdoor Noise Levels

Common Outdoor Noises	Sound Pressure Levels (dB)	Common Indoor Noises
	110	Rock Band (15 ft)
Jet Fly-Over (1000 ft)		
	100	
Gas Lawn Mower (3 ft)		
	90	Food Blender (3 ft)
Diesel Truck (50 ft)		
	80	Garbage Disposal (3 ft)
Gas Lawn Mower (100 ft)	70	
		Vacuum Cleaner (10 ft)
		Normal Speech (3 ft)
Heavy Traffic (300 ft)	60	
	50	Dishwasher Next Room
Typical Urban Daytime		
	40	
Urban Nighttime		Library
	30	Bedroom at Night
Rural Nighttime		
	20	Whisper
	10	
	0	Threshold of Hearing

Source: Arizona DOT 2008

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978, USC. 42 4901-4918), delegates authority to the states to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations. Many local noise ordinances are qualitative, such as prohibiting excessive noise or noise resulting in a public nuisance. Because of the subjective nature of such ordinances, they are often difficult to enforce.

There is considerable variation in individual response to noise. Noise that one person would consider mildly annoying, another person may consider highly annoying or not annoying at all. The EPA noise guideline recommends an Ldn of 55 dBA, which is sufficient to protect the public from the effect of broadband environmental noise in typical outdoor and residential areas. These levels are not regulatory goals but are “intentionally conservative to protect the most sensitive portion of the American population” with “an additional margin of safety” (EPA 1974). The U.S. Department of Housing and Urban Development (HUD) considers an Ldn of 65 dBA or less to be compatible with residential areas (HUD 1985).

Noise levels continuously vary with location and time. In general, noise levels are high around major transportation corridors along highways, railways, airports, industrial facilities and construction activities. Sound from a source spreads out as it travels from the source, and the sound pressure level diminishes with distance. In addition to distance attenuation, the air absorbs sound energy; atmospheric effects (wind, temperature, precipitation) and terrain/vegetation effects also influence sound propagation and attenuation over distance from the source. An individual’s sound exposure is determined by measurement of the noise that the individual experiences over a specified time interval.

Community noise refers to outdoor noise near a community. A continuous source of noise is rare for long periods and is typically not a characteristic of community noise. Typical background day/night noise levels for rural areas range between 35 and 50 dB whereas higher-density residential and urban areas background noise levels range from 43 dB to 72 dB (EPA 1974). Background noise levels greater than 65 dBA can interfere with normal conversation, watching television, using a telephone, listening to the radio and sleeping.

4.20.2 Environmental Consequences for Noise

4.20.2.1 General Impacts to Noise

Vegetation maintenance activities that could affect noise and the existing soundscape include the use of motorized equipment, or machinery used to implement methods at work sites and transport workers and equipment, and the use of aircraft (fixed wing or rotary) for condition assessments, wall trimming or for aerial application of herbicides.

Equipment used for vegetation maintenance activities would include (but may not be limited to) mulchers, chippers, excavators, compactors, skidders, loaders, haul trucks, and bulldozers. Noise from equipment primarily is contained within the work site. As illustrated by Table 4-22, typical noise levels from equipment used are expected to be 85 dBA or less when measured at 50 feet. These types of noise levels would diminish with distance from the work site at a rate of approximately 6 dBA per each doubling of distance and therefore would be expected to attenuate to the recommended EPA noise guideline of 55 dBA at 1,500 feet. However, this distance would be shorter in the field as objects and topography would cause further noise attenuation.

Table 4-22. Typical Equipment Noise Levels

Equipment	Noise Level (dBA) at 50 ft[1]
Air Compressor	80
Chain saw	120[2]
Compactor	80
Crane (mobile)	85
Dozer	85
Dump truck	84
Excavator	85
Fixed wing propeller aircraft	88
Flatbed Truck	84
Front end loader	80
Generator	82
Helicopter	100[2]
Scraper	85
Sheers (on backhoe)	85
Grapple (on backhoe)	85
Mowers	96[2]
Pickup truck	55
Pneumatic Tools	85
All other equipment >5 HP	85

Source: [1]Unless otherwise noted source is from FHWA 2018; [2]Purdue University 2018

4.20.2.2 Impacts on Noise from Vegetation Control Methods

4.20.2.2.1 Impacts on Noise from Manual Methods

The manual removal of vegetation would primarily use hand-operated equipment including chainsaws, machetes, brush hooks, axes, and brush blades, among others. Manual removal may be necessary in select areas where large equipment cannot access or in sensitive areas such as wetland, steep slopes, or where restrictions are imposed on other viable methods. Chainsaws would be used where larger, woody vegetation needs to be removed. Chainsaw use produces noise at around 120 dBA range which is considered very loud and would be heard from a distance above the natural ambient sounds of the immediate environment. The noise impact from chainsaw use would be notable in proximity to developed areas, but intermittent and short-term as noise would occur only during the actual use of the equipment. Once an area is cleared or treated, crews would move to a different location and noise levels would return to ambient conditions.

4.20.2.2.2 Impacts on Noise from Mechanical Methods

Mechanical cutting and trimming uses a range of equipment depending on the need including:

- *Clearing* **–** using bulldozer, track-hoe, skid steer, shears (e.g., feller-buncher), mulcher/chipper, or Hydro-ax including (various other attachments).
- *Mowing* **–** using mower or brush hog.
- *Side-Wall Trimming (Aerial or Ground)* – using helicopter tree saw, Hydro-ax, Jarraff & Kershaw line trimmers, or aerial lifts.

Noise from use of this equipment, as well as transport of the equipment and crews to each site, would be above the ambient sound levels. Equipment used under this alternative can be considered loud, with noise levels ranging from 85 to 120 dBA (see Table 4-22). Adverse impacts from the use of this equipment would be notable but intermittent and short-term. Subsequent to vegetation control activities, crews would move to a different location and noise levels would return to natural ambient noise levels ambient conditions.

4.20.2.2.3 Impacts on Noise from Herbicide Application Methods

Noise impacts from the herbicide application methods are variable. These methods range from crews on foot and used of small motorized vehicles such as ATV to aerial application via fixed-wing aircraft or helicopters. Spot and localized application would involve crews working on foot with backpack sprayers or ATVs equipped with tractor spray guns. Because noise emissions from such equipment are relatively low, noise impacts from these methods would be limited. In contrast, noise emissions from fixed wing aircraft or helicopters may be as much as 100 dBA (see Table 4-22). However, while such impacts would be notable, they would be intermittent and short-term, whereas noise impacts from spot and localized application would be minor. Subsequent to vegetation control activities, crews would move to a different location and noise levels would return to natural ambient conditions.

4.20.2.3 Impacts on Noise from Debris Management

Methods to manage debris typically entail both manual and mechanical methods and use mulchers and chippers to reduce cut vegetation. Other equipment may be used to move debris to these machines. Noise from use of this equipment, as well as transport of the equipment and crews to each site, would exceed existing ambient sound levels. Equipment used under this alternative can be considered loud, with noise levels ranging from 85 to 120 dBA (see Table 4-22). Adverse impacts from the use of this equipment would be notable but intermittent and short-term. Subsequent to debris management activities, crews would move to a different location and noise levels would return to natural ambient noise levels.

4.20.2.4 Impacts on Noise from Restoration

Restoration measures entail the use of either manual or mechanical tools to seed disturbed areas. Mechanical tools and equipment used can include chainsaws, skidders, tractors and helicopters for aerial seeding. Noise from use of this equipment, as well as transport of the equipment and crews to each site, would exceed existing ambient sound levels. Equipment used under this alternative can be considered loud, with noise levels ranging from 55-85 dBA (see Table 4-19). Adverse impacts from the use of this equipment would be notable but intermittent and short-term. Subsequent to site restoration activities, crews would move to a different location and noise levels would return to natural ambient noise levels ambient conditions.

4.21 Socioeconomics and Environmental Justice

The study area consists of the 241 counties where TVA maintains or could build transmission ROW (see Figure 1-3). In addition to population, economy, employment and income, this section describes the relative size and location of minority and low-income populations in the region and study area.

4.21.1 Affected Environment

4.21.1.1 Population Characteristics

The population of the study area was approximately 12.9 million in 2015 (Bureau of Census 2018). This is slightly higher than the PSA service area (where population is estimated to be nearly 10 million people, as the study area includes all counties where TVA maintains or could build transmission ROW. This population in the study area represents a 3 percent increase over the 2010 population, which is less than the 4.1 percent increase for the U.S. as a whole. Population varies greatly among the counties in the study area. The larger population concentrations tend to be located along major river corridors: the Tennessee River and its tributaries from northeast Tennessee through Knoxville and Chattanooga into north Alabama; the Nashville area around the Cumberland River; and the Memphis area on the Mississippi River (Figure 4-9). Counties with smaller populations are scattered throughout the region, but most are in Mississippi, the Cumberland Plateau of Tennessee and the Highland Rim of Tennessee and Kentucky.

The 2015 Integrated Resource Plan looked at the TVA service area consisting of the 178 counties where TVA provides electric power and or has large generating facilities. That study showed that an increasing proportion of the region's total population (66.1 percent in 2000 and 68.1 percent in 2010) lives in metropolitan areas (Table 4-23). Two of these areas have populations greater than one million: Nashville, almost 1.7 million, and Memphis, 1.3 million. The Knoxville and Chattanooga metropolitan areas have populations greater than 500,000. These four metropolitan areas account for about 46 percent of the TVA region's population.

Although the proportion of the region's population living in metropolitan areas is lower than the national average of 84 percent, it has been increasing and this trend appears likely to continue in the future (TVA 2015). A substantial part of this increase is likely to follow the pattern of increases in the geographic size of metropolitan areas as growth spreads out from the central core of these areas. Conversely, several lifestyle and economic concerns, including commuting time and costs and proximity to social amenities, have led to increased residential populations in the urban core areas of several cities in the regions, including the largest cities (TVA 2015).

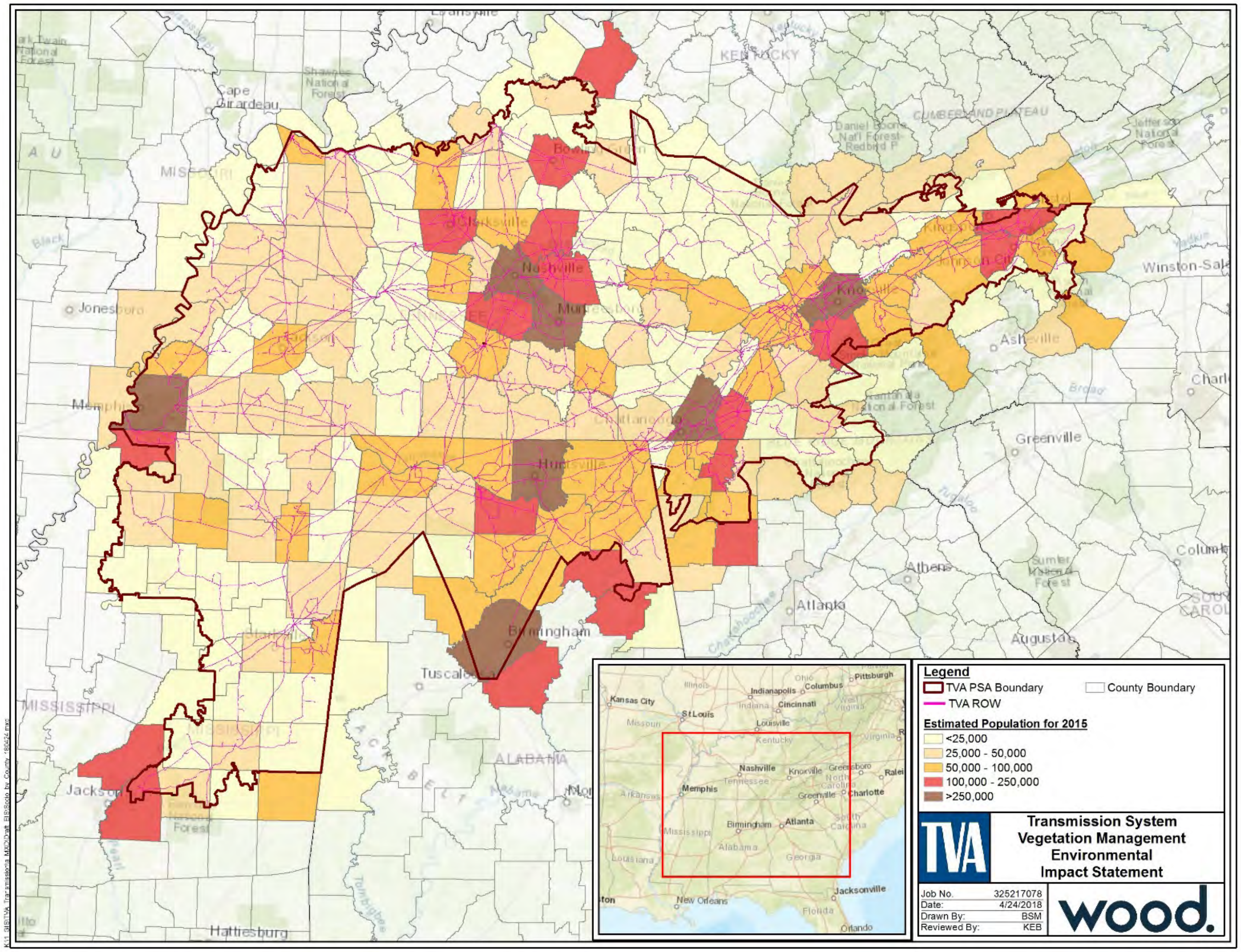


Figure 4-9. Estimated 2015 Population by County Within the TVA Study Area

Table 4-23. Population within Selected TVA Region Metropolitan Areas

Metropolitan Area	2000	2010
Bowling Green, Kentucky	134,976	158,599
Chattanooga, Tennessee-Georgia	476,531	528,143
Clarksville, Tennessee-Kentucky	219,630	260,625
Cleveland, Tennessee	104,015	115,788
Dalton, Georgia	120,031	142,227
Decatur, Alabama	145,867	153,829
Florence-Muscle Shoals, Alabama	142,950	147,137
Huntsville, Alabama	342,376	417,593
Jackson, Tennessee	121,909	130,011
Johnson City, Tennessee	181,607	198,716
Kingsport-Bristol-Bristol, Tennessee- Virginia	298,484	309,544
Knoxville, Tennessee	748,259	837,571
Memphis, Tennessee-Arkansas	1,213,230	1,324,829
Morristown, Tennessee	102,422	113,951
Nashville- Davidson-Murfreesboro-Franklin, Tennessee	1,381,287	1,670,890
Total	**5,733,574**	**6,509,453**

Source: TVA 2015

4.21.1.2 Environmental Justice Populations

On February 11, 1994, President Clinton signed EO 12898 Federal Actions to Address Environmental Justice in minority and low-income populations. This EO mandates some federal agencies to consider Environmental Justice when identifying and addressing disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations. While TVA is not subject to this EO, TVA applies it as a matter of policy.

The relevant regulations define minority as any race and ethnicity, as classified by the U.S. Census Bureau, as: Black or African American; American Indian or Alaska Native; Asian; Native Hawaiian and Other Pacific Islander; some other race (not mentioned above); two or more races; or a race whose ethnicity is Hispanic or Latino (CEQ 1997). Low-income populations are based on annual statistical poverty thresholds also defined by the Census Bureau.

Identification of minority populations requires analysis of individual race and ethnicity classifications as well as comparisons of all minority populations in the region. Minority populations exist if either of the following conditions is met:

- The minority population of the impacted area exceeds 50 percent of the total population.

- The ratio of minority population is meaningfully greater (i.e., greater than or equal to 20 percent) than the minority population percentage in the general population or other appropriate unit of geographic analysis (CEQ 1997).

4.21.1.2.1 Minority Populations

The minority population of the study area, as of 2015, is estimated to be about 3.1 million, or about 24 percent of the region's total population (USCB 2018). This is well below the national average minority population share of about 38 percent. Minority populations are largely concentrated in the metropolitan areas in the western half of the region and in rural counties in Mississippi and western Tennessee (Figure 4-10).

4.21.1.2.2 Low Income Populations

Low-income populations are those with incomes that are less than the poverty threshold (CEQ 1997). The poverty threshold takes into account family size and the age of individuals in a family. In 2014, the poverty threshold for a family of four with two children below the age of 18 was $24,008 (USCB 2015). A low-income population is identified if either of the following two conditions are met:

- The low-income population exceeds 50 percent of the total number of households.
- The ratio of low-income population significantly exceeds (i.e., greater than or equal to 20 percent) the appropriate geographic area of analysis.

The estimated poverty level for TVA region counties, as of 2013, is 18.5 percent, an increase from the 15.8 percent in 2008 and higher than the 2013 national poverty level of 15.8 percent (USCB 2015). Counties with the higher poverty levels are generally outside the metropolitan areas and most concentrated in Mississippi (TVA 2015).

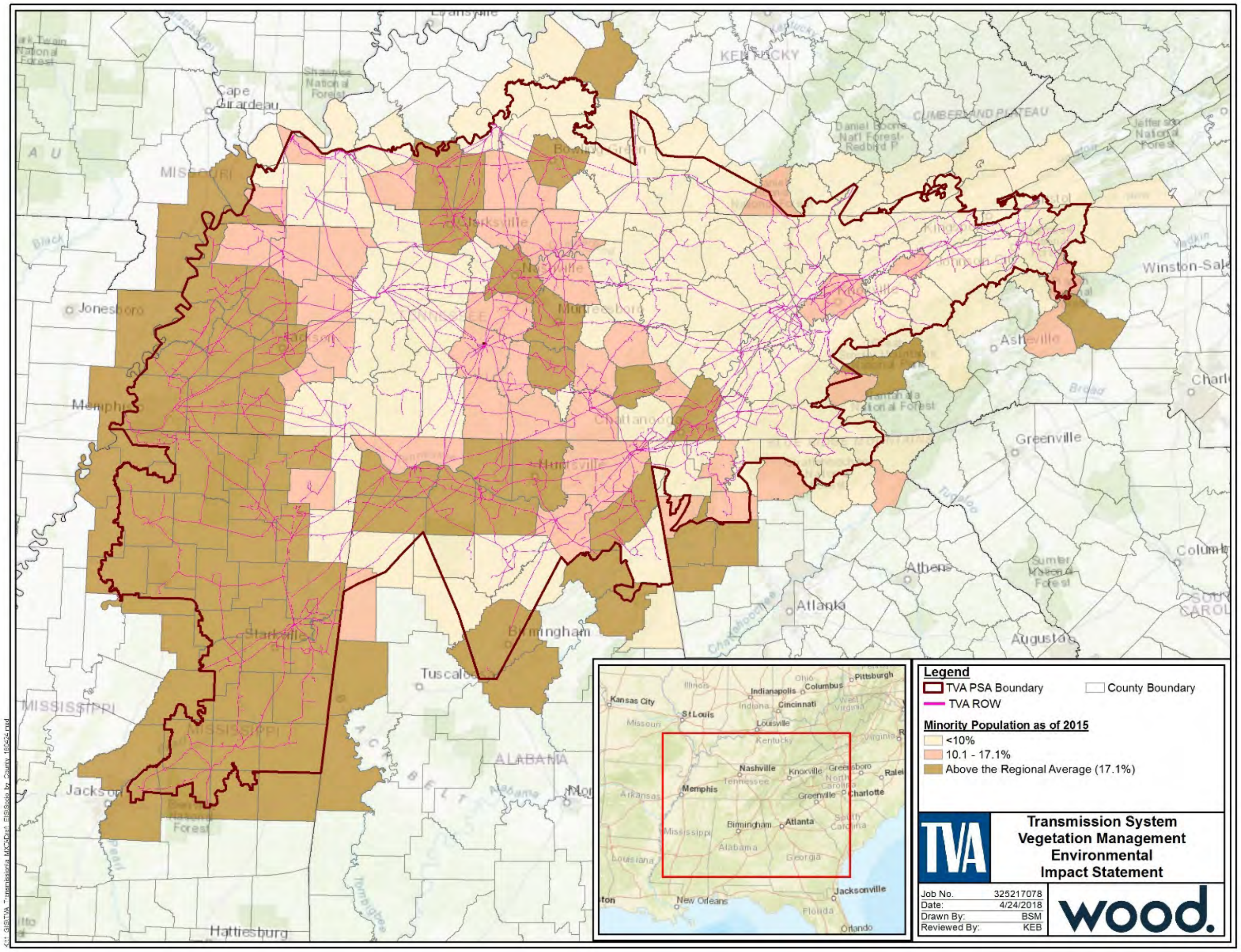


Figure 4-10. Estimated 2015 Minority Population by County Within the TVA Study Area

4.21.1.3 Economy and Employment

In 2013, the TVA region had an economy of almost $400 billion in gross product and total personal income of about $365 billion, about 2.5 percent of the national total (TVA 2015). Total employment was approximately 5.2 million. While income levels in the region have increased relative to the nation over the past several decades, average income is still below the national level. Per capita income in the study area averaged $20,746 in 2015 according to Census Bureau estimates. Figure 4-11 presents per capita income levels by county. Higher incomes are associated with more populated areas such as the metropolitan areas.

In November 2014, the average unemployment rate for counties in the TVA region was 6.9 percent (TVA 2015). Although there is considerable geographic variation in unemployment rates with adjacent counties sometimes having large differences, the counties with the highest unemployment rates in the TVA region are somewhat concentrated in east-central Mississippi, in non-urban counties near the Mississippi River, and in the northern Cumberland Plateau in Tennessee.

4.21.1.1 Economics and Workforce Characteristics of Transmission ROW Vegetation Management Program

ROW vegetation maintenance contracts typically range between $10 and $15 million on an annual basis, but occasionally can be significantly higher. The program, therefore provides a moderate level of employment which enhances economic spending throughout the region. Beneficial economic impacts occur locally and regionally from this spending in the form of wages and salaries as well as through the purchase of goods and services necessary to execute the work. These goods and services include such items as fuel, food, lodging, equipment and equipment servicing, and employee training.

TVA’s vegetation management program involves a workforce composed of contract workers who are variously skilled as manual laborers, supervisors, foremen, maintenance staff and equipment operators. Many workers who are actively deployed at work sites throughout the Valley on a rotating basis are seasonal and migrant workers who are in the U.S on temporary visas.

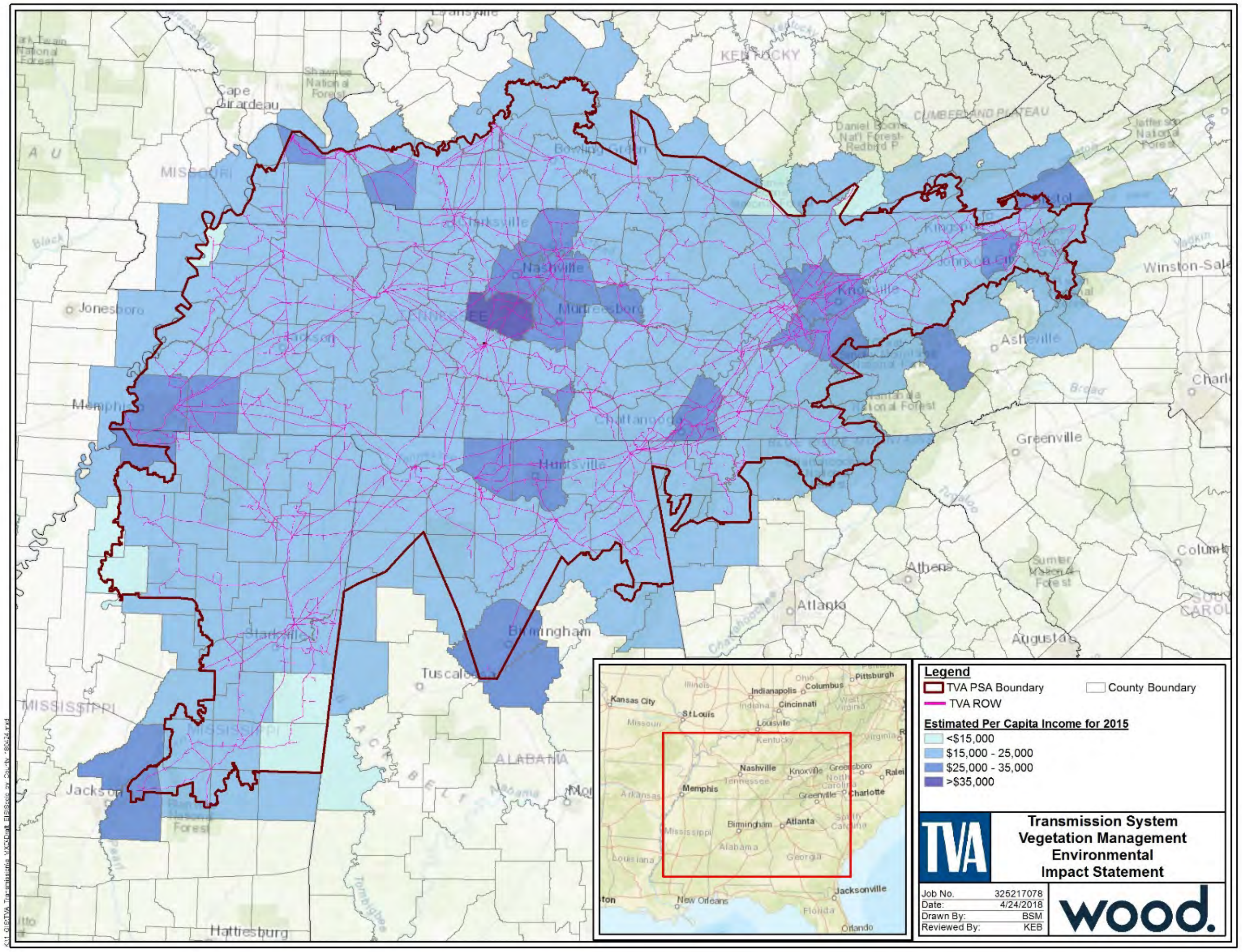


Figure 4-11. Per Capita Income by County Within the TVA Study Area

4.21.2 Environmental Consequences for Socioeconomics and Environmental Justice

4.21.2.1 General Impacts to Socioeconomics and Environmental Justice

Vegetation management of transmission line corridors benefits communities, socially and economically, by ensuring safe and reliable power which provides the framework for the local and regional economy. Other than the strong beneficial impact a well maintained transmission system has on the area economy, none of the methods is expected to significantly influence social or economic conditions. There are no notable effects on demographics, community facilities or services from the vegetation management program due to the short-term presence of work crews in any given location. The transient workforce associated with the program would provide a short-term beneficial impact to local economies.

The vegetation management program, regardless of the method, would not disproportionately affect minority or low-income communities. Beneficial impacts to some minority immigrant groups would be experienced as many of the contractors that TVA works through reported hiring migrant workers who are in the U.S. on working visas. To support socioeconomic justice for those who work on TVA projects, or who provide services to TVA, TVA requires contractors to abide by, and to treat its employees in accordance with all applicable federal, state, and local laws, regulations, ordinances, judicial or administrative decisions or injunctions, or any other legal pronouncements having the force or effect of law. Contractors are required to be OSHA-compliant and comply with their submitted safety program. Additionally, TVA establishes internal goals to support Small, Minority Owned, and Woman Owned (SMWO) businesses as well as local (“Valley”) businesses. As of November 2017, three-fourths of the businesses that currently have contracts for TVA transmission ROW vegetation control are SMWO Businesses and over one-half of TVA’s transmission ROW contractors are also “Valley” businesses.

The manual removal of vegetation would have little to no social or economic impacts due to the short duration and localized nature of the activity. However, the transient workforce associated with the program would provide a short-term beneficial impact to local economies.

Mechanical cutting and trimming would have little to no social or economic impact due to the short duration and localized nature of the activity. However, the transient workforce associated with the program would provide a short-term beneficial impact to local economies.

Herbicide application methods would have little to no social or economic impact. However, the safe and proper application of these chemicals is crucial to the prevention of impacts to adjacent water resources, landscaping, and crops or timber. Herbicide application typically involves unskilled labor, and although TVA does not control who is hired by its contractors, TVA’s herbicide contractors tend to employ many migrant laborers.

Implementation of any of the vegetation control methods would have little to no social or economic impact due to the short duration and localized nature of the activity. However, the transient workforce associated with the vegetation control program would provide a short-term beneficial impact to local economies.

Methods to manage debris typically entail both manual and mechanical methods and use mulchers and chippers to reduce cut vegetation. Other heavy equipment such as excavators are used to move debris to these machines. This method would have little to no social or economic impact due to the short duration and localized nature of the activity. However, the transient workforce associated with the vegetation control program would provide a short-term beneficial impact to local economies.

Restoration measures entail the use of either manual or mechanical tools to reseed disturbed areas. This method would have little to no social or economic impact due to the short duration and localized nature of the activity. However, the transient workforce associated with the vegetation control program would provide a short-term beneficial impact to local economies.

4.22 Summary of Method Impacts

As described in each of the preceding sections each aspect of TVA’s vegetation management program (vegetation control, debris management, restoration) vary with respect to their impact to environmental resources. Table 4-24 provides a summary of impacts associated with each of the vegetation methods.

Table 4-24. Summary of Impacts Associated with Vegetation Management Methods

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
Vegetation	Potential impact on non-target vegetation; may result in benefits to some herbaceous species due to improved light penetration. Tree removal may result in conversion of forest or tree dominated communities to herbaceous communities.	May result in substantial impacts to non-target vegetation, potential and increase the spread of invasive species due to soil disturbance. Some methods may reduce adverse effects by minimizing soil disturbance. Repeated mowing may promote dense regrowth of woody stems that suppress herbaceous species.	Direct effects to targeted vegetation. Spot or localized spraying result in reduced impacts to non-target vegetation and may result in some positive effects on species composition. Broadcast and aerial application methods may have high potential for negative impacts to vegetation, including non-target vegetation.	Some methods may hinder or impede plant growth and restoration of treated areas.	Little potential to negatively affect transmission ROW vegetation because standard BMPs would dictate revegetation efforts to avoid the use of invasive weed species.
Wildlife	Lower potential for toxic inputs; less disturbing to soils; short-term noise and odor disturbance; disruptive to wildlife due to more frequent treatments; potential for localized direct injury to wildlife.	Promotes early successional habitat favorable to wildlife; less disruptive to wildlife due to less frequent treatments; short-term disturbance of wildlife; habitat alteration, impact to less mobile biota; short-term soil disturbance.	Use can create low-growing habitat beneficial to some wildlife; less disruptive to wildlife due to less frequent treatments; potential for herbicide toxicity to non-target wildlife, soil, and water.	Leaving debris can be beneficial by creating cover, nutrient recycling, and erosion control; leaving debris increases wildfire fuel load and can harbor tree diseases and pests; debris piles alter habitat; offsite debris removal involves mechanical equipment that increases wildlife disturbance and erosion.	Minor temporary impacts associated with increased erosion and potential for fuel oil leaks or spills. Impacts minimized with standard BMPs. Overall long-term benefit to habitat.

Table 4-24. Summary of Impacts Associated with Vegetation Management Methods

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
Threatened and Endangered Species[1]	TVA uses the O-SAR process to avoid and minimize impacts to federally and state-listed species that are known to occur on transmission ROWs and select methods that are least likely to negatively impact those resources.	TVA uses the O-SAR process to avoid impacts to federally and state-listed species that are known to occur on transmission ROWs and select methods that are least likely to negatively impact those resources.	Similar to Vegetation, Wildlife, and Aquatic Ecology impacts. TVA uses the O-SAR process to avoid impacts to federally and state-listed species that are known to occur on transmission ROWs and select methods that are least likely to negatively impact those resources.	TVA uses the O-SAR process to avoid impacts to federally and state-listed species that are known to occur on transmission ROWs and select methods that are least likely to negatively impact those resources.	Minor temporary impacts associated with increased erosion and potential for fuel oil leaks or spills. Impacts minimized with standard BMPs and SMZs. Overall long-term benefit to habitat.
Surface Water	Temporary, minor impacts from potential sedimentation; less impact relative to mechanical control.	Temporary, minor impacts from potential fuel/lubricant leaks and spills and sedimentation from soil-disturbing heavy equipment. Minimized through use of BMPs.	Minor potential for herbicides to reach surface waters through leaching, drift, or runoff and potential for sedimentation from heavy equipment. No significant impact expected due to BMPS, prior planning, proper implementation, and proper application of herbicides.	Excess vegetation debris in surface water may alter flows; potential fuel/lubricant leaks and spills; sedimentation from soil-disturbing heavy equipment. Impacts expected to be temporary and minor through use of BMPs.	Minor, temporary impacts from the use of soil disturbing equipment. Overall long-term benefit to water quality due to reduced erosion and sedimentation.
Aquatic Ecology	Minor potential for sedimentation; minor chance of chainsaw oil/fuel leaks/spills; likely no impacts to aquatic biota.	Minor potential for sedimentation and stream bank destabilization from soil-disturbing mechanical equipment; minor amounts of cut	Minor potential for sedimentation from equipment; minimized through the use of BMPs. Potential for herbicides to reach waterways	Minor impacts to aquatic biota as TVA manages placement of debris to avoid placement proximate to streams or other aquatic environments.	Minor potential for sedimentation from soil-disturbing equipment; minor amounts of cut debris reaching streams. Overall long-term

Table 4-24. Summary of Impacts Associated with Vegetation Management Methods

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
		debris reaching streams; minor chance of oil/fuel leaks/spills; minor potential for altered water quality and impacts to aquatic biota. Minimized through the use of BMPs.	(rarely at toxic concentrations); potential acute and chronic impacts minimized through BMPs, prior planning, proper herbicide mixtures, and advanced technology to reduce or eliminate drift during application.	Minor positive impact as large woody debris can provide fish habitat; wood chips and mulch can reduce erosion.	benefit to the aquatic environment due to reduced erosion and sedimentation.
Wetlands	Little/no impact on non-target wetland areas. Tree removal may result in conversion of wetland type and reduction in wetland function; forested wetland conversion may be considered a jurisdictional activity by wetland regulatory agencies.	Minor potential for vehicular rutting and disturbance of wetland soils. Impact minimized with the use of BMPs such as matting, low ground pressure equipment, and dry season work. Tree removal may result in conversion of wetland type and reduction in wetland function; forested wetland conversion may be considered a jurisdictional activity by wetland regulatory agencies.	Impacts to non-target wetland areas due to runoff, leach, or drift of herbicides. Conversion of forest to emergent wetland may result in reduction of wetland function.	Debris left in wetlands may be considered a regulated fill by wetland regulatory agencies due to potential for obstructing flow, altering existing contours, changing water storage, and/or conversion to upland.	Positive benefit to wetlands as restoration would prevent the spread of invasive weeds within the wetlands, promote the establishment of low-growing vegetation, and promote wildlife habitat.
Floodplains	No impact.	No significant impact; greater impact relative to manual or selective	No significant impact Impacts mitigated through the use of	Debris left in floodplains can impede the flow of water and	No impact.

Table 4-24. Summary of Impacts Associated with Vegetation Management Methods

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
		herbicide. Impacts mitigated through the use of BMPs and measures taken to comply with EO 11988 and the National Flood Insurance Program.	BMPs and measures taken to comply with EO 11988 and the National Flood Insurance Program.	create obstructions in the floodplain and floodway. Impacts mitigated through the use of BMPs and measures taken to comply with EO 11988 and the National Flood Insurance Program.	
Geology/Soils	No impact.	No impact to geology. Potential for localized soil disturbance and erosion.	No impact to geology or soils.	No impact on geology. Potential beneficial impact in erosion control.	No impact on geology. Potential beneficial impact in erosion control.
Groundwater	No impact.	Potential impact associated with contaminant release in proximity to groundwater recharge zones. Impact would be mitigated by BMPs and are anticipated to be minor.	Potential impact associated with contaminant release in proximity to groundwater recharge zones. Impact would be mitigated by BMPs and are anticipated to be minor.	Potential impact associated with contaminant release in proximity to groundwater recharge zones. Impact would be mitigated by BMPs and are anticipated to be minor.	Potential impact associated with contaminant release in proximity to groundwater recharge zones. Impact would be mitigated by BMPs and are anticipated to be minor.
Land Use and Land Ownership/ Management	No impact to land use, potential short-term disruption of character of lands. Vegetation management on state and federal lands must adhere to existing Land and Resource	No impact to land use, potential short-term disruption of character of lands. Vegetation management on state and federal lands must adhere to existing Land and Resource	No impact to land use, potential short-term disruption of character of lands. Vegetation management on state and federal lands must adhere to existing Land and Resource	No impact to land use, potential short-term disruption of character of lands. Vegetation management on state and federal lands must adhere to existing Land and Resource	No impact to land use. Vegetation management on state and federal lands must adhere to existing Land and Resource Management Plans,

Table 4-24. Summary of Impacts Associated with Vegetation Management Methods

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
	Management Plans, Special Use Permits, as well as programmatic or related agreements.	Management Plans, Special Use Permits, as well as programmatic or related agreements.	Management Plans, Special Use Permits, as well as programmatic or related agreements.	Management Plans, Special Use Permits, as well as programmatic or related agreements.	Special Use Permits, as well as programmatic or related agreements.
Prime Farmland	No impact	Localized potential for disturbance or degradation of prime farmland soils from use of mechanized equipment. Minimized using BMPs.	No impact.	No impact.	No impact.
Natural Areas, Parks, Recreation	Minor, short-term impacts from equipment noise and presence of work crews.	Minor, short-term impact from equipment noise and work crews associated with trimming. Impacts from clearing would be greater as the character of vegetation could change.	Potential impacts from noise and odors from application of selective targeting herbicides. Minor beneficial impact associated with erosion protection, enhanced wildlife food and cover, and greater diversity. Greater minor, temporary impact from aerial application indiscriminate treatment of vegetation.	Minor impacts from large debris left in place as it could interfere with recreation activities. Short-term impacts from burning due to presence of smoke and work crews.	Minor temporary impact associated with increased pedestrian traffic and noise. Long-term benefit due to enhancement of Natural Areas.
Cultural	No impact on subsurface cultural deposits when cutting methods are employed. Pulling methods have the potential to disturb	If machinery causes soil disturbance, subsurface cultural deposits could be affected. Impacts would be minimized through	No impact to subsurface cultural deposits.	No impact to subsurface deposits.	No impact to subsurface deposits.

Table 4-24. Summary of Impacts Associated with Vegetation Management Methods

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
	cultural deposits depending on size of plant and root ball. Caution should be used when cutting or pulling near aboveground historic remains (i.e. foundations, cemeteries) and sacred sites.	adherence to BMPs and Section 106 program alternatives, such as the PA, where applicable. Activities that would have the potential to effect historic properties would require Section 106 review on an individual basis.			
Visual Resources	Pruned trees and shrubs, exposed stumps, and the resulting debris may seem unsightly to some viewers.	Can leave swaths of disturbed areas that can contrast with surrounding vegetation.	Areas of browned vegetation can be unsightly. However, the impact would be temporary as vegetation would eventually reestablish.	Felled logs and scattered branches can contrast with the surrounding landscape; stacking as windrows can reduce the unkempt look. Mulching and chipping can improve the visual landscape by covering bare earth with woodchips.	Minor, temporary visual discord due to the presence of additional personnel and equipment. Long-term improvement aesthetic condition.
Public and Worker Health & Safety	Minimal impact on public safety, minor potential for worker safety in conjunction with type and frequency of tool use and environmental conditions.	Minor potential for public safety issues, improved worker safety in proportion to treated area.	Low potential for public exposure to herbicides; selectively higher risk to workers based on herbicide active ingredient, tool use, and environmental conditions. Potential adverse effects mitigated and minimized by training,	Debris left in place has potential implications on worker safety. Burning has potential minor localized effects on public and worker health and safety.	Additional workforce increases short-term safety risk. Long-term increase in worker safety through development of a plant community that is compatible to ROW management.

Table 4-24. Summary of Impacts Associated with Vegetation Management Methods

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
			safety equipment, and adherence to labeling guidelines.		
Solid and Hazardous Waste	Low impact. Minor generation of waste oil/fluids from maintenance of equipment.	Maintenance on equipment generates waste oils/fluids. Potential spills/releases of fuel/fluids. Generation of waste containers.	Potential accidental releases/spills. Generation of waste containers for herbicides.	Low impact related to use of mechanized equipment. Reduction in solid waste when debris is left to compost.	Low impact related to use of mechanized equipment.
Transportation	Little to no impact.	No impact with side-wall trimming (from air). Minor traffic volume generated by construction workforce.	No impact with aerial spraying of herbicides. Minor traffic volume generated by construction workforce.	Short-term increase in traffic volumes due to additional haul trucks needed for debris transport. No impact when debris is managed on site.	Minor traffic volume generated by construction workforce.
Air Quality and Climate Change	No impact to overall air quality; mobilization of work crews to and from project sites represents a negligible increase in roadway traffic.	No impact to overall air quality; mobilization of work crews to and from project sites, represents minimal localized and temporary emissions from combustion engines.	No impact to overall air quality; in addition to crew mobilization, minor impacts may be from mechanical methods and airborne herbicide constituents.	Chipping, mulching, etc. would have impacts similar to manual control methods; pile burning would produce local smoke and particulate emissions; overall minor impacts to air quality would be temporary and local.	No impact to overall air quality; in addition to crew transport-related impacts minimal localized and temporary emissions from combustion engines.
Noise	Loud intermittent and short-term noise from use of chainsaws.	Loud intermittent and short-term increase in noise from transport of equipment and crews and use of chainsaws	Limited and minor noise from crews on foot. Loud intermittent noise from aerial	Loud noise from transport of equipment and crews and use of heavy mulchers and	Intermittent and short-term increase in noise from transport of equipment and crews and use of chainsaw

Table 4-24. Summary of Impacts Associated with Vegetation Management Methods

Resource	Manual	Mechanical	Herbicides	Debris Management	Restoration
		and mechanized equipment.	spraying.	chippers.	and mechanized equipment.
Socioeconomics and Environmental Justice	Minor short-term impact to local economies due to increased workforce.	Minor short-term impact to local economies due to increased workforce.	Minor short-term impact to local economies due to increased workforce.	Minor short-term impact to local economies due to increased workforce.	Minor short-term impact to local economies due to increased workforce.

4.23 Environmental Consequences of Management Alternatives

4.23.1 Alternative A: No Action Alternative

Under the No Action Alternative there would be no change to the current process by which TVA manages vegetation along the transmission line ROW. Floor work typically would continue on a recurring three-year cycle across the entire 238,000-acre ROW system and would result in plant communities of variable composition that are managed in a low height existing condition. Due to the Sherwood v. TVA litigation, TVA has stopped removing woody vegetation in the buffer zone (except for trees that are an immediate hazard). As a result, buffer zones within the existing ROW continue to contain vegetation incompatible with TVA's transmission system. The volume of non-compatible woody vegetation is also increasing within the previously-cleared ROWs due to the court injunction order.

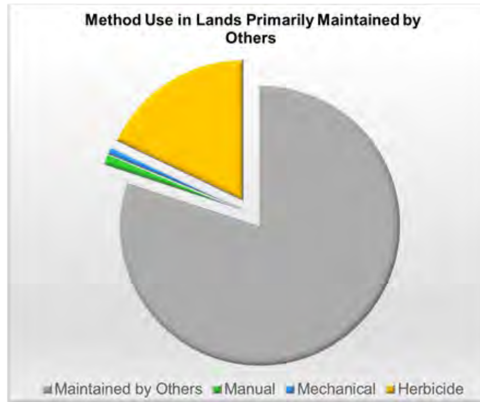
As part of this alternative TVA must leave existing trees in the maintained area of the transmission ROW so long as they do not pose an immediate hazard to the transmission lines. TVA may remove or trim any trees in the maintained area of the transmission ROW, or in the non-maintained areas of the transmission ROW, or any danger tree outside the ROW, in accordance with its contract rights, that it deems to present an immediate hazard to its transmission lines. No removal of woody vegetation or trees that either remained or have redeveloped within the transmission ROW since the initial construction period would be conducted.

As a result of the regular cycle of floor work under this alternative, vegetation would be controlled using a range of techniques. Plant communities within the transmission ROW would be maintained in the existing condition and the larger expanses of lands that may be subject to vegetation removal under other alternatives would remain forested. Woody vegetation would establish within the existing maintained transmission ROW by either sprouting from existing root stocks or by germination and growth of propagules that are dispersed to the corridor from seed sources. Because TVA utilizes an IVM approach to manage vegetation on a site-specific basis, some localized impacts may be expected to result from the selection and application of methods of each tool as described for each of the resources described in the preceding sections. However, impacts of this alternative within a broader context (Sector or Study Area) can be evaluated in consideration of:

- The frequency and context of tool application.
- TVA's O-SAR methodology (Appendix F) for identification of sensitive resources that represent a BMP-approach to guiding vegetation management methods and minimizing environmental impacts.
- PAs and related agreements with other agencies including USFWS, USFS, NPS, and SHPOs.
- Long-term cost effectiveness.
- Effect on system reliability and safety.
- Assessment approach.

Within lands actively managed and maintained by TVA, herbicide methods would be the primary tools used to maintain the floor in its existing condition. For large public lands (NPS, USFS, etc.) methods would be subject to the terms of any special agreements and authorizations with each agency. Tree removal would be the focus of vegetation management within buffer zones along the edges of the transmission ROW where such trees present an immediate hazard to the transmission system. Mechanical and manual methods would be used as the primary tools for controlling or removing such incompatible woody vegetation including trees in the maintained area or in the non-maintained areas of the transmission ROW, or any danger tree that is outside the ROW.

Within lands primarily maintained by others but managed by TVA, it is expected that the approximately 80 percent of floor and buffer areas would be maintained by others using mechanical or manual methods. TVA would perform limited treatments of fence rows, towers, and other areas using primarily herbicide techniques. Additionally, TVA would use mechanical and manual methods as the primary tools for controlling or removing incompatible woody vegetation including trees in the maintained area or in the non-maintained areas of the transmission ROW, or any danger tree outside the ROW.



Method Use in Lands Primarily Maintained by Others

As such, direct impacts to herbaceous plant communities vegetation with this and all other alternatives would continue to exert a recurring impact on plants within the ROW. Such effects would include crushing, damaging, accidental treatment or removal of both target and non-target vegetation. However, because this is part of an existing management program it would not result in in widespread alteration of the overall plant community. Therefore, overall impacts to vegetation are considered to be moderate as the routine maintenance of vegetation would periodically impact plant communities across the broader transmission system, but they would not destabilize the general plant communities of the study area.

Other potential natural resource impacts of this repeated disturbance within the transmission ROW include the following:

- Limited disturbance and erosion of soils resulting from vegetation removal, traffic of maintenance equipment, and localized manual clearing activities.
- Potential for small, localized and short-term alteration of water quality from runoff including residual herbicides and sedimentation through erosion from disturbed surfaces are mitigated by use of O-SAR process and adherence to BMPs.
- Potential for small, localized and short-term effects on aquatic biota are minimized are mitigated by use of O-SAR process and adherence to BMPs to absence of measurable effects.
- Potential removal of bat roost trees.
- Potential inadvertent spraying or damage to listed or sensitive plant species and communities.
- Disturbance and displacement of wildlife (disturbance or removal of habitats).

- Expanded floor area managed in long-term as end-state consisting of low height condition that may be expected to have reduced wildlife value.
- Potential for generation of woody debris that may impede or alter flood flows.

However, sound planning and the incorporation of TVA's O-SAR process as a BMP measure and the incorporation of other established TVA transmission ROW Management BMPs (TVA 2017a) and established transmission-related environmental protection practices (Appendix E) would minimize the effects to resources (Appendix I and J) from this alternative. Each of the above effects would be localized and short-term disturbances that are not expected to result in notable or destabilizing effects on any of the above resources. As such, impacts from this alternative on the natural environment are minor.

Impacts on factors related to the human environment (land use, socioeconomics, air, noise, cultural resources, solid/hazardous waste, public and worker safety, etc.) and landowners/managers (residential, recreational, agricultural, commercial, industrial, NPS, USFS, city, county, and state) specific to this management approach would occur as a result of the repetitive and intensive maintenance disturbance on the transmission ROW. Periodic recurring vegetation control of the floor would be conducted in conjunction with other vegetation management actions within buffer zones and along the edges of the transmission ROW where danger trees may represent a risk to reliability and safety. The potential impacts of this repeated disturbance within the transmission ROW to elements of the human environment include the following:

- Periodic presence of work crews on private and public lands within project areas.
- Transient movement of equipment and work crews on the associated roadway network.
- Localized air, greenhouse gas (GHG) and noise emissions from equipment operated within the transmission ROW.
- Visual intrusion of workers and equipment.
- Disturbance of cultural resource sites.
- Periodic intrusions into the immediate viewshed of sacred sites.
- Management of debris.
- Need for access, and local coordination efforts with affected landowners.
- Exposure of the public and workers to herbicides and other safety hazards.

Each of the above effects would be localized and short-term and are not expected to result in notable or destabilizing effects on any of the above resources. Additionally, impacts to cultural, historic and TCPs would be minimized by sound planning and the incorporation of mitigation measures such as TVA transmission ROW Management BMPs (TVA 2017a). They also may be minimized by adhering to any conditions or program alternative established in the Section 106 process. As such, impacts from this alternative on the elements of the human environment are minor.

Under this alternative, vegetation maintenance activities within transmission ROWs would continue within the safety-conscious culture in accordance with applicable standards or specific TVA guidance. TVA would continue to address and manage reduction or elimination of public and worker safety hazards through implementation of safety practices, training and control measures. Debris and wastes generated in conjunction with vegetation management would be managed in accordance with federal, state, and local requirements.

Worker and public health and safety during vegetation management operations including material transportation would be maintained, and impacts to public health and safety would, in general, be minor. However, under this alternative, TVA would continue to allow homeowners to maintain trees within and along the transmission ROW. As such, this alternative represents a greater safety risk to homeowners.

Under this alternative, initial removal of trees would not be conducted, reducing equipment operations and manpower requirements in comparison to the other alternatives over the first eight years. Additionally, less floor work would be required in the future for approximately 8,094 acres of land that would be maintained under Alternatives B, C and D. Alternative A seemingly reduces risk to workers due to the less initial work required and fewer lands maintained compared to other alternatives; however, this alternative would increase overall worker safety concerns due to the risk of serious injuries and fatalities associated with the increased need to undertake manual removal of large trees as they become immediate hazards. Overall implementation of this alternative would not have an impact on public health and safety.

Cost of this alternative would be less than other alternatives in the short-term as this alternative would not entail the initial woody vegetation removal included in the other alternatives. However, the increasing cost associated with management of danger trees using LIDAR and other methods with this alternative would increase annual costs relative to other alternatives in subsequent years. As such the NPV (2018 costs) of this alternative for a 20-year period is estimated to be approximately $205 Million.

4.23.2 Alternative B: Cyclical-Based Control Strategy

Under Alternative B the full extent of the transmission ROW subject to TVA maintenance would be cleared or treated on a recurring cycle (typically every 3 years) to ensure that vegetation would not threaten the transmission system until the next cycle of treatment. Under this alternative initial removal of woody vegetation (8,094 acres) would be conducted in the first eight years to remove trees that either remained or had regrown within the transmission ROW since the line's initial construction. All areas within the transmission ROW thereafter would be managed as floor. Along the edge of the transmission ROW, all danger trees would be removed using a combination of mechanical or manual methods depending on the specific site condition. Incompatible vegetation would be determined by inspectors in the field.

Vegetation within the floor of the transmission ROW would be controlled using a mix of approximately 90 percent herbicide, 6 percent mechanical and 4 percent manual methods. TVA maintenance activities of the floor on lands primarily maintained by others would be focused on fence rows, towers, and other features using the same mix of methods. Under this alternative floor vegetation would be maintained at a low height. Because this management approach would be cyclical and would maintain the floor at a low height condition, it would not result in a meadow-like end-state that is composed of both low-growing herbaceous and shrub-scrub species that naturally provide for safe and reliable operation of the transmission system.

Vegetation control methods and the proportion of use are expected to be similar to Alternative A for all floor areas and edges of the transmission ROW or any danger tree outside the ROW including on lands primarily maintained by others. However, under this alternative the initial removal of overgrown transmission ROW would consist of a greater use of mechanical methods. Additionally, debris management activities would be substantially greater than those under Alternative A for the initial eight-year period of buffer vegetation removal. Thereafter, the proportion of method use is expected to be the same for floor, edge and danger tree management as described for Alternative A.

This alternative would continue to exert recurring, direct impacts to herbaceous plant communities within the ROW that are similar to Alternative A. Additionally, this alternative would impact more forest resources in conjunction with initial woody vegetation removal to the full width of the existing ROW. However, because initial vegetation removal would be conducted within the buffer zone of the previously established ROW, the overall effect of this alternative on vegetation is considered to be moderate. Both the routine maintenance of vegetation and initial removal of the existing buffer zones would not destabilize the general plant communities within the study area.

Other potential natural resource impacts of this alternative are similar to those of Alternative A, but would include additional potential impacts in conjunction with initial woody vegetation removal and repeated disturbance of the ROW. These potential impacts include the following:

- Long-term habitat loss and displacement of wildlife associated with initial woody vegetation removal.
- Long-term impacts to bat roost trees and foraging habitat associated with initial woody vegetation removal.
- Repeated disturbance and minor erosion of soils resulting from vegetation removal, traffic of maintenance equipment, and localized manual clearing activities.
- Minor alteration of water quality from runoff including residual herbicides and sedimentation through erosion from disturbed surfaces.
- Increased effects on wetlands from soil compaction, rutting, and long-term alteration of wetland type (forested to emergent) resulting in reduced functional value.
- Localized minor effects on aquatic biota in conjunction with sedimentation and habitat alteration.
- Expanded floor area managed in long-term as end-state consisting of low height condition that may be expected to have reduced wildlife value.
- Increased visual disruption of the landscape.
- Potential damage to listed or sensitive plant species and communities.
- Minor increased potential for large woody debris that may impede or alter flood flows.

However, sound planning and the incorporation of TVA's O-SAR process as a BMP measure and the incorporation of other established TVA transmission ROW Management BMPs (TVA 2017a) and established transmission-related environmental protection practices would minimize the effects to resources from this alternative. The above effects include both short-term disturbances and long-term impacts. Habitat alteration associated with initial woody vegetation removal is notably greater than under Alternative A and considered to be notable, but it should not destabilize associated resources. Therefore, impacts to wildlife and forested land cover are considered to be moderate under this alternative.

Associated loss of forested lands would also result in a corresponding reduction in the capacity to sequester GHGs. TVA has adopted a climate adaptation plan that establishes adaptation planning goals and describes the challenges and opportunities climate change may present to its mission and operations. The goal of TVA's adaptation planning process is to ensure that TVA continues to achieve its mission and program goals and to operate in a secure, effective and efficient manner in a changing climate.

EPA's quantification tool was used to estimate the carbon sequestration that may be lost due to initial removal of forested buffers (EPA 2017d). Assuming that 8,094 acres of forested areas (the land cover with the greatest potential carbon sink) are completely cleared from the transmission ROW and forest composition and age is typical for the region, TVA estimates that the conversion of these forested lands would result in the loss approximately 8,580 metric tons of carbon sequestered in one year. The loss of carbon sequestered or stored is very small relative to the total carbon sequestered in forested areas of the study area. Overall, forest carbon sequestration in the study area has increased due to net increases in forest areas from conversion of farmland to forested areas, improved forest management, as well as higher vegetation growth productivity rates and longer growing seasons. Within the study area, it is estimated that existing forested lands (26,976,751 acres) sequester approximately 28,595,356 metric tons of carbon per year. Therefore, no impact on climate change is anticipated.

Impacts on factors related to the human environment (land use, socioeconomics, air, noise, cultural resources, solid/hazardous waste, public and worker safety, etc.) and landowners/managers (residential, recreational, agricultural, commercial, industrial, NPS, USFS, City, County, and State) specific to this management approach would be similar to that described for Alternative A except for the following associated with the initial woody vegetation removal and as a result of repeated disturbance of the floor which would encompass the entire extent of the transmission ROW. These impacts include the following:

- Increased air, GHG and noise emissions from equipment operated within the transmission ROW.
- Increased presence of work crews on private and public lands within project areas requiring vegetation removal.
- Increased transient movement of equipment and work crews on the associated roadway network.
- Greater visual intrusion of workers and equipment and visual alteration.
- Disturbance of cultural resource sites.
- Periodic intrusions into the immediate viewshed of sacred sites.
- Disposal of debris and other wastes associated with increased equipment use.
- Need for access, and local coordination efforts with affected landowners.
- Increased risk of exposure of the public and workers to safety hazards from mechanized equipment during initial woody vegetation removal.
- Increased health and safety risks associated with required maintenance of the expanded floor area.

Each of the above effects would be localized and short-term disturbances that are not expected to result in notable or destabilizing effects on any of the above resources. Additionally, impacts to cultural, historic and TCPs would be minimized by sound planning and the incorporation of mitigation measures such as TVA transmission ROW Management BMPs (TVA 2017a). They also may be minimized by adhering to any conditions or program alternative established in the Section 106 process. As such, impacts from this alternative on the elements of the human environment are minor.

Implementation of Alternative B would include customary safety standards as well as the establishment of applicable BMPs and job site safety plans that describe how job safety would be maintained. Debris and wastes generated in conjunction with vegetation management would be managed in accordance with federal, state, and local requirements. Additionally, under this alternative, TVA would not continue to allow homeowners to maintain trees within and along the transmission ROW. As such, this alternative reduces the risk to homeowners' safety. Worker and public health and safety during vegetation maintenance operations including debris transportation would be maintained, and impacts to public health and safety would be minor.

However, this alternative would represent a greater short-term safety risk to workers in conjunction with the initial removal of trees in the first eight years. In addition, this alternative entails the cyclical treatment of the entire transmission ROW to maintain the floor and would not be expected to result in a vegetative end condition that is as compatible as Alternatives C and D. As such this alternative would require additional physical on-the-ground inspection as compared to all other alternatives, and management of a greater extent of the transmission ROW as compared to Alternative A. In the long-term, this alternative may be expected to require an incrementally greater number of worker-hours and accordingly a minor increase in potential worker health and safety impacts.

As described in Chapter 3.2.2, ground inspection provides an evaluation of vegetation clearances in both its current state, as well for grow-in and fall-in threat potential where trees have the potential to fall toward the transmission line. However, ground inspection fails to account for potential changes in the vertical or horizontal positioning of the transmission line. Additionally, the quality and accuracy of ground inspection is dependent on human judgment which increases the risk of missing a higher priority threat relative to an assessment technique that incorporates LIDAR. Therefore, this alternative would result in an increased risk to safety and reliability as compared to Alternatives C and D. In contrast, transmission system safety and reliability would be incrementally greater than under Alternative A as the potential for development of incompatible vegetation within the transmission ROW would be minimized.

Cost of this alternative would be less than A, but comparable to Alternatives C and D in the short-term due to the additional costs of initial woody vegetation removal. Cost to remove danger trees under this alternative in subsequent years (beyond year eight) is approximately 50 percent less than that required for Alternative A due to initial woody vegetation removal. However, in subsequent years, this alternative would entail additional effort to maintain the entire extent of the transmission ROW as floor. This alternative would not include the use of LIDAR as an inspection technique because floor maintenance would be cyclical and height based. As such the NPV (2018 costs) of this alternative for a 20-year period is estimated to be approximately $169 Million.

4.23.3 Alternative C: Condition-Based Control Strategy – End-State Meadow-Like

Under Alternative C, TVA would implement a process of vegetation community conversion within the full extent of the actively-managed transmission ROW. This would be accomplished with an IVM approach to promote the establishment of a low-growing herbaceous plant community that is compatible with the safe and reliable operation of the transmission system. Similar to Alternative B, this alternative would entail initial removal of incompatible vegetation to the full width of the existing ROW easement over the first eight years of the program. Removal would target trees and woody vegetation that either remained or have regrown within the transmission ROW since construction. Only three percent of the total ROW (8,094 of 238,196 acres) would require initial woody vegetation removal. All areas within the transmission ROW would thereafter be managed as floor. TVA would also use an approach that is condition based for identification and removal of danger trees that would use LIDAR and other assessment techniques.

Routine vegetation maintenance would include identification and removal of vegetation within the transmission ROW that is incompatible with TVA's desired end-state condition. Within lands primarily managed by TVA, floor work would continue on an established cycle and in general, vegetation within the transmission ROW would be controlled using a mix of approximately 90 percent herbicide, 6 percent mechanical and 4 percent manual methods. The resulting end-state consisting of a mix of herbaceous and low-growing shrub species is more compatible and expected to provide improved habitat value that over time is expected to minimize intensity of floor work.

In the long-term all vegetation with the potential to interfere with the safe and reliable operation of the transmission line would be removed using combination of mechanical or manual methods depending on the specific site condition.

This alternative would continue to exert recurring, direct impacts on herbaceous plant communities within the ROW similar to Alternative B. However, under this alternative the plant community would develop into a meadow-like end-state that is more compatible with the safe and reliable operation of the transmission system and of higher quality than Alternative B. Overall impacts of this alternative would be moderate, but marginally better than Alternative B.

Other potential natural resource impacts of this alternative are similar to those of Alternative B but would include the following additional potential impacts:

- Relatively increased long-term habitat quality associated with ROW floor end-state.
- Potential for reduced frequency of vegetative controls in localized areas of the transmission ROW that are established by inherently more compatible herbaceous and shrub communities.
- Potential for increased habitat and support for pollinator species.
- Potential for recruitment of sensitive herbaceous plant species within suitable areas of the transmission ROW.

Alternative C provides benefits relative to Alternative B in terms of habitat quality and management intensity based on differences in the end-state. The effects of Alternative C include both short-term and long-term impacts as described for Alternative B. Sound planning and the incorporation of TVA's O-SAR process, BMP measures, and adhering to any conditions or program alternatives established in the Section 106 process would also be similar to those described for Alternative B. However, habitat alteration of initial woody vegetation removal would be notable but not destabilizing of the associated resources under Alternative C. Overall impacts to wildlife, forested land cover and related factors remain moderate under this alternative compared to other alternatives.

Impacts to the human environment (e.g., land use, socioeconomics, air, noise, cultural resources, solid/hazardous waste, public and worker safety, etc.) and landowners/managers (i.e., residential, recreational, agricultural, commercial, industrial, NPS, USFS, city, county, and state) specific to this management approach would be similar to those described for Alternative B.

Under Alternative C there would be greater coordination and interaction with local landowners to identify compatible vegetation. TVA would work with local property owners to evaluate the compatibility of vegetation within or near the transmission ROW. Vegetation compatible with the safe and reliable operation of the transmission system may be allowed to remain within the ROW. Thus, this alternative is expected to increase landowner satisfaction relative to Alternative B.

Alternative C would entail implementation of customary industrial safety standards as well as the establishment of applicable BMPs and job site safety plans that describe how job safety would be maintained. Debris and wastes generated in conjunction with vegetation maintenance under this alternative would be similar to that described for Alternative B. Under this alternative however, it is expected that the resulting end-state would be inherently be more compatible with electricity transmission than that resulting under Alternative B. This alternative would also incorporate remote techniques such as LIDAR to assess conditions and determine needs for additional management (especially danger tree removal). As such, this alternative would require an incrementally lower number of worker-hours as compared to Alternative B. Therefore, worker and public health and safety during vegetation maintenance operations including debris transportation would be maintained and impacts to public health and safety would be minor.

Like Alternative B, TVA would not allow homeowners to maintain incompatible vegetation within and along the transmission ROW, therefore this alternative reduces the risk to homeowners' safety.

The condition based assessment approach that TVA would utilize to identify and remove incompatible vegetation would incorporate LIDAR and other assessment techniques which would enhance safety and reliability relative to Alternative A and B.

Cost of this alternative would be less than Alternative A, and somewhat more than Alternative B. Similar to Alternative B, this alternative includes the additional costs of initial woody vegetation removal and the additional effort to maintain the entire transmission ROW as floor. Although, under this alternative, vegetation management would utilize an assessment-based targeted approach that creates the potential for reduced frequency and extent of maintenance in the long-term. Costs associated with management of the transmission ROW are estimated to be the same as Alternative B; however, TVA would still be responsible for managing all areas of the transmission ROW on a cyclical basis and there is additional cost with this alternative relative to Alternative B due to the use of LIDAR as an inspection technique, which would improve the safety and reliability of the transmission system. As such the NPV (2018 costs) of this alternative (Alternative C) for a 20-year period is estimated to be approximately $180 Million.

4.23.4 Alternative D: Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone

Under Alternative D, TVA would manage vegetation in the transmission ROW using a wire zone/border zone approach. Alternative D would entail the use of a condition-based assessment approach to managing and maintaining transmission ROW vegetation and is therefore similar to Alternatives C. This alternative was formulated based upon input during the scoping process. As with Alternative C, TVA would implement a process of vegetation community conversion within the ROW wire zone using an IVM approach to promote the establishment of a low-growing herbaceous plant community dominated by low-growing compatible herbaceous and shrub-scrub species that is compatible with the safe and reliable operation of the transmission system. However, under Alternative D, the buffer zone would be allowed to redevelop with compatible species of shrubs and trees. The goal of this management alternative is to promote a soft or "feathered" edge which could be used to provide a transition from forested habitat into the meadow-like habitat of the wire zone.

Routine vegetation maintenance would include identification and removal of vegetation within the transmission ROW that are incompatible with TVA’s desired end-state condition. Within lands primarily managed by TVA, floor work would continue on an established cycle and in general, vegetation within the transmission ROW would be controlled using a mix of approximately 90 percent herbicide, 6 percent mechanical and 4 percent manual methods. Vegetation within the border zone would generally be controlled using a mix of 70 percent herbicide and 30 percent manual methods based on specific site conditions.

All danger trees would be removed using a combination of mechanical or manual methods depending on the specific site conditions.

This alternative would continue to exert a recurring impact on herbaceous plant communities within the ROW similar to Alternative C. However, under this alternative the buffer zone would be allowed to redevelop with compatible species of shrubs and trees. Overall, impacts of this alternative would remain moderate.

Other potential natural resource impacts of this alternative are similar to those of Alternative C but would include the following additional potential impacts in conjunction with the proposed management of the border zones:

- Relatively increased long-term habitat quality associated with border zone regrowth consisting of compatible herb, shrub and tree species.
- Potential for increased habitat and support for pollinator and wildlife species.

Potential for recruitment of sensitive herbaceous plant species within suitable areas of the transmission ROW.

The effects of Alternative D include both short-term and long-term impacts as described for Alternative C. Sound planning and the incorporation of TVA’s O-SAR process, other BMP measures, and adhering to any conditions or program alternatives established in the Section 106 process would also be similar. This alternative provides greater benefits for selective wildlife species relative to Alternative C in terms of habitat quality in the end-state. However, because habitat alteration associated with initial woody vegetation removal would be notable, but not destabilizing of the associated resources, impacts to wildlife, forested land cover and related factors would be moderate under this alternative.

Impacts on the human environment (e.g., land use, socioeconomics, air, noise, cultural resources, solid/hazardous waste, public and worker safety, etc.) and landowners/managers (i.e., residential, recreational, agricultural, commercial, industrial, NPS, USFS, city, county, and state) specific to this management approach would be similar to those described for Alternative C. Additionally, as described for Alternative C, Alternative

D would result in greater coordination and interaction with local landowners to identify vegetation that is compatible with the safe and reliable operation of the transmission system.

Implementation of customary industrial safety standards as well as the establishment of applicable BMPs and job site safety plans that describe how job safety would be maintained would be similar to that described for Alternative B. Under this alternative however, management of the resulting end-state to a condition that includes a greater percentage of compatible shrubs and trees in the border zone would require additional staff (botanists) to accompany each work crew to assess condition and prescribe selective treatment based on compatible species composition. As such, this alternative would require an incrementally greater number of worker-hours as compared to the other alternatives. Nonetheless, worker and public health and safety during vegetation management operations including material transportation would be maintained, and impacts to public health and safety would be minor.

Like Alternative B, TVA would not allow homeowners to maintain incompatible vegetation within and along the transmission ROW and as such this alternative reduces the risk to homeowners' safety.

The condition based assessment approach that TVA would utilize to identify and remove danger trees would incorporate LIDAR and other assessment techniques which would enhance safety and reliability relative to Alternative A and B.

The cost of this alternative would be greater than any other alternative. Similar to Alternatives B and C, this alternative includes the additional costs of initial woody vegetation removal. Under this alternative management of the floor is intended to result in a meadow-like condition similar to Alternative C. Notably however, this alternative would allow for the development of a compatible border zone in which herbs, shrubs and compatible trees are allowed to grow. Accomplishment of this end-state requires additional manpower and the inclusion of trained staff (botanists) with each crew who can direct the application of control methods to achieve the desired end-state. This alternative also includes the use of LIDAR as an inspection technique. As such the NPV (2018 costs) of this alternative for a 20-year period is estimated to be approximately $223 Million.

4.24 Cumulative Impacts

The CEQ regulations (40 CFR 1500-1508) implementing the procedural provisions of the NEPA of 1969, as amended (42 USC 4321 et seq.) define cumulative impact as:

> …the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR § 1508.7).

Baseline conditions reflect the impacts of past and present actions. The impact analyses summarized in preceding sections are based on baseline conditions and either explicitly or implicitly consider cumulative impacts.

4.24.1 Geographic Area of Analysis

The appropriate geographic area over which past, present and future actions could reasonably contribute to cumulative effects is variable and dependent on the resource evaluated. Actions related to vegetation management within the existing transmission corridors vary with respect to location and timing. However, they are unified under this cumulative effects analysis as “similar” actions. Therefore, for this programmatic level cumulative effects analysis TVA’s study area is considered to be the appropriate context for analysis of cumulative effects of TVA vegetation management for most resource areas. The TVA study area is a more than 82,000 square mile area that is inclusive of all areas where TVA maintains or could build transmission ROW.

4.24.2 Identification of “Other Actions”

TVA recognizes that many types of state, private and non-federal activities within the TVA PSA have potential to occur in the foreseeable future, and that these would have varying levels of impact on environmental resources. Such actions may include state highway maintenance and improvement projects, airport operations and expansions, rail development projects, and industrial and mining operations.

Other actions may include routine maintenance and/or improvement of public lands by state and local agencies or an influx of new companies that leads to new infrastructure.

There also could be cumulative effects that result from implementation of a TVA activity or activities that is as yet unforeseen, such as the transfer of land from TVA to another landowner. Under this situation, TVA may or may not know what is planned for the land following the transfer as such potential future development is not reasonably foreseeable. Therefore, the potential impacts cannot be incorporated into this cumulative effects assessment. Future routine operations and including vegetation maintenance activities conducted by TVA have the potential to trigger state, private and non-federal actions. Those actions cannot be identified sufficiently to take them into account in TVA’s analyses other than in the broadest sense. Therefore, for this analysis TVA considered its broader program activities within the study area, coupled with other past and ongoing vegetation maintenance activities (across all land uses) as representing the baseline conditions within the study area. As such this baseline is the predominant and appropriate context for analysis against the proposed vegetation maintenance activities. Within this defined context, TVA has identified potential future development of new transmission corridors within its PSA that are included in this cumulative effects assessment. TVA estimates that approximately 20,600 acres of new transmission ROW may be developed over the next 20 years, which would include the clearing of 1,360 acres of forest. This planning level estimate is consistent with other cumulative effects analyses that include the recent BA prepared by TVA on behalf of transmission ROW maintenance activities and their potential effects on listed bat species (see Section 1.9).

4.24.3 Analysis of Cumulative Effects

To address cumulative impacts, the existing affected environment surrounding the proposed action was considered in conjunction with the environmental impacts presented in Chapter 4. The potential for cumulative effects to each of the identified environmental resources of concern are analyzed below based on the management alternatives discussed in Chapter 4.

4.24.3.1 Alternative A: No Action

Effects to natural and human resources under this alternative would be localized and short-term and are not expected to result in notable or destabilizing effects. TVA would still develop new transmission ROW, resulting in the clearing of additional vegetation, including forests. Future transmission line development would result in additional conversion of forest or tree dominated communities to herbaceous communities. However, because TVA's transmission line ROWs are linear in nature and spread out over a large geographical area, the construction of future transmission corridors in combination with the proposed vegetation management method would contribute relatively minor impacts when viewed in the context of the study area. In addition, when considered together with other actions in the region, including farming, logging, or industrial/commercial development, vegetation maintenance activities by TVA are not considered to have significant cumulative impacts on natural resources.

4.24.3.2 Alternative B: Cyclical Based Control Strategy

Under Alternative B, the initial removal of forested transmission ROW would entail greater use of mechanical methods. Additionally, debris management and site restoration activities would be proportionally greater than those under Alternative A for the initial eight-year period. In combination with the potential forest land alteration that may occur in conjunction with future transmission line development (1,360 acres) a total forest alteration may be up to 9,454 acres. This combined forest loss accounts for less than 0.05 percent of the forest land within the study area. Cumulative effects of land cover alteration associated with this alternative are therefore minor and not notable. Therefore, after the initial clearing phase is complete, cumulative effects to vegetation as a result of ongoing transmission corridor vegetation management and actions by others within the study area are expected to be the same as those under Alternative A.

4.24.3.3 Alternative C: Condition-Based Control Strategy – End-State Meadow-Like

The maintained meadow-like state under Alternative C would result in an incremental improvement of habitat of the floor end-state over the long-term and in some locations a reduced intensity of control measures. However, in the context of other land use practices within the study area, including farming, construction, and logging activities, the incremental benefits of habitat would be negligible. When considered with other future actions within the study area, including the development of new transmission corridors, this alternative is not anticipated to have significant cumulative impacts.

4.24.3.4 Alternative D: Condition-Based Control Strategy – End-State Compatible Vegetation Variable by Zone

The effects of Alternative D include both short-term and long-term impacts as described for Alternative C. However, these alternatives provide greater benefits for selected wildlife species relative to Alternative C, in terms of habitat quality within the border zone in the end-state. However, in the context of other land use practices within the study area including farming, construction, and logging activities, the incremental benefits of habitat would be negligible. When considered with other future actions within the study area, including the development of new transmission corridors, this alternative is not anticipated to have significant cumulative impacts.

4.25 Unavoidable Adverse Impacts

Unavoidable adverse impacts are the effects of the proposed action on natural and human resources that would remain after mitigation measures or BMPs have been applied. Mitigation measures and BMPs are typically implemented to avoid, minimize or compensate for potential environmental impacts. Managing vegetation requires controlling the growth of plants within the transmission ROW which is an adverse effect. However, this action is needed to promote the safe, efficient and reliable operation of the existing transmission system. Sound planning, the incorporation of TVA's O-SAR process as a BMP measure, and the incorporation of other established TVA transmission ROW Management BMPs identified in this PEIS would reduce adverse effects associated with vegetation management practices.

Under the No Action Alternative, TVA would only continue to conduct floor work and would remove trees identified as an immediate hazard. In contrast, Alternatives B, C, and D include an initial woody vegetation removal to the full width of the transmission ROW. As such, adverse effects would be more substantial under Alternatives B, C, and D than under the No Action Alternative. Unavoidable effects of initial woody vegetation removal include habitat alteration and associated changes in wildlife use as well as wetland functional alterations where forested wetlands are converted to emergent wetlands.

Under any of the management alternatives considered, the presence of humans and noise from vegetation maintenance activities has the potential to temporarily disturb wildlife located within the transmission ROW. However, it is anticipated that wildlife would avoid areas when work is underway and TVA employs mitigation measures as described in Subsection 4.6.2.4.1 for specific animals and habitats. These adverse effects would be temporary, short-term and localized.

Additional unavoidable adverse impacts would be dependent on the specific vegetation control method selected. Although each vegetation control method creates unavoidable adverse impacts, TVA considers the environmental setting as well as cost effectiveness in its selection of control method.

With the application of appropriate BMPs and adherence to permit requirements, these unavoidable adverse effects would be minor.

4.26 Relationship of Short-Term Uses to Long-Term Productivity

NEPA requires a discussion of the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. For the purposes of this PEIS, vegetation maintenance activities including controlling vegetation within TVA transmission line ROWs are considered a short-term use of the environment. Long-term productivity relates to converting the natural productivity of the land to some developed use including transmission lines.

Under Management Alternatives B, C, and D, TVA would initially remove vegetation to the full width of the transmission ROW (except for grasses, forbs, and some small shrubs). The long-term productivity of lands within TVA transmission ROWs has already been affected by construction of the existing facilities. The use of transmission line ROWs for transmitting power precludes the use of the land for some activities (e.g., mining, timber production) and the implementation of a vegetation management program would not affect long-term productivity.

4.27 Irreversible and Irretrievable Commitments of Resources

A resource commitment is considered irreversible when impacts from its use would limit future use options and the change cannot be reversed, reclaimed, or repaired. Irreversible commitments generally occur to nonrenewable resources such as minerals or cultural resources and to those resources that are renewable only over long time spans, such as soil productivity. A resource commitment is considered irretrievable when the use or consumption of the resource is neither renewable nor recoverable for use by future generations until reclamation is successfully applied. Irretrievable commitments generally apply to the loss of production, harvest, or natural resources and are not necessarily irreversible.

Resources required by vegetation maintenance activities, including labor and fossil fuels for vehicles and equipment, would be irreversibly lost regardless of the alternative selected. However, it is unlikely that their limited use in TVA's vegetation management program would adversely affect the overall future availability of these resources.

Land and natural resources within TVA's transmission ROWs were previously committed to uses compatible with safe and reliable electric transmission at the time the transmission lines were constructed. While this commitment is considered to be long-term, it is not irretrievable as transmission lines may be decommissioned and lands re-committed to other uses. Additionally, uses of lands primarily maintained by others would be unaltered with any alternative as the productivity of croplands, orchards and other related lands would not be modified. No new transmission lines would be constructed as part of the No Action or any of the proposed action alternatives. Vegetation management would not impact potential future uses of the land should the transmission lines be removed. Therefore, no additional areas of land or natural resources would be irretrievably committed under any alternative.

Under Management Alternatives B, C, and D, initial woody vegetation removal to the full width of the transmission ROW would constitute an irretrievable short-term and long-term loss of wildlife habitat and vegetation. Until the area is successfully reclaimed through the decommissioning of a transmission line), the loss of these habitats would be an irretrievable, but not an irreversible commitment of resources.

CHAPTER 5 – LIST OF PREPARERS

5.1 NEPA Project Management

Name:	**Anita Masters (TVA)**
Education:	M.S., Biology/Fisheries; B.S., Wildlife Management
Project Role:	TVA Project Manager, TVA NEPA Coordinator, NEPA Compliance
Experience:	32 years in project management, managing and performing NEPA and ESA compliance and community/watershed biological assessments.

Name:	**Bill Elzinga (Wood)**
Education:	M.S. and B.S., Biology
Project Role:	Project Manager, NEPA Coordinator
Experience:	30 years of experience managing and performing NEPA analyses for electric utility industry, and state/federal agencies; ESA compliance; CWA evaluations.

5.2 Other Contributors

TENNESSEE VALLEY AUTHORITY

Name	**Jack Byars (TVA)**
Education:	B.S., Environmental Science and Technology, M.S., Environmental, Safety, and Health Management
Project Role:	Air Quality
Experience:	20 years in air permitting and compliance

Name:	**Adam Dattilo (TVA)**
Education:	M.S., Forestry
Project Role:	Vegetation, Threatened and Endangered Plants
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Name:	**Elizabeth B. Hamrick (TVA)**
Education:	M.S., Wildlife and B.S. Biology
Project Role:	Terrestrial Ecology (Animals), Terrestrial Threatened and Endangered Species
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Name:	**Michaelyn Harle (TVA)**
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Project Role:	Archaeologist
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Name:	**T. Hill Henry (TVA)**
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Project Role:	106 PA Facilitator; reviewer of T&E Species, Cultural Resources, Wildlife and Migratory Bird input.
Experience:	23 years of Natural Resource Law and Regulatory engagement and development of Multi-agency agreements; Certified Wildlife Biologist B.S. Wildlife Science, M.S. Zoology – Endangered Species

Name:	**Kenneth Hickerson (TVA)**
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Project Role:	Solid Waste
Experience:	31 years of experience

Name:	**Holly LeGrand (TVA)**
Education:	M.S., Wildlife; B.S., Biology
Project Role:	TVA Project Manager, TVA NEPA Coordinator; NEPA Specialist; Alignment with implementation of ESA Section 7 Programmatic Consultation for federally listed bats and routine actions
Experience:	17 years in biological and environmental studies and analysis 10 years in natural resources planning, ESA compliance, NEPA compliance and project management.

Name:	**Robert Marker (TVA)**
Education:	B.S., Outdoor Recreation Resources Management
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Name	**Craig Phillips (TVA)**
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Project Role:	Aquatic Ecology and Threatened and Endangered Species
Experience:	7 years sampling and hydrologic determination for streams and wet-weather conveyances; 5 years in environmental reviews

Name:	**Kim Pilarski-Hall (TVA)**
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Project Role:	Wetlands, Natural Areas
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Name:	**Jesse Troxler (TVA)**
Education:	M.S. and B.S., Wildlife Science
Project Role:	Threatened and Endangered Terrestrial Animals
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Name:	**Carrie Williamson, P.E., CFM (TVA)**
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Project Role:	Floodplains
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Name	**A. Chevales Williams (TVA)**
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WOOD ENVIRONMENT AND INFRASTRUCTURE SOLUTIONS, INC.

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Education:	Ph.D., Biology; M.S., Biology and B.S., Biology
Project Role:	Aquatic Ecology
Experience:	Experience developing and executing fishery studies, investigating and evaluating threatened and endangered species distribution, conducting stream evaluations using the index of biotic integrity, providing assessments of habitat quality using the qualitative habitat evaluation index, quantifying habitat use and preference of aquatic species, and assessing environmental impacts on glacial lakes and wetlands.

Name:	**Matt Basler (Wood)**
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Name:	**Karen Boulware (Wood)**
Education:	M.S., Resource Planning and B.S., Geology
Project Role:	NEPA Lead
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Name:	**Joel Budnik (Wood)**
Education:	M.S. and B.S., Wildlife and Fisheries Sciences
Project Role:	Threatened and Endangered Species, Wildlife and Vegetation
Experience:	19 years of experience in environmental planning, NEPA analysis and documentation, ecological studies, and preparation of technical documents.

Name:	**Kelvin Campbell (Wood)**
Education:	B.S., Geology, Geological Science and Hydrogeology
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Name:	**Jim Field, Ph.D., RG (Wood)**
Education:	Ph.D., Hydrogeology
Project Role	Reviewer
Experience:	27 years as a hydrogeologist, groundwater modeler, and program/project manager

Name:	**Linda Hart (Wood)**
Education:	B.S., Business/Biology
Project Role	Technical Editing
Experience:	30 years of experience in production of large environmental documents including technical editing, formatting, and assembling.

Name:	**Richard Hart (Wood)**
Education:	A.S. of Applied Science
Project Role:	Noise Analysis
Experience:	20 years of experience in Computer-Aided Design Technology, baseline noise measurements and noise modeling using the Traffic Noise Model

Name	**Wayne Ingram P.E. (Wood)**
Education	B.S., Civil Engineering and B.S., Physics
Project Role	Surface Water
Experience:	30 years of experience in surface water engineering and analysis including drainage, stormwater management, water quality assessment, erosion and sedimentation, sediment transport, wetlands hydrology, stream restoration, and stormwater detention systems

Name:	**Stephanie Miller (Wood)**
Education:	M.S., Biology and B.S., Marine Biology
Project Role:	Land Use and Prime Farmland, Visual Resources
Experience:	8 years of experience in visual assessment, land use, aquatic and terrestrial ecology
Name:	**Chris Musselman (Wood)**
Education:	M.S., Fisheries and Aquatic Ecology; B.S., Biology
Project Role:	Vegetation Management, Aquatic Ecology, Threatened and Endangered Species, NEPA
Experience:	5 years NEPA experience
Name:	**Glenn Scherer (Wood)**
Education:	M.S., Geology; B.S., Geology
Project Role:	Solid and Hazardous Waste Consultant
Experience:	26 years of experience managing various environmental projects throughout the United States
Name:	**Lana Smith (Wood)**
Education:	M.S., Biology; B.S., Environmental Biology
Project Role:	Public Health and Safety
Experience:	21 years in Health and Safety, Hazard Analysis Assessment and Health and Safety Plan development
Name:	**Steve Stumne (Wood)**
Education:	B.S., Biology
Project Role:	Vegetation, Threatened and Endangered Species, Wildlife
Experience:	Over 20 years of experience providing natural resource investigations, NEPA analysis and documentation, wetland and stream delineation/permitting/mitigation and endangered species investigations

CHAPTER 6 – PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT RECIPIENTS

Following is a list of the agencies, organizations, and persons who have received copies of the PEIS or notices of its availability with instructions on how to access the PEIS on the project web page.

6.1 Federal Agencies

USDA Forest Service, Region 8, Atlanta, GA
U.S. Environmental Protection Agency, Washington, DC
U.S. Environmental Protection Agency, Region 4, Atlanta, GA
Department of Interior, Atlanta, GA
U.S. Fish and Wildlife Service, Southeast Region Office, Atlanta, GA
U.S. Fish and Wildlife Service, Frankfort, KY
U.S. Fish and Wildlife Service, Asheville, NC
U.S. Fish and Wildlife Service, Abingdon, VA
U.S. Fish and Wildlife Service, Cookeville, TN
U.S. Fish and Wildlife Service, Gloucester, VA
U.S. Fish and Wildlife Service, Daphne, AL
U.S. Fish and Wildlife Service, Athens, GA
U.S. Army Corps of Engineers, Savannah District
U.S. Army Corps of Engineers, Nashville District
U.S. Army Corps of Engineers, Memphis District
U.S. Army Corps of Engineers, Wilmington District
U.S. Army Corps of Engineers, Vicksburg District
U.S. Army Corps of Engineers, Mobile District
Economic Development Administration, Atlanta, GA
Advisory Council on Historic Preservation

6.2 Federally Recognized Tribes

Cherokee Nation
Eastern Band of Cherokee Indians
United Keetoowah Band of Cherokee Indians in Oklahoma
The Chickasaw Nation
Muscogee (Creek) Nation of Oklahoma
Poarch Band of Creek Indians
Alabama-Coushatta Tribe of Texas
Alabama-Quassarte Tribal Town
Kialegee Tribal Town
Thlopthlocco Tribal Town
Choctaw Nation of Oklahoma
Jena Band of Choctaw
Mississippi Band of Choctaw
Seminole Tribe of Florida
Seminole Nation of Oklahoma
Absentee Shawnee Tribe of Oklahoma
Eastern Shawnee Tribe of Oklahoma
Shawnee Tribe

6.3 State Agencies

Alabama
Department of Agriculture and Industries
Department of Conservation and Natural Resources
Department of Economic and Community Affairs
Department of Environmental Management
Department of Transportation
Alabama Historic Commission
Top of Alabama Regional Council of Governments
North-Central Alabama Regional Council of Governments
Northwest Alabama Council of Local Governments

Georgia
Georgia State Clearinghouse
Historic Preservation Division

Kentucky
Department for Local Government
Department for Environmental Protection
Energy and Environment Cabinet
Department for Energy Development and Independence
Department for Natural Resources
Kentucky Heritage Council

Mississippi
Northeast Mississippi Planning and Development District
Department of Finance and Administration
Department of Environmental Quality
Department of Wildlife, Fisheries, and Parks
Historic Preservation Division

North Carolina
North Carolina State Clearinghouse
Office of Archives and History

Tennessee
Department of Environment and Conservation
Office of Policy and Planning
Tennessee Historical Commission
Tennessee Wildlife Resources Agency
First Tennessee Development District
East Tennessee Development District
Southeast Tennessee Development District
Upper Cumberland Development District
South Central Tennessee Development District
Greater Nashville Regional Council
Southwest Tennessee Development District
Memphis Area Association of Governments
Northwest Tennessee Development District

Virginia
Office of Environmental Review
Department of Historic Resources

6.4 Individuals and Organizations

Albiston, Robert and Lucinda
Arrowood, Nicole
Aviotti, Pete
Baily, Ms.
Ballin, Josie
Bass, Ann
Bates, Todd
Berryman, John
Bettice, Gerald
Blane, Dianne
Boike, Sonja
Boyd, Brandy
Brewer, John
Brown, Larry F.
Burris, Randall and Jane
Byers, Marc
Carnes, Nancy
Carroll, Jewell
Carson, Joseph
Carter, Linda
Cartor, Joyce M.
Chamberlain, Rosemary
Chanslow, Gene
Chapman, Larry and Barbara
Chesney, Karen
Clayton, Skip
Cook, Barbara
Cook, Denise
Cotton, Douglas
Crone, Saj (Sierra Club)
Crossno, Jerry and Ellalyn
Crowe, Nick and Mary Ann
Dailey, Brian
Dalrymple, Christine
Daniels, Raymond
DeLauder, Caprice
Dilley, Al
Dodson, Don
Drewly, Dean
Eklund, Len and Donna
Eldridge, John E.
Ellis, Lisa E.
Eskew, Tate A.
Essner, Joel
Eubanks, Phil
Evans, Cornelia and William
Feathers, Susan (Sierra Club)
Forman, Carol
Foster-Allen, Terry
Fraser, Kathryn

Freeman, Kathryn K.
Gibbons, Beverly
Goss, Sandra (Tennessee Citizens for Wilderness Planning)
Greene, Alice
Greenman, Mark
Gregory, Brian
Halcomb, Ethan
Hargis, Paula
Hart, Victor
Hembree, Julie
Hillon, Don
Hobson, Leonard
Holland, Richard
Howard, David
Hulley, Nancy
Huston, Willie
Hylton, Josie K.
Ingle, LaQuita
Jones, Carey
Jordon, Jeff
Kirk, Albert
Larrabee, Alan
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Lofaro, Michael A. and Nancy
Loughery, Richard
Lousep
MacGillivray, Bill
MacKinnon, Page
Marion, Sandra
Massingale, Lynn
May, Amanda
Mccoy, Curtis
McDonald, Kevin
McMekin, James W.
McPeters, Mary Ann
McVeigh, Marilyn
Moss, Sarah Rimer
Oakbreag, Frank
Ogle, Mary
Panodie, Marilyn
Patten, Andrea
Pennebaker, Pat
Peterson, Thea
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Presnell, Janice Ellen
Priestley, Mary
Ray, Jane
Raymond, Ed
Raymond, Sherrie
Renier, Carolyn
Revora, Dave

Ringe, Axel C. (Tennessee Chapter of the Sierra Club)
Rogers, William Henry
Runyan, Tom
Russell, Helen
Sanders, Michael W.
Sargent, Jennifer
Scott, Karen
Sevotti, Michael
Shaffer, Frank
Shepherd, Paul
Silverstein, Larry
Slavin, Robert Jeff
Sloves, Felicitas
Sloves, Harold
Smith, Kim
Smith, Martha Jo
Spratley, Carolyn
Stanley, B.J.
Stephens, Mark
Stone, Kay
Stouder, Richard
Strobush, Carol
Swann, Trenta and Roy
Tabler, Michael
Taylor, Bryan
Thompson, Katherine
Tipton, Fredda
Townsend, Akisha
Turner, Amy
Turner, Leslie
Vanelli, Ruth
Vaughn, James
Vinson, David
Vowell, Donald (Attorney for the Plaintiffs in *Sherwood, et al. v. TVA*)
Weber, Melinda G
Weeks, Sarah
Westbrook Jr., John E.
Wetzel, Chris
Wilder, Johnny
Wilkerson, Bill
Wilkerson, John
Williams, Gerry M.
Williams, Mark W.
Williams, Richard E.
Wooten, Margaret
Wright, Avery Taylor
Ziemer, Becky

CHAPTER 7 – LITERATURE CITED

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