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GROUNDWATER CORRECTIVE ACTION
DRAFT PROGRAMMATIC ENVIRONMENTAL ASSESSMENT

Tennessee Valley, Tennessee

PEAX-455-00-000-1749653532

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Symbols, Acronyms, and Abbreviations

ADEM	Alabama Department of Environmental Management
ALF	Allen Fossil Plant
APE	Area of Potential Effect
BCC	Birds of Conservation Concern
BGEPA	Bald and Golden Eagle Protection Act
BMP	best management practice
BRF	Bull Run Fossil Plant
CAA	Clean Air Act
CBMPP	Construction Best Management Practices Plans
CCR	coal combustion residuals
CFR	Code of Federal Regulations
COF	Colbert Fossil Plant
COI	Constituent of Interest
CUF	Cumberland Fossil Plant
CWA	Clean Water Act
dBA	A-weighted decibels
DEP	Department for Environmental Protection
EIST	Enhanced In Situ Treatment
EO	Executive Order
ESA	Endangered Species Act
ETSZ	East Tennessee Seismic Zone
FEMA	Federal Emergency Management Agency
GAF	Gallatin Fossil Plant
GHG	greenhouse gas
gpm	gallons per minute
GWPS	groundwater protection standard
HUC	Hydrologic Unit Code
IPaC	Information for Planning and Consultation
JOF	Johnsonville Fossil Plant
JSF	John Sevier Fossil Plant
KIF	Kingston Fossil Plant
MBTA	Migratory Bird Treaty Act
MGD	million gallons per day
MLRA	major land resource areas
MNA	Monitored Natural Attenuation
MOA	memorandum of agreement
NAAQS	National Ambient Air Quality Standard
NEPA	National Environmental Policy Act
NMSZ	New Madrid Seismic Zone
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
OSHA	Occupational Safety and Health Administration
PAF	Paradise Fossil Plant
PCB	polychlorinated biphenyl
PEA	programmatic environmental assessment

PGA	peak ground acceleration
PRB	Permeable Reactive Barrier
PSA	Power Service Area
RCRA	Resource Conservation and Recovery Act
ROI	radius of influence
SHF	Shawnee Fossil Plant
SHPO	State Historic Preservation Office
SMS	Scenery Management System
SSA	sole source aquifer
SWPPP	Stormwater Pollution Prevention Plan
TDEC	Tennessee Department of Environment and Conservation
TMDL	total maximum daily load
TVA	Tennessee Valley Authority
U.S.	United States
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WBF	Watts Bar Fossil Plant
WCF	Widows Creek Fossil Plant
WVSZ	Wabash Valley Seismic Zone

CHAPTER 1 – PURPOSE OF AND NEED FOR THE PROPOSED ACTION

1.1 Introduction

The Tennessee Valley Authority (TVA) is evaluating groundwater corrective actions at one or more TVA properties within the TVA Power Service Area (PSA) with the preparation of a Programmatic Environmental Assessment (PEA), pursuant to the National Environmental Policy Act (NEPA). This PEA will programmatically assess the effects of corrective actions designed to address exceedances of federal groundwater protection standards (40 Code of Federal Regulations [CFR] Part 257, Appendix IV) at various sites. As part of this programmatic assessment, TVA has developed new guidance, including an Environmental Screening Checklist and a bounding analysis, that complies with NEPA's procedural requirements, up to and including potential site-specific considerations of groundwater corrective actions at one or more of these TVA properties. The programmatic approach would allow TVA to adequately cover most of the site-specific activities that could occur, including the alternatives discussed in Chapter 2. TVA would consider this guidance, including recommended environmental practices and mitigation measures, in its decision-making processes.

TVA's PSA covers 80,000 square miles in the southeastern United States, including almost all of Tennessee and parts of Mississippi, Kentucky, Alabama, Georgia, North Carolina, and Virginia (**Table 1-1**). TVA has twelve (12) properties which may require groundwater corrective actions in Alabama, Kentucky, and Tennessee. The 12 TVA properties, considered in this PEA, include: Allen Fossil Plant (ALF), Bull Run Fossil Plant (BRF), Colbert Fossil Plant (COF), Cumberland Fossil Plant (CUF), Gallatin Fossil Plant (GAF), John Sevier Fossil Plant (JSF), Johnsonville Fossil Plant (JOF), Kingston Fossil Plant (KIF), Paradise Fossil Plant (PAF), Shawnee Fossil Plant (SHF), Watts Bar Fossil Plant (WBF), and Widows Creek Fossil Plant (WCF) (**Figure 1-1; Table 1-1**). Aerial Figures for each TVA property are available in Appendix A.

Table 1-1. TVA Properties Proposed for Groundwater Corrective Actions

TVA Property Name	Code	Location	Status	Acreage
Allen Fossil Plant	ALF	Shelby County, Tennessee	Closed	502
Bull Run Fossil Plant	BRF	Anderson County, Tennessee	Closed	1,001
Colbert Fossil Plant	COF	Colbert County, Alabama	Closed	1,640
Cumberland Fossil Plant	CUF	Stewart County, Tennessee	Operating	2,552
Gallatin Fossil Plant	GAF	Sumner County, Tennessee	Operating	1,725
John Sevier Fossil Plant	JSF	Hawkins County, Tennessee	Closed	1,115
Johnsonville Fossil Plant	JOF	Humphreys County, Tennessee	Closed	706
Kingston Fossil Plant	KIF	Roane County, Tennessee	Operating	861
Paradise Fossil Plant	PAF	Muhlenberg County, Kentucky	Closed	3433
Shawnee Fossil Plant	SHF	McCracken County, Kentucky	Operating	2610
Watts Bar Fossil Plant	WBF	Rhea County, Tennessee	Closed	299
Widows Creek Fossil Plant	WCF	Jackson County, Alabama	Closed	1,835

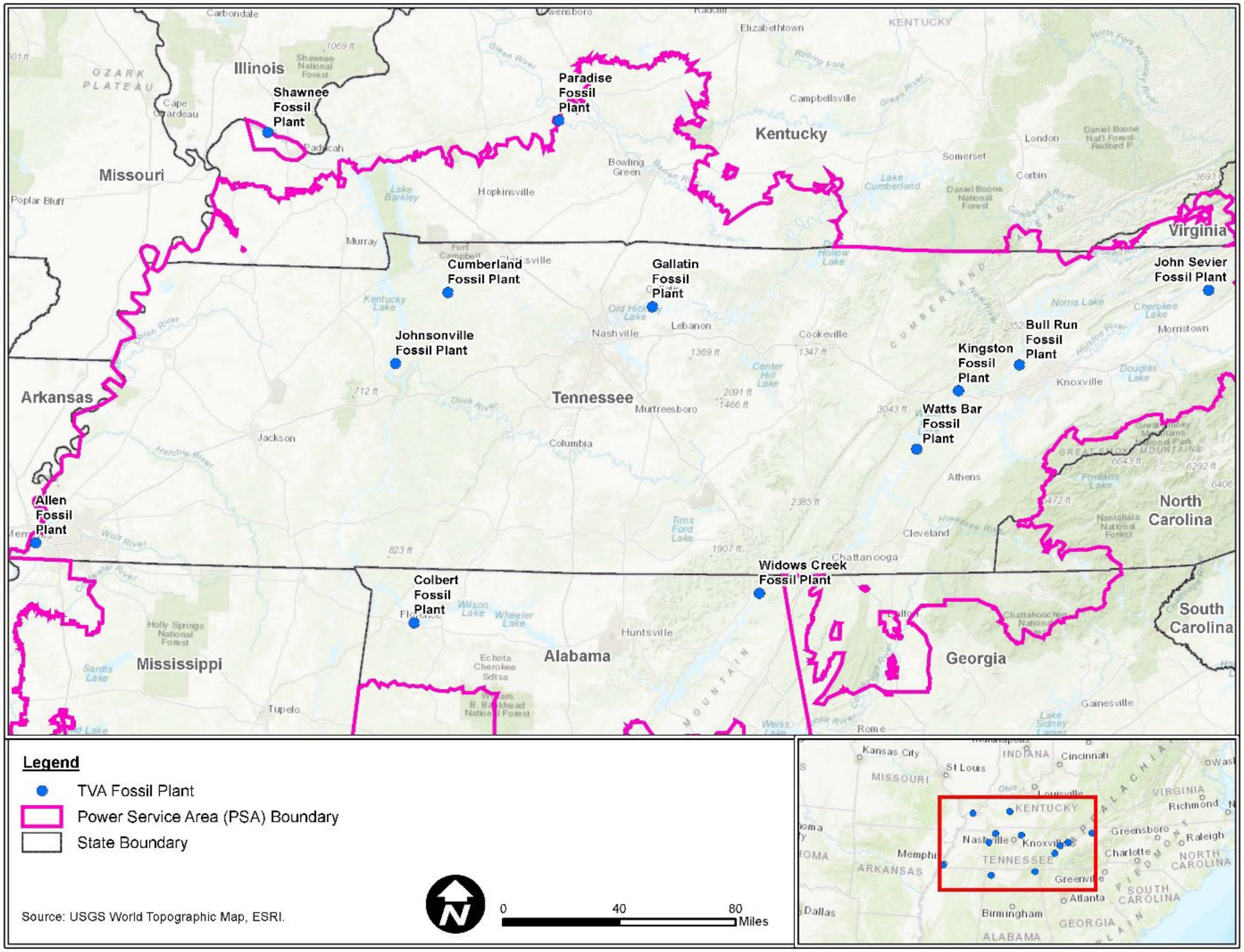


Figure 1-1. TVA Properties being Considered for Groundwater Corrective Actions

1.2 Background

All 12 TVA properties evaluated in the scope of this proposed action are either active or closed fossil plants that may have exceedances of groundwater protection standards (GWPS) that monitoring data indicates could arise from storage of coal combustion residuals (CCR). CCR are by-products produced from burning coal and include fly ash, bottom ash, boiler slag, and flue gas desulfurization materials (USEPA 2024a). These by-products have historically been stored or disposed of in surface impoundments (like ash ponds), landfills, and other CCR units. “CCR units” is used generally to describe areas where CCR are or were stored and are the current focus of potential groundwater corrective action.

Beyond compliance requirements with the Federal CCR regulations (40 CFR Part 257), TVA is currently conducting environmental studies under the oversight of the Tennessee Department of Environment and Conservation (TDEC), as directed by a TDEC Commissioner’s Order (Office of General Council 15-0177) from August 6, 2015 (TDEC Order). The TDEC Order created a process by which sites that have CCR in Tennessee would be investigated and assessed for unacceptable risks. The TDEC Order also provides a process by which TDEC could oversee TVA’s implementation of the 2015 Environmental Protection Agency Final Rule on Disposal of Coal Combustion Residuals from Electric Utilities (the CCR Rule) to ensure coordination and compliance with applicable Tennessee law. TVA is also pursuing several studies and planning actions pursuant to applicable Alabama and Kentucky state law and regulation, respectively.

Ultimately, TVA is pursuing all CCR unit and facility closures in support of compliance with the Federal CCR Regulations (40 CFR Part 257) (Federal CCR Rule), which is a self-implementing federal regulation that provides minimum performance standards and groundwater actions for all CCR units. TVA would adhere to all applicable federal and state regulations regarding oversight throughout the course of implementation of the proposed groundwater corrective actions.

Following implementation requirements and guidelines in the Federal CCR Rule and applicable state agency regulations, TVA identified 12 TVA facilities containing one or more CCR units with GWPS exceedances, herein referred to as Sites, that required additional testing of groundwater and an assessment of corrective measures. This identification process requires TVA to consider and evaluate potential actions that could be taken to address constituents of interest (COIs) measured at statistically significant levels above established GWPS. For the purposes of this document, a COI is defined as a CCR constituent in groundwater that requires corrective action. The process includes detection and assessment monitoring to confirm that some COIs are statistically above GWPS in onsite monitoring wells.

1.3 Programmatic Analysis and Tiering

The purpose of this PEA is to programmatically analyze potential impacts of proposed groundwater corrective actions (Proposed Actions) at one or more TVA facilities across the TVA PSA. TVA conducted this Programmatic NEPA review of the Proposed Actions in accordance with TVA’s NEPA regulations (18 CFR 1318 et seq.) (TVA 2020a). Programmatic NEPA reviews address the general environmental issues relating to broad decisions, such as those establishing policies, plans, programs, or a suite of projects, and can effectively frame the scope of subsequent site- and project-specific federal actions. This PEA is intended to reduce the cost of duplicative, site-specific analyses of environmental impacts of Proposed Actions. Because these impacts are likely to be similar within typical environmental contexts, they can be effectively evaluated at a broad scale for TVA properties analyzed in this PEA.

Following the completion of this PEA and a Finding of No Significant Impact, if appropriate, any Proposed Actions would tier from this PEA. This document identifies potential effects of the proposed action and establishes mitigation measures to reduce adverse impacts from a programmatic perspective. If needed, future site-specific reviews would integrate the processes, findings, and conclusions from this PEA. The site-specific reviews may also provide opportunities for additional public review and comment to ensure broad stakeholder input.

1.4 Purpose and Need

The purpose of the Proposed Action is to programmatically address GWPS across CCR units at TVA facilities within the TVA PSA (Sites), regardless of a CCR unit's agreed upon closure methodology, which is needed to pursue adherence with state and federal solid waste requirements. The PEA is needed to programmatically assess the direct and indirect impacts of the Proposed Actions TVA may pursue, or as directed by applicable permitting or regulatory authority for any respective CCR unit. The purpose of this PEA is to assess potential groundwater corrective actions proposed to meet this purpose and need.

1.5 Environmental Screening Checklist

TVA would consider the conditions of each Site from the list of TVA properties in Table 1-1 when reviewing the proposed groundwater corrective actions to determine whether it is appropriate to tier from this PEA. TVA would use the Environmental Screening Checklist in Appendix B to evaluate the proposed project and document potential effects. This information would describe the physical characteristics of the Sites proposed for groundwater corrective action and any applicable permits that would be required to execute the action. Criteria reviewed in the Environmental Review Checklist are based on the bounding values developed in this PEA as described in Section 2.3.3.

During the screening process, if TVA determines no sensitive resources are present at the Site or there is no potential for effects on sensitive resources within the bounded values, the findings of this PEA with respect to NEPA compliance would apply to the proposed project. Conversely, if TVA determines that the effects of the proposed project on sensitive resources extend beyond the bounded values assessed in this PEA, the proposed project would be subject to a site-specific environmental review consistent with TVA NEPA procedures. Relevant portions of this PEA could be incorporated into that site-specific environmental review.

The Environmental Screening Checklist would help TVA maintain compliance with bounding thresholds, maintain consistency of review, and streamline environmental assessments of multiple sites.

1.6 Decision to be Made

TVA must decide whether programmatically evaluating the bounded potential environmental effects of Proposed Actions at potentially several Sites could have environmental effects above site-specific standards, or if it could adequately support a programmatic finding of no significant impact. This PEA is being prepared to inform TVA decision makers and the public about the environmental consequences of the proposed action at a programmatic level. TVA's decision will consider factors such as potential effects, economic issues, and TVA's long-term goals as provided in the bounding analysis.

1.7 Related Environmental Reviews

Related environmental documents and materials were reviewed concerning this assessment and are listed in Table 1-2. The contents of these documents help describe the affected environment and are incorporated by reference as appropriate.

Table 1-2. Websites for Related Environmental Documents

Name	Website Address
Ash Impoundment Closure EIS Part I – Programmatic NEPA Review* Allen Fossil Plant EIS** Bull Run EIS** Colbert Fossil Plant EIS** John Sevier Fossil Plant EIS** Kingston Fossil Plant EIS** Widows Creek Fossil Plant EIS**	https://www.tva.com/environment/environmental-stewardship/environmental-reviews/nepa-detail/Closure-of-Coal-Combustion-Residual-Impoundments
Bull Run Fossil Plant Final EIS	https://www.tva.com/environment/environmental-stewardship/environmental-reviews/nepa-detail/Bull-Run-Fossil-Plant-Landfill-Management-of-Coal-Combustion-Residuals
Cumberland Fossil Plant EIS	https://www.tva.com/environment/environmental-stewardship/environmental-reviews/nepa-detail/Cumberland-Fossil-Plant-Coal-Combustion-Residuals-Management-Operations
Gallatin Fossil Plant EA	https://www.tva.com/environment/environmental-stewardship/environmental-reviews/nepa-detail/Gallatin-Fossil-Plant-Bottom-Ash-Process-Dewatering-Facility
Johnsonville Fossil Plant EA	https://www.tva.com/environment/environmental-stewardship/environmental-reviews/nepa-detail/Johnsonville-Fossil-Plant-Coal-Yard-and-Coal-Yard-Runoff-Pond-Closure-Construction-of-a-Process-Water-Basin-and-Development-of-a-Borrow-Si
Kingston Fossil Plant EA and SEA	https://www.tva.com/environment/environmental-stewardship/environmental-reviews/nepa-detail/Kingston-Fossil-Plant-Landfill-Expansion
Paradise SEA and EA	https://www.tva.com/environment/environmental-stewardship/environmental-reviews/nepa-detail/Management-of-Coal-Combustion-Residuals-from-the-Paradise-Fossil-Plant
Shawnee Fossil Plant SEIS and EIS	https://www.tva.com/environment/environmental-stewardship/environmental-reviews/nepa-detail/Management-of-Coal-Combustion-Residuals-from-the-Shawnee-Fossil-Plant
Shawnee Fossil Plant Final EA	https://www.tva.com/environment/environmental-stewardship/environmental-reviews/nepa-detail/Shawnee-Fossil-Plant-Bottom-Ash-Process-Dewatering-Facility
Widows Creek Fossil Plant EA	https://www.tva.com/environment/environmental-stewardship/environmental-reviews/nepa-detail/Widows-Creek-Fossil-Plant-Soil-Excavation-and-Gypsum-Stack-Closure

* On July 28, 2016, TVA issued a Record of Decision for a programmatic NEPA review entitled Ash Impoundment Closure Environmental Impact Statement (Part I). The purpose of the programmatic NEPA review was to support TVA's goal to eliminate all wet CCR storage at its fossil plants by closing CCR surface impoundments across TVA's system and to assist TVA in complying with the CCR Rule.
** This site-specific NEPA Review tiers off the programmatic level review provided in Part I.
EIS = environmental impact statement

1.8 Scope of the PEA and Summary of the Proposed Action

This PEA provides a bounding analysis of the potential effects of Proposed Actions at TVA Sites. This document does not address any specific Site; rather, it is intended to cover the facilities described in **Table 1-1**. A detailed description of the proposed corrective actions and alternatives considered are provided in Chapter 2.

TVA intends to streamline the review of site-specific groundwater corrective actions at Sites through a programmatic evaluation of the bounded potential effects of the proposed actions. This bounding analysis establishes the analytical framework for the development of the Environmental Screening Checklist, which would be used to ensure that future evaluation of site-specific potential environmental effects are within the bounded parameters considered in the PEA prior to TVA making any decision to construct and operate groundwater corrective actions.

TVA prepared this PEA to comply with the NEPA statute, TVA regulations, and related procedures from various agencies for implementing NEPA. TVA considered the possible environmental effects of the bounding parameters of the proposed alternatives and determined that potential effects on the environmental resources listed below were relevant to the decisions to be made, and therefore, assessed the potential impacts on these resources in detail in this PEA.

- Land Use
- Geology, Soils, and Prime Farmland
- Groundwater
- Surface Water and Soil Erosion
- Floodplains
- Wetlands
- Habitat, Ecology, and Threatened and Endangered Species
- Cultural and Historic Resources
- Visual Resources
- Natural Areas, Parks, and Recreation
- Noise
- Air Quality
- Greenhouse Gas and Climate Change
- Transportation and Navigation
- Hazardous Materials and Solid Waste
- Public Health and Safety
- Socioeconomics

1.9 Public and Agency Involvement

TVA's public and agency involvement actions include publication of a notice of availability at www.tva.com/nepa and a 30-day public review of the Draft PEA. To solicit public input, the availability of this Draft PEA was announced in regional and local newspapers. A media advisory was also issued. The Draft PEA was posted on TVA's website, and hard copies were made available by request.

TVA's agency involvement includes sending notices to local, state, and federal agencies and federally recognized tribes to inform them of the availability of the Draft PEA.

1.10 Necessary Permits and Licenses

Proposed Actions would comply with applicable local, state, and federal regulations and permit requirements, and best management practices (BMPs) would be implemented in accordance with the given environmental resource as discussed in Section 2.6.1. After completion of the PEA process and during reviews of the site-specific potential effects of the Proposed Actions, TVA would determine if any permits, licenses, and approvals are required. TVA anticipates implementation of the Proposed Actions at any TVA Site could require the following permits:

- A National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activities or an Individual Construction Storm Water permit may be required for the proposed project. A Storm Water Pollution

Prevention Plan (SWPPP) would be required to detail sediment and erosion control BMPs. In conjunction with erosion and sediment control plans that are required for the Construction General Permit, a Construction Best Management Practices Plan (CBMPP) is required by Alabama Department of Environmental Management [ADEM].

- Actions involving impacts to Waters of the United States (U.S.) would be subject to federal Clean Water Act (CWA) Section 404 permit requirements.
- A Section 401 Water Quality Certification/Aquatic Resource Alteration Permit may be required from the appropriate state permitting agencies (TDEC, Kentucky Department for Environmental Protection [DEP], and/or ADEM for actions that involve or affect streams and wetlands.
- Any new outfalls would require a notification or permit modification request to TDEC, Kentucky DEP, and/or ADEM for a NPDES process wastewater permit.
- Air permitting regulations under the Clean Air Act (CAA) require TVA to secure an Air Pollution Control Permit to Construct prior to the commencement of the proposed construction. The project would likely require a new Title V Permit under the CAA for operations or revisions to an existing permit, as applicable.
- Entrance and right-of-way permits from the Tennessee Department of Transportation, the Kentucky Transportation Cabinet, and/or Alabama Department of Transportation for roads, ramps, driveways, and other access points and installation of utilities within highway rights-of-way.
- Applicable Hazardous and Solid Waste Permits or associated CCR permits from TDEC Division of Solid Waste Management, Kentucky DEP, ADEM and/or the U.S. Environmental Protection Agency (USEPA).

Any other necessary permits would be evaluated based on site-specific conditions. Details of permitting requirements would be determined using the Environmental Screening Checklist based upon final design.

CHAPTER 2 – DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.1 Introduction

To support TVA's need to meet GWPS, TVA is considering five alternatives as described below.

2.2 Alternatives Evaluated in this Programmatic Environmental Assessment

TVA has determined that five alternatives, including one no action alternative and four potential corrective action alternatives, are technically and economically feasible for consideration and/or subsequent implementation to address groundwater exhibiting statistically significant concentrations above the GWPS. These alternatives include:

- Alternative A – No Action
- Alternative B – Enhanced In Situ Treatment (EIST)
- Alternative C – Hydraulic Control and Groundwater Treatment
- Alternative D – Monitored Natural Attenuation (MNA)
- Alternative E – Combination of Corrective Actions

Each of these technologies is described below.

There are overarching assumptions that have been developed related to each of technologies/approaches that have been incorporated into this document. Site-specific conditions would dictate any full-scale implementation, but in general these assumptions have been assimilated into a Bounding Value Analysis. Details related to the Bounding Value Analysis are provided in Section 2.3 for the action alternatives.

Under Alternatives B, C, D, and E, TVA would develop Adaptive Site Management strategies to identify potential alternate remedies should MNA not meet short- and long-term performance goals as planned.

2.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed. The No Action Alternative does not meet the purpose and need because it does not actively mitigate environmental risks (if any) and may fail to meet regulatory compliance if COI levels exceed GWPS with statistical significance. However, the No Action Alternative provides a baseline for comparison against the action alternatives. All groundwater monitoring required would continue in conjunction with the CCR Rule, TDEC permits, or as required under TVA's agreement with TDEC.

Groundwater corrective actions are currently ongoing at two of the Sites. Therefore, these ongoing activities are not analyzed as new actions in this PEA. These corrective actions were previously assessed under separate NEPA analyses, and therefore, constitute part of the existing environment at these facilities. Ongoing corrective actions would continue under Alternative A. A brief overview of the corrective actions at these two Sites is provided below.

Allen Fossil Plant

The East Ash Pond is currently operating a system of vertical extraction wells with a hydraulic control and groundwater treatment. The West Ash Pond is being evaluated for MNA. If MNA is not progressing as planned, an adaptive management plan would likely involve vertical extraction wells and treatment. The West Ash Pond has also recently undergone a closure by removal project.

Shawnee Fossil Plant

TVA selected MNA as the remedy at the Ash Pond 2 and the Consolidated Waste Dry Stack multi-unit groundwater network, effective in 2023.

2.2.2 Alternative B – Enhanced In Situ Treatment (EIST)

EIST of groundwater is an established technology for a variety of site conditions and contaminants. Under this alternative, TVA would address statistically significant exceedances above the GWPS by utilizing appropriate measures implemented *in situ* (i.e., treatment within the uppermost aquifer) to immobilize, reduce or degrade COIs. *In situ* technologies can be deployed in a variety of configurations depending on the extent of COIs and their proximity to potential receptors, though they typically involve introducing reactive media, chemical reagents, or biological agents (herein referred to generally as reagents) into the groundwater.

Evaluation of EIST approaches for COIs is typically dependent upon a detailed hydrogeologic conceptual site model, a groundwater flow model, and a geochemical model.

These approaches offer targeted treatment strategies that adapt to site-specific hydrogeologic conditions. Bench-scale testing is designed to develop an understanding of geochemistry and assess the effectiveness of prospective reagents to be used *in situ,* and can also be used to inform the scope and necessity of field-scale pilot testing. The geochemical model is then used to evaluate potential COI attenuation rates and long-term stability for the EIST approach. A groundwater monitoring program is also typically an integral part of any EIST system in order to track changes in COI concentrations and provide feedback on the effectiveness of the EIST system.

Several critical site-specific conditions need to be considered when evaluating the applicability of an EIST system, including site access, dike stability, depth of installation, and geochemistry. Four specific EIST approaches were selected for further evaluation because of their potential applicability at TVA properties, including:

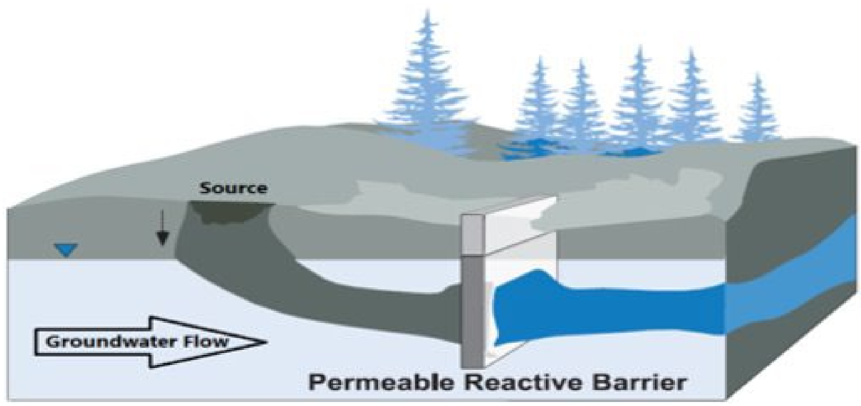
- Permeable reactive barriers (PRBs) using continuous (one-pass) trenching equipment;
- Vertical injection wells, including infiltration galleries and direct injection;
- Horizontal injection wells; and
- Funnel-and-gate approach.

Additional details related to each of the four EIST approaches are provided in Appendix C.

2.2.2.1 Permeable Reactive Barrier (PRB)

For the scope of this PEA, a PRB would entail the excavation of a trench perpendicular to groundwater flow direction that would be backfilled with a permeable treatment media that allows groundwater to flow through it while reducing concentrations of COIs through chemical, physical, and/or biological processes. Trenches are typically 1.5 to 3 feet wide and up to 60 feet deep. PRBs would typically be installed continuously along the Site perimeter with treatment media placed to target the zone where transmission of reagents can occur. It would then be backfilled above the treatment media with bentonite slurry in CCR material and native soil above to reduce spoils.

As groundwater passes through the reactive zone, COIs are immobilized or chemically transformed, and the water exiting the PRB is remediated. Metals associated with CCR sites are elements and not chemical compounds; therefore, the COIs (i.e., metals) cannot be destroyed. Rather, the specific metal that requires remediation can either be caused to precipitate out of solution through chemical or biological reactions, or they can be sequestered/adsorbed onto solid materials such that they are no longer in the dissolved phase.



Source: VEI Contracting 2024

2.2.2.2 Vertical Injection

The use of vertical injections can be used to introduce reagents to the subsurface. These injections can be accomplished using direct-push technology in geologic materials that are conducive to the use of direct-push technology, such as sands, silts and clays. However, in rock and more dense geologic media, the injection of reagents is facilitated through a series of temporary or permanently installed injection points. These injection points are drilled and constructed using conventional drilling equipment such as hollow stem auger, air rotary or sonic techniques. Once the injection points have been established, additional equipment, which makes up the EIST delivery system, is required to prepare the aqueous treatment for introduction in the subsurface.

For the scope of this PEA, vertical injections may be in the form of either infiltration galleries or direct injection. Infiltration galleries consist of regularly spaced injection wells installed in the target area that allow for delivery of a reagent to stabilize or transform COIs in place and allows for repeated treatments as needed to meet remedy goals. Direct injection refers to regularly spaced injection points that can be advanced into the target area to allow for the one-time delivery of a reagent to stabilize or transform COIs in place. A mixing and delivery system for reagent delivery would consist of:

- Storage tanks or totes used to hold water-based solutions of treatments (e.g., carbon substrates, pH buffers, or oxidants) prepared for in situ injection;
- Chemical metering and injection pumps;

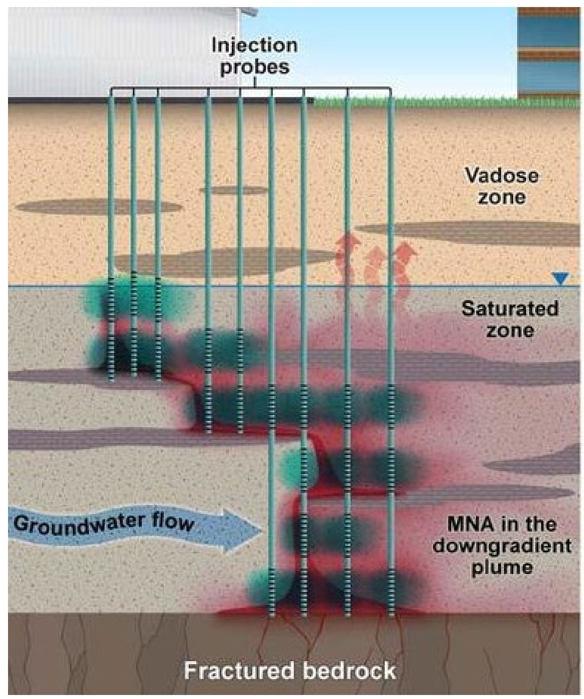
- Injection manifold;
- Conveyance lines; and
- Other equipment and instrumentation (e.g., mixers, weight scales, etc.).

The reagent is typically delivered under low pressure with a gravity feed up to 50 pounds per square inch. The injection facilitates the placement of the reagent into pore spaces of the surrounding formation. The use of low pressure is intended to promote the horizontal injection into the formation and mitigate the possibility of short circuiting or "daylighting," which refers to when reagents delivered to the subsurface via injection travel underground and resurface in areas away from the intended injection area.

Typically, the injection wells are installed in one to two rows, in a staggered pattern, to allow for the generation of a continuous permeable reactive barrier or zone, and equivalent to the use of a continuous trenching application. The typical radius of influence (ROIs) from a single injection point is in the range of 10 to 20 feet; therefore, the spacing between injection points is typically between 15 to 25 feet.

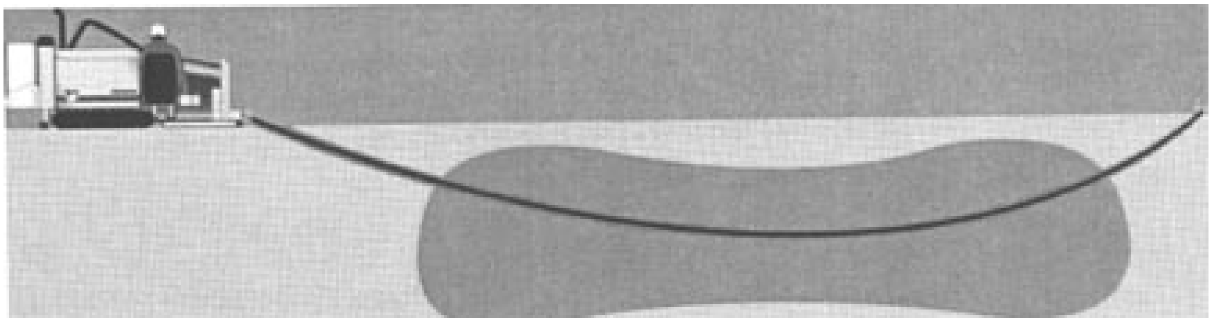
2.2.2.3 Horizontal Injection

The use of horizontal wells is another alternative used to introduce reagents to the subsurface. Horizontal wells are installed using specialized horizontal drilling equipment and these wells can be installed in a variety of geologic settings, including sands, silts, clays, and rock. The horizontal wells consist of long screen sections which are then used to facilitate the injection of reagents, and a single horizontal well can cover the same area as multiple vertical injection points; though, the installation of a horizontal well is more complicated.



Like vertical injection wells, horizontal wells would typically be utilized along the treatment perimeter. The wells would be installed with casing beneath dikes for support. Multiple horizontal wells can be installed at different depths (i.e., stacked or nested) to facilitate the treatment of thicker target zones using the same entry and exit points.

Once the horizontal well has been installed, the reagents can be delivered using a dedicated mixing and delivery system similar to vertical injection. The reagents would be delivered under low pressure to push reagent solutions into pore spaces of the target formation. In general, horizontal injection wells result in lower local ROI than vertical injection (5 to 10 feet) but increase downgradient ROI due to dispersion.

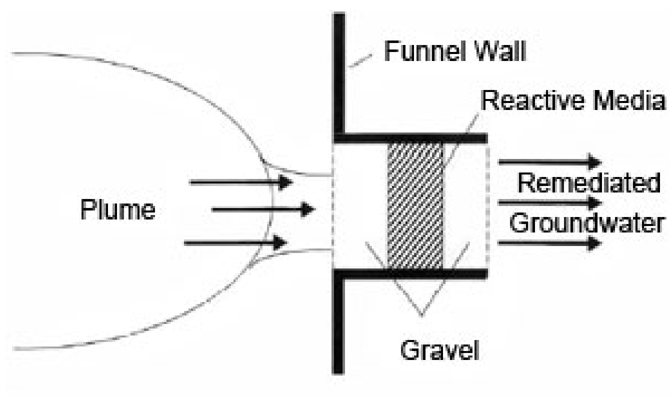


Source: Horizontal Environmental Well Handbook Prepared by Directed Technologies Drilling, Inc. December 2004

2.2.2.4 Funnel and Gate

Another EIST approach related to the implementation of a PRB is known as Funnel-and-Gate. The Funnel-and-Gate is similar to a continuous trench, except that it consists of a series of low permeability sections (i.e., funnel) and a series of permeable sections (i.e., gate). The concept is that impacted groundwater from a Site is redirected with the funnel sections and exits from the established permeable gate sections that are filled with the designed reagent. The gate sections are oriented in areas where the groundwater flow and mass flux of COIs have been determined to be the highest.

The funnel sections consist of low permeability subsurface walls that are typically installed via continuous trench or vertical injection points. The targeted treatment zones, or gates, are also constructed using either continuous trenching or vertical injection points (installed within the gate via either hollow stem or sonic drilling). The reagent is introduced to the subsurface in a similar manner to that which has been previously discussed.



Source: ITRC 1999

2.2.3 Alternative C – Hydraulic Control and Groundwater Treatment

Hydraulic control is a reliable, proven technology that has been employed for decades to control impacted groundwater. Hydraulic control, also referred to as hydraulic containment or “ex situ”, typically involves the active extraction of impacted groundwater from collection galleries, wells or trenches, through the use of submersible pumps, for treatment at the surface before either being discharged. These methods provide direct control over COI migration and mass removal and allow for a range of treatment options, including physical (filtration, sedimentation), chemical (oxidation, precipitation), and biological (bioreactors) processes.

The applicability and orientation of a hydraulic control system is largely based on site-specific conditions such as aquifer dimensions and hydraulic conductivity, presence of confining layers, depth, gradient, characteristics of the COIs, and presence of receiving water bodies or wells.

Groundwater extraction deployment approaches for hydraulic control include vertical and horizontal wells. Vertical wells can be used in unconsolidated soils and bedrock. The number of wells, spacing between wells, and well depths are a function of aquifer characteristics and the targeted control zone. Horizontal wells potentially allow for the installation of more well screen along a zone of COI impacts in comparison with vertical wells, thus improving the overall efficiency of the extraction system, though they may not be as practical as vertical wells depending on site-specific conditions.

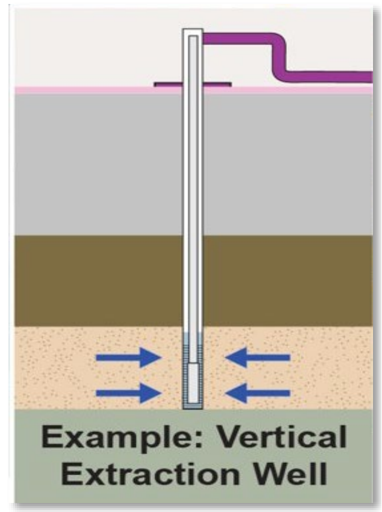
For both vertical and horizontal extraction, extracted groundwater would be pumped through a conveyance pipeline and treated through an above-ground treatment facility prior to discharge under applicable permit(s). If there is not already a water treatment facility at the site, one would need to be constructed. Water treatment operations would occur within a 10,000-square-foot area containing a cargo container (Conex) and storage tank. Water treatment involves separating solids from liquids and removing impurities and suspended solids with a filter press, producing clean water and waste solids. Discharges from the water treatment facility would be to nearby surface water at a permitted outfall. Appropriate permits would be obtained for groundwater withdrawal (e.g., water allocation permits) whose requirements vary by state.

Hydraulic control methods of extraction provide direct control over COI mass removal and allow for a range of treatment options, including physical (filtration, sedimentation), chemical (oxidation, precipitation), and biological (bioreactors) processes. Treatment of the extracted groundwater would be completed onsite using treatment methodologies such as pH adjustment, chemical precipitation, adsorption, and ion exchange (see Appendix C for more information on treatment methodologies).

A groundwater monitoring program is typically an integral part of any hydraulic control system. The monitoring program tracks changes in groundwater levels and COI concentrations to provide feedback on the effectiveness of the hydraulic control system.

The time frame to achieve GWPS with a hydraulic control system is strongly dependent on the site’s hydrogeologic conditions, the degree and extent of COI impact, and the geochemical behavior of COIs in the subsurface. These inherent site conditions often function as rate limiting characteristics and should be considered when developing the schedule for achieving GWPS.

2.2.3.1 Vertical Extraction



Source: Enviraj Consulting 2020

The use of vertical groundwater extraction wells has been used for years to collect and hydraulically contain impacted groundwater. Vertical groundwater extraction wells can be used in unconsolidated soils and bedrock. The number of wells, spacing between wells, and well depths are a function of aquifer characteristics and the targeted control zone. Well installation techniques and other information are similar to those presented in Section 2.2.2.2.

Vertical groundwater extraction wells are oriented in a line perpendicular to groundwater flow to provide hydraulic control based on overlapping cones of influence. The groundwater extraction wells would be located along the downgradient portion of the Site that is targeted for treatment. The vertical extraction wells would be spaced at an interval that is appropriate for the site conditions to meet performance objectives based on the estimated ROI and resulting hydraulic capture zones. The vertical extraction wells would be screened within the aquifer that is targeted for hydraulic control. Extracted groundwater would be pumped through a conveyance pipeline and treated through an above-ground treatment facility prior to discharge under applicable permit(s).

2.2.3.2 Horizontal Extraction

The installation of horizontal groundwater extraction wells has been more frequent than vertical extraction wells over the past 5 to 10 years. A single horizontal extraction well can be used to replace the need for multiple vertical wells. Horizontal wells are installed using directional drilling equipment and would typically be located along the downgradient perimeter of a Site. The wells would be installed with casing beneath dikes for support. Typical horizontal well diameters range from 2 inches up to 8 inches. However, larger diameter wells require larger borehole sizes and therefore larger drilling equipment which can be problematic in any well with a small working footprint.

Multiple horizontal groundwater extraction wells can be utilized to extract water from different target depth intervals, and multiple wells can often be drilled from a common location in order to provide for a close spacing of well heads. Once the horizontal well is completed, the extracted groundwater would be pumped through a conveyance pipeline and treated prior to discharge under applicable permit(s).

The use of horizontal wells potentially allows for the installation of more well screen along a zone of COI impacts in comparison with vertical wells, thus improving the overall efficiency of the extraction system. The use of horizontal wells is not recommended for aquifers where there is large differential between high and low groundwater elevations as it may be difficult to pinpoint the COI recovery zone. Deep horizontal wells may not be as practical as vertical wells depending on site-specific conditions.

2.2.4 Alternative D: Monitored Natural Attenuation (MNA)

Monitored Natural Attenuation (MNA) is a corrective action strategy that involves establishing a program to monitor the physical, chemical, or biological processes that occur naturally at a site. These processes can often work to reduce the toxicity, concentration, or mobility of site COIs in a time frame that is acceptable and can be comparable to other technologies. MNA is increasingly employed at sites where COI concentrations are near GWPS threshold levels, do not have an immediate pathway to sensitive receptors, and are not resultant from an ongoing source. These conditions increase the likelihood that natural processes can attenuate COI concentrations in an acceptable time frame.

The basis of a MNA remedy for COI is typically centered on developing a detailed hydrogeologic conceptual site model, a groundwater flow model, and a geochemical model. MNA implementation would consist of designing a monitoring and assessment program to demonstrate that the COI concentrations present in the groundwater are being reduced by natural processes. Existing and potentially new monitoring wells at the facility would be used to characterize reduction in COI concentrations over time.

Reliance on natural processes rather than active treatment may require institutional controls to restrict access to affected zones. MNA relies upon naturally occurring processes to reduce COI levels and, by itself, does not provide a means to affect change in the subsurface environment. This strategy can be effective, especially when used in combination with unit closure and source control.

2.2.5 Alternative E: Combination of Corrective Actions

Under Alternative E, TVA would address groundwater statistically significant exceedances above the GWPS by utilizing a combination of Alternatives B, C, and D to meet the purpose and need of the project. The most likely combination of corrective action alternatives would be the use of Alternative B and Alternative D or the use of Alternative C and Alternative D. It is unlikely that there would be any occurrence where a combination of Alternatives B, C, and D would be applicable.

A hybrid remediation approach integrates multiple corrective actions and alternatives to optimize effectiveness and adaptability for site-specific conditions. The combination of corrective actions leverages a mix of EIST, hydraulic control, and MNA techniques to address contamination through a phased or targeted strategy. This alternative allows for flexible applications where highly impacted groundwater zones may require hydraulic control treatment, while less impacted groundwater zones may benefit from stabilization through EIST and/or MNA. By incorporating multiple technologies, this approach maximizes contaminant removal, enhances regulatory compliance, and balances efficiency with environmental sustainability.

2.3 Bounding Analyses

For purposes of this programmatic analysis, siting and environmental criteria, and the range of known activities associated with the design and implementation of corrective action, provided the bounding conditions informing the impact analysis for resource areas presented in this PEA. The bounding analysis provides not-to-exceed thresholds for each resource to help determine the potential level of impact and need for project-specific analysis. The range of potential impacts or risks can then be used to inform the comparison of alternatives. **Table 2-1** provides maximum values anticipated for characteristics and resources for which the environmental consequences were analyzed for Alternatives B, C, and D. Although maximum values were used to analyze impacts within this PEA, values of actual impacts are anticipated to be less. Alternative A, the No Action Alternative, is not included as it does not involve any actions that require bounding. Alternative E, as a site-specific combination of groundwater corrective actions from either Alternative B or C and Alternative D, would be bounded by the more conservative bounding values (either B or C) added to bounding values for Alternative D for each resource or characteristic.

Table 2-1. Action Alternative Bounding Values

Feature	Parameter	Shared Assumptions	Bounding Values and Assumptions[1]			
			Alternative B – EIST	Alternative C – Hydraulic Control	Alternative D - MNA	Alternative E – Combination
Treatment Methodology Bounding Characteristics						
Wells	Number of wells Dimensions Diameter and depth	The number of wells is per Site. Horizontal wells are vertically nested wells with shared workspace for entry and exit points. Vertical injection wells, horizontal injection wells, and observation wells are ≤4-inches in diameter and ≤60 feet deep. Vertical injection includes both infiltration galleries and direct injection.	**PRB**: ≤15 observation wells **Vertical**: ≤601 vertical wells plus ≤15 observation wells *Assumption(s):* Injection wells will be installed with 5-foot spacing along ≤3,000-foot corridor. **Horizontal**: ≤3 horizontal wells plus ≤15 observation wells **Funnel and gate**: ≤15 observation wells *Assumption(s):* Follows rule of 90% flow through 20% of cross section area. Corridor allows for ≤4 gates, each 150-200 feet in length.	**Vertical**: ≤76 wells **Assumption(s):** No additional observation wells needed. **Horizontal**: ≤2 wells, 1,500 feet long *Assumption(s):* Assumes range from 350 feet to 400 feet between vertical wells. No additional observation wells needed.	**MNA**: ≤2 monitoring wells; ≤3-inch diameter and 75 feet deep. *Assumption(s):* Assumes 2 additional monitoring wells.	**Alternative B + Alternative D** ≤601 wells plus ≤15 observation wells plus ≤2 monitoring wells OR **Alternative C + Alternative D** ≤76 wells plus ≤2 monitoring wells
Land Requirement	Land Use Disturbance Footprint	Installation would occur on pre-disturbed land. All disturbance estimates are provided per Site. Operational disturbance impacts are included within construction disturbance impacts.	**PRB**: ≤5 acres *Assumption(s):* PRB trench corridor dimensions are 3,000 feet (L) x 75 feet (W) (5 acres). 75 feet width applies to construction only. **Vertical:** ≤2 acres *Assumption(s):* Vertical wells would occur along a 3,000-foot (L) x 25-foot (W) (2 acres) corridor. **Horizontal**: ≤2.5 acres disturbance above and below ground. ≤0.5 acres surface disturbance. *Assumption(s):* Horizontal wells require 100 feet x 100 feet (0.5 acres) above ground disturbance at entry and exit points. About 3,000 linear feet along drill path would be disturbed below ground for each nested well path. **Funnel and gate with vertical injection:** ≤3.5 acres 3,000-foot (L) x 50-foot (W) corridor	**Vertical Extraction Wells**: ≤4.5 acres *Assumption(s):* Wells would be within or along the perimeter of the CCR unit. Includes wells (2 acres), treatment facility (0.5 acres), and discharge outfalls (2 acres). **Horizontal:** ≤5 acres *Assumption(s):* One long corridor along the downgradient border of the CCR unit. Includes treatment facility (0.5 acre) and discharge outfalls (2 acres).	**MNA:** ≤1.5 total acres *Assumptions:* Access road disturbance: ≤0.5 acres. Monitoring well development: 0.5 Temporary laydown: ≤.5 acres	**Alternative B + Alternative D** ≤6.5 acres OR **Alternative C + Alternative D** ≤6.5 acres

[1] Notes: L = length; W = width; D = depth

Feature	Parameter	Shared Assumptions	Bounding Values and Assumptions[1]			
			Alternative B – EIST	Alternative C – Hydraulic Control	Alternative D - MNA	Alternative E – Combination
Soil Requirements	Volume Geology	All soil, gravel, or other fill would be sourced from a local, permitted, and existing site within 30 miles of the TVA property. For both horizontal and vertical wells, fill is needed for the cargo container (Conex) and storage tank (for operational area in a 100-foot x 100-foot area).	**PRB Construction**: ≤12,000 cubic yards *Assumption(s):* 3,000 feet (L) x 10 feet (W) x 60 feet (D) Gravel for access road dimensions: 1,000 feet (L) x 10 feet (W) x 1 feet (D) construction of access road and area around the PRB. **Vertical Injection Construction:** ≤500 cubic yards **Horizontal Injection Construction:** ≤500 cubic yards **Funnel and gate with vertical injection Construction:** ≤4,000 cubic yards **Funnel and gate with vertical injection post-construction**: ≤4,000 cubic yards of soil 1,000 feet (L) x 10 feet (W) x 60 feet (D)	**All Methods**: ≤500 cubic yards *Assumption(s):* No fill required for well installation.	**Construction**: ≤405 cubic yards *Assumption(s):* Access road would require ≤6 inches of gravel on the surface of the road over 0.5 acres. No soil is required for well development.	**Alternative B + Alternative D** ≤12,405 cubic yards OR **Alternative C + Alternative D** ≤905 cubic yards
Radius of Influence (ROI)	Feet	ROIs are the radii within which the groundwater levels are expected to be affected by operation of the system(s).	**PRB:** ROI is determined by the length and width of the associated PRB. **Vertical Injection**: ≤20 feet *Assumption(s):* With reasonable planning and approach to injection of subsurface reagents, no daylighting is expected. Monitoring wells would be used to evaluate/assess injection well ROI. **Horizontal Injection**: ≤10 feet in vertical and horizontal directions **Funnel and gate with vertical injection**: ≤20 feet	**Vertical Extraction Wells:** 25 to 185 feet **Horizontal Extractions Wells**: ≤25 feet	Not applicable to MNA.	**Alternative B + Alternative D** ≤20 feet OR **Alternative C + Alternative D** ≤185 feet

[1] Notes: L = length; W = width; D = depth

Feature	Parameter	Shared Assumptions	Bounding Values and Assumptions[1]			
			Alternative B – EIST	**Alternative C – Hydraulic Control**	**Alternative D - MNA**	**Alternative E – Combination**
Construction	Duration Equipment Requirements Transportation Laydown Areas	Work vehicles are trucks or other vehicles dedicated to onsite work. Duration for construction assumes the worst case for all aspects of remedy installation, including data evaluation, supplemental investigations, replacement wells, etc. Duration for all alternatives would be a maximum of 1 year and assumes construction would occur ≤365 days per year. Treatment duration for Alternatives B, C, and E would be ≤3 years.	**Equipment Requirements:** ≤4 drill rigs, 2 dump trucks (17 cubic yards), 2 skid steers, 10 work vehicles **Transportation:** ≤4 truckloads (8 truck trips) per day for material deliveries and waste disposal. 10 work vehicles per day (20 trips on/off site) Borrow material transportation: ≤150 truckloads per day, up to 150 days per yea	**Equipment requirements:** ≤2 drill Rigs, 1 dump truck (17 cubic yards), 1 skid steer, 5 work vehicles, 1 crane, 1 telehandler **Transportation:** ≤2 truckloads (4 truck trips) per day for material deliveries and waste disposal. One 18-wheeler/flatbed truck for delivery of water treatment facility. 5 work vehicles per day (10 trips on/off site)	**Equipment requirements:** ≤2 drill rigs, 1 dump truck (17 cubic yards), 1 skid steer, 5 work vehicles **Transportation:** ≤2 truckloads (4 truck trips) per day for material deliveries and waste disposal. 5 work vehicles per day (10 trips on/off site)	**Alternative B + Alternative D** **Equipment Requirements:** ≤27 vehicles **Transportation:** ≤42 truck trips per day OR **Alternative C + Alternative D** **Equipment requirements:** ≤18 vehicles, 1 crane, 1 telehandler **Transportation:** ≤28 truck trips per day One 18-wheeler/flatbed truck for delivery of water treatment facility. An additional ≤150 truckloads per day, up to 150 days per year for borrow material transportation.
Waste	Solid and hazardous	Assume possible sustained generation of small quantities of hazardous or special waste in the form of waste oil or solvents from parts washers, etc. generated as part of onsite maintenance of construction equipment. No hazardous waste would be generated during operation of Proposed Actions. Waste would be managed in accordance with applicable federal, state, and local laws and regulations.	**Construction:** ≤3 cubic yards of solid waste from material packaging (total). ≤1,500 cubic yards for spoils generated from drilling operations for well installation (i.e., vertical, or horizontal). **Operations:** 3 cubic yards solid waste biweekly	**Construction:** ≤3 cubic yards of solid waste from material packaging (total). ≤1,500 cubic yards for spoils generated from drilling operations for well installation (i.e., vertical, or horizontal). **Operation**: ≤3 cubic yards of solid waste every 2 weeks from treatment building; includes solid waste from filter press. Sand filter material (purchased from vendor) in treatment tanks would need to be replaced every 3 years over ≤30 years of treatment. Quantity would depend on size of treatment tanks; would be ≤10 cubic yards.	**Construction**: ≤2, 55-gallon drums of solid waste total for installation of both wells. **Operation**: No additional solid waste generated over routine sampling and analysis for existing groundwater monitoring wells.	**Alternative B + Alternative D** **Construction:** ≤3 cubic yards of solid waste from material packaging (total). ≤1,500 cubic yards for well spoils. **Operations:** 3 cubic yards solid waste biweekly OR **Alternative C + Alternative D** **Wells**: **Construction:** ≤3 cubic yards of solid waste from material packaging ≤1,500 cubic yards for well spoils. **Operations:** 3 cubic yards solid waste

[1] Notes: L = length; W = width; D = depth

Feature	Parameter	Shared Assumptions	Bounding Values and Assumptions[1]			
			Alternative B – EIST	Alternative C – Hydraulic Control	Alternative D - MNA	Alternative E – Combination
Groundwater	Groundwater quality Groundwater quantity (water levels, volume, rates of flow)	Groundwater impacts are bound by the ROIs discussed above. ROIs are the radii within which the groundwater levels are expected to be affected by operation of the system(s). Proposed Actions would continue until GWPS are met. Groundwater quality would be monitored during the corrective action implementation, in accordance with a groundwater monitoring plan. If there are unexpected negative consequences, they can be identified and addressed. Groundwater is not a resource being used at most/all of these work sites for either potable or non-potable uses. Vertical injection includes both infiltration galleries and direct injection.	**Quality**: ≤GWPS **Quantity**: No Impact **PRB:** Minimal local impact. *Assumption(s):* PRB relies on the existing groundwater flow system. **Vertical/horizontal injection wells:** Impact within the ROIs listed above. Little/no impact beyond the ROIs. **Funnel-and-gate:** Little if any overall change in the total volume of groundwater flow.	**Quality**: ≤GWPS **Quantity:** ≤300 gallons per minute for extraction *Assumption(s):* Extraction rates would not affect surrounding streams given sufficient depths of withdrawals. Rates of withdrawal would not be of sufficient quantity to affect nearby streams or nearby groundwater users. Treated groundwater would be discharged to surface water at a permitted outfall. Appropriate permits would be obtained for groundwater withdrawal (e.g., water allocation permits) whose requirements vary by state.	**Quality**: ≤GWPS **Quantity**: No impact. *Assumption(s):* MNA results in no change to the groundwater flow system.	**Alternative B + Alternative D** **Quality**: ≤GWPS **Quantity**: Little to no impact OR **Alternative C + Alternative D** **Quality**: ≤GWPS **Quantity**: ≤300 gallons per minute for extraction
Labor	Employment Workforce	Employees would be newly employed, both local and non-local. Construction workers would be drillers, engineer oversite, health & safety officers, truck drivers, and operators.	**Construction**: ≤14 workers **Operation**: 2 workers for monthly/quarterly sampling	**Construction**: ≤7 workers **Operation**: ≤4 operators (2 per shift) for treatment facility; ≤2 workers for monthly/quarterly sampling	**Construction**: ≤7 workers **Operation**: ≤2 workers for monthly/quarterly sampling *Assumption(s):* ≤30 years for operation	**Alternative B + Alternative D** **Construction**: ≤21 workers **Operation**: ≤4 workers for monthly/quarterly sampling OR **Alternative C + Alternative D** **Construction**: ≤14 workers **Operation**: ≤4 operators for treatment facility; ≤4 workers for monthly/quarterly sampling
Visual/Aesthetics	Height of system Visibility from different vantage points Equipment and structures	Impacts on visual resources would be similar to past and current operations. During construction, equipment and material hauling would be visible on TVA property and on local roads. During operations, some wellheads may be visible from offsite locations.	**Construction & Operation**: Within viewshed of work site and surrounding roads.	**Construction & Operation**: Within viewshed of work site and surrounding roads. Crane use during operation would have wider visibility than other alternatives.	**Construction & Operation**: Within viewshed of work site and surrounding roads.	**Alternative B + Alternative D** Within viewshed of work site and surrounding roads. OR **Alternative C + Alternative D** Within viewshed of work site and surrounding roads. Crane use during construction would have wider visibility than other alternatives.

[1] Notes: L = length; W = width; D = depth

Feature	Parameter	Shared Assumptions	Bounding Values and Assumptions[1]			
			Alternative B – EIST	Alternative C – Hydraulic Control	Alternative D - MNA	Alternative E – Combination
Bounding Resource Impacts						
Surface Waters and Wetlands	Streams, wetlands, lakes, etc.	Avoid/minimize impacts to streams or wetlands to the extent practicable. Any unavoidable disturbances would be minimized and/or permitted through the appropriate federal and state agencies, including compensatory mitigation if necessary. Use of BMPs as described in TVA's *A Guide for Environmental Protection and Best Management Practices for Tennessee Valley Authority Construction and Maintenance Activities.*				
Floodplains	100-year and 500-year floodplain	Avoidance of Federal Emergency Management Agency (FEMA) 100-year and 500-year floodplain for permanent flood-damageable above-ground structures. Avoidance also includes the area below the 100-year flood elevation. For EIST, adverse impacts would be minimized by anchoring the well casings in a small concrete pad and installing bollards and water-tight well caps to protect the wells.				
Vegetation	Forested lands, rare/sensitive vegetation communities and habitats	Minimal impacts to vegetation and forested lands are anticipated. Disturbed areas would be reseeded/revegetated with noninvasive and/or native plants after groundwater protection standards are met. Tree removal is not expected. If necessary, tree removal would occur according to TVA's Guidelines for Conducting Biological and Cultural Surveys and Impact Analysis (TVA 2025a).				
Aquatic Ecology	Habitats provided by surface waters and wetlands)	Avoid/minimize effects to aquatic habitats. Any disturbances would be minimized or permitted through the appropriate federal and state agencies.				
Species of Concern	Protected species, heronries, osprey, eagles, etc.	Avoidance of impacts to listed species and other species of concern. Activities must comply with the Endangered Species Act, state specific regulations for rare and protected species, the Migratory Bird Treaty Act (MBTA), and Bald and Golden Eagle Protection Act (BGEPA). Construction activities would be 660 feet away from any known protected species nests or would comply with MBTA/BGEPA permitting requirements. Avoid potential impacts to bats by observing seasonal restrictions for tree clearing and avoiding impacts to potentially suitable roost trees, caves, water bodies, sinkholes, buildings, and bridges.				
Cultural and Historic Resources	National Register of Historic Places (NRHP) listed properties	Project assumed to be located in a previously disturbed area within a TVA property where no NRHP-listed or -eligible archaeological sites are present and outside the viewshed of any NRHP-listed or -eligible historic architectural properties or would require coordination with the State Historic Preservation Office.				
Natural Areas, Parks, and Recreation	Areas within 0.1 miles	Minor and temporary impacts from noise and traffic during construction.				
Noise	Construction noise and operational noise affecting nearby sensitive receptors	Not to exceed 85 decibels at property boundary per Occupational Safety and Health Administration standards. If noise exceeds this threshold, noise mitigation measures would be employed.				
Air Quality	Dust emissions	Minimize impacts of air quality impacts through BMPs for fugitive dust emissions.				
Greenhouse Gas and Climate Change	Carbon sequestration	Treatment technologies would be located on previously disturbed areas with minimal impacts to forested lands limiting the loss of carbon sequestration.				
Public Health and Safety	Health and Safety	Minimize potential risks to worker safety and public health and safety through BMPs.,				

[1] Notes: L = length; W = width; D = depth

2.4 Comparison of Alternatives

Based on feasibility evaluations of potential corrective action alternatives and the associated bounding values, the overall impacts of the various components of a particular corrective action alternative may be evaluated as beneficial or adverse and may apply to the full range of natural, aesthetic, historic, cultural, and socioeconomic resources within the project areas of each corrective action alternative and within the surrounding areas. Impact severity is dependent upon their relative magnitude and intensity and resource sensitivity.

In this document, the level of impacts is characterized in a manner that is consistent with TVA's current practice as less-than-significant or significant. In order of degree of impact, the descriptors are as follows:

- **Less-than-significant:**
  - **No Impact (or "absent")** – Resource not present or, if present, not affected by project alternatives under consideration.
  - **Minor** – Environmental effects are not detectable or are so minor that they would not noticeably alter any important attribute of the resource.
  - **Moderate** – Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
- **Significant:** For negative impacts, environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource. For beneficial impacts, environmental effects are measurable and are sufficient to improve important attributes of the resource.

The environmental impacts of each of the alternatives under consideration are summarized in **Table 2-2**. These summaries are derived from the information and analyses provided in the Affected Environment and Environmental Consequences sections in Chapter 3.

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

Resource Area	Alternative A – No Action	Alternative B – EIST	Alternative C – Hydraulic Control	Alternative D – MNA	Alternative E – Combination
Land Use	No impacts	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor
Geology, Soils, and Prime Farmland	No impacts	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor
Groundwater	Moderate	*C:* Moderate *O:* Moderate (Beneficial)	*C:* Moderate *O:* Moderate	*C:* Minor *O:* Moderate (Beneficial)	*C:* Moderate *O:* Moderate
Soil Erosion and Surface Water	Moderate	*C:* Minor *O:* Minor	*C:* Minor *O:* Moderate	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor to Moderate
Floodplains	No impacts	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor
Wetlands	No impacts	*C:* Minor to Moderate *O:* Minor	*C:* Minor to Moderate *O:* Minor	*C:* Minor to Moderate *O:* Minor	*C:* Minor to Moderate *O:* Minor
Wildlife and Threatened and Endangered Species	No impacts	*C:* Minor to Moderate *O:* Minor	*C:* Minor to Moderate *O:* Minor	*C:* Minor to Moderate *O:* Minor	*C:* Minor to Moderate *O:* Minor
Cultural and Historic Resources	No impacts	*C:* Minor *O:* Minor	*C:* Moderate *O:* Moderate	*C:* Minor *O:* Minor	*C:* Moderate *O:* Moderate
Visual Resources	No impacts	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor
Natural Areas, Parks, and Recreation	No impacts	*C:* Minor *O:* No Impacts	*C:* Minor *O:* No Impacts	*C:* Minor *O:* No Impacts	*C:* Minor *O:* No Impacts
Noise	No impacts	*C:* Minor *O:* No Impacts	*C:* Minor *O:* No Impacts	*C:* Minor *O:* No Impacts	*C:* Minor *O:* No Impacts
Air Quality	No impacts	*C:* Minor *O:* No Impacts	*C:* Minor *O:* No Impacts	*C:* Minor *O:* No Impacts	*C:* Minor *O:* No Impacts
Greenhouse Gas and Climate Change	No impacts	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor
Transportation and Navigation	No impacts	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor
Hazardous Materials and Solid Waste	No impacts	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor	*C:* Minor *O:* Minor
Public Health and Safety	Minor	*C:* Minor *O:* Minor (Beneficial)	*C:* Minor *O:* Minor (Beneficial)	*C:* Minor *O:* Minor (Beneficial)	*C:* Minor *O:* Minor (Beneficial)
Socioeconomics	Minor	*C:* Minor (Beneficial) *O:* Minor (Beneficial)	*C:* Minor (Beneficial) *O:* Minor (Beneficial)	*C:* Minor (Beneficial) *O:* Minor (Beneficial)	*C:* Minor (Beneficial) *O:* Minor (Beneficial)

Note: C – Construction; O - Operations

2.5 TVA's Preferred Alternative

Based on the review of the potentially applicable corrective action alternatives and the associated bounding values, Alternative E (Combination of Corrective Actions) is TVA's preferred alternative across all Sites. TVA anticipates using a combination of corrective actions at various Sites consisting of Alternatives B or C used in combination with Alternative D to meet the purpose and need of the project. Alternatives B and C would not be used together.

Alternative E is consistent with the established Purpose and Need to address groundwater protection exceedances across the Tennessee Valley at TVA fossil plant properties. Other alternatives used would not be sufficient to meet GWPS independently. By pursuing a programmatic Environmental Screening Checklist, TVA can efficiently pursue programmatic review of site-specific environmental effects and continue to pursue adherence with federal and state groundwater requirements. A specific preferred groundwater corrective action alternative for each Site would be determined as a result of the site-specific analysis.

2.6 Summary of Bounded Best Management Practices and Mitigation Measures

All individual projects would be subject to BMPs, as determined by applicable law. The vendor and/or host would be responsible for employing standard practices, routine measures, and other project-specific measures to avoid and minimize effects on resources from the implementation of the Proposed Action Alternative. TVA's analysis of potential impacts or effects includes consideration of BMPs and mitigation measures implemented as required to reduce or avoid adverse effects. Standard measures that TVA expects would be required are summarized below and are incorporated into the analysis in Chapter 3.

Additionally, based on the completion of site-specific designs, TVA would review each project location to ensure that the bounding attributes and resource characteristics at each location are consistent with the values contained in **Table 2-1**. Should site-specific conditions and potential effects exceed the bounding values, TVA would perform a site-specific NEPA review as needed to encompass the additional scope.

2.6.1 Best Management Practices

TVA has identified the following BMPs that could be used to minimize impacts and restore areas disturbed during proposed project activities; these are bounding BMPs, and would be employed on an as-needed basis at any given site:

- Fugitive dust emissions from site preparation and construction would be controlled by wet suppression and other BMPs (CAA Title V operating permit incorporates fugitive dust management conditions).
- Erosion and sedimentation control BMPs (e.g., silt fences, truck washes) would be used to ensure surface waters and wetlands are protected from construction impacts.
- Equipment refueling and maintenance operations would be conducted at designated locations using applicable BMPs.
- Construction would include customary industrial safety standards, applicable BMPs, and jobsite safety plans to maintain worker and public safety.

- The vendor and/or host would develop a project specific SWPPP, as required, prior to the start of construction.
- Consistent with Executive Order (EO) 13112 (Invasive Species), disturbed areas would be revegetated with native or non-native, non-invasive plant species to avoid the introduction or spread of invasive species.
- BMPs in accordance with TVA's *A Guide for Environmental Protection and Best Management Practices for Tennessee Valley Authority Construction and Maintenance Activities* (TVA 2022) would be used during construction activities to minimize and restore areas disturbed during construction.
- BMPs that may be implemented to help minimize impacts to bat species would include standards for noise during construction, human presence guidance, tree removal BMPs, standards for sedimentation, spills, pollutants and contaminants, lighting, and bat species monitoring.
- TVA would manage all solid waste generated in accordance with applicable state regulations and following procedures outlined in TVA's current Environmental Procedures and applicable BMPs.
- Above-ground structures and laydown areas would be located outside 100-year floodplains as delineated on Federal Emergency Management Agency (FEMA) flood insurance rate maps and/or on contour maps showing known 100-year flood elevations.
- Perennial, intermittent, and ephemeral streams that could be affected by the proposed construction would be protected by implementing standard BMPs as identified in the project specific SWPPP.
- BMP procedures for controlling soil erosion and sediment control, such as the use of buffer zones, to the extent practicable, surrounding perennial and intermittent streams, would be implemented.

2.6.2 Mitigation Measures

As part of its site-specific screening process using the Environmental Screening Checklist, TVA would employ the following mitigation measures on an as-needed basis at any given site:

- TVA would determine if a Site proposed for corrective action would have wetlands present and if there would be potential adverse impacts to wetlands. Wetlands would be preferentially avoided during construction. Any potential unavoidable wetland impacts would be mitigated under regulations implementing Sections 401 and 404 of the CWA, applicable state regulations, and EO 11990 (Protection of Wetlands). Compensatory mitigation would be purchased if necessary.
- If forest is present at a proposed site, surveys would be conducted to determine suitability of summer roosting habitat for federally listed bat species. Sites with presence of suitable summer roosting habitat for federally listed bats, and for which the removal of such habitat would not be avoidable, may be subject to seasonal surveys to determine bat presence prior to construction actions.

- Potential impacts to bats and other sensitive species would be avoided by observing seasonal restrictions on tree clearing and avoiding impacts to potentially suitable habitat identified during surveys.
- TVA's commitment to abiding by the Endangered Species Act (ESA) and state-level regulations would minimize impacts to terrestrial animal species that are federally or state-listed. Under the bounding condition, project activities would comply with the Migratory Bird Treaty Act (MBTA) and Bald and Golden Eagle Protection Act (BGEPA), as construction activities would be at least 660 feet away from any known protected species nests or would comply with MBTA and BGEPA permitting requirements.
- TVA would initiate consultation with the State Historic Preservation Office (SHPO) and tribes to determine the area of potential effect (APE), identify historic properties in the APE, and assess the potential effects of the proposed action on any National Register of Historic Places (NRHP)-listed or -eligible properties in the APE. TVA would complete any needed surveys for historic architectural surveys, assess potential adverse effects on any identified NRHP-listed or -eligible historic architectural properties, and seek ways to avoid such adverse effects, in consultation with the appropriate SHPO and tribes as project plans are developed. Should avoidance of adverse effects on historic properties prove to be infeasible, TVA would work with the appropriate consulting parties to develop a Memorandum of Agreement (MOA) for the resolution of the adverse effects, pursuant to § 800.6(b)(1).

CHAPTER 3 – AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes the baseline environmental conditions (affected environment) of environmental resources that exist within the TVA PSA and the potential effects (environmental consequences) that would occur from implementation of the alternatives described in Chapter 2. The specific criteria for evaluating the potential environmental impacts of the No Action Alternative and Action Alternatives are described in the following sections. The significance of an action is also measured in terms of its context and intensity. The affected environment descriptions below are based on surveys conducted by TVA, published and unpublished reports, and personal communications with resource experts. Information on regulatory frameworks for select resources is available in Appendix D.

Environmental consequences are and would continue to be assessed in multiple phases, including those associated with site preparation, construction, and operation. For the purposes of this PEA the project consists of construction phase activities that include construction or site preparation (grading, excavation, infrastructure development, and other actions) and operations.

Impacts may apply to the full range of natural, aesthetic, historic, cultural, and socioeconomic resources within the TVA PSA and within the surrounding area. Impact severity is dependent upon their relative magnitude and intensity and resource sensitivity. The context and intensity of potential environmental impacts are described in terms of their duration, magnitude, whether they are direct or indirect, and whether they are adverse or beneficial, as summarized in the following paragraphs:

- Short-term or long-term. Short-term impacts are those that would occur only for a limited, finite time with respect to the proposed action. Long-term impacts are those that would be persistent and chronic throughout the life of the proposed action or would last years after an impact producing activity occurred.
- Less-than-significant (no impact, minor, moderate) or significant, as defined in Section 2.4.
- Direct or indirect. Direct impacts are those that would occur as a result of and at the same time and place as the proposed action. Indirect impacts are those that would be caused by the proposed action but would occur at a different time or place.
- Adverse or beneficial. An adverse impact would cause unfavorable or undesirable outcomes on the human-made or natural environment. A beneficial impact would cause positive outcomes on the human-made or natural environment.

The impact analysis also includes consideration of effects associated with reasonably foreseeable future actions that have a close causal relationship to Sites. Potential effects could result from projects occurring at the same time and in close proximity to projects at respective Sites. Because specific Sites have not yet been identified, specific reasonably foreseeable future actions with a close causal relationship also cannot be identified; however, for all alternatives, it is assumed that reasonably foreseeable future actions in the vicinity of the Sites would comply with applicable local, state, and federal regulations and permit requirements, and BMPs would be implemented in accordance with the given environmental resource. Therefore, potential effects associated with reasonably foreseeable future actions in the vicinity of the Sites would be minor. Any reasonably foreseeable future actions that may affect environmental resources would be addressed during separate site-specific analyses, and actions taken to minimize further potential effects.

TVA would consider the conditions of each Site when reviewing the Proposed Action to determine whether it is appropriate to tier from this PEA. TVA would evaluate each proposed project during the Environmental Screening Checklist screening process. If TVA determines that no sensitive resources are present at the proposed Site or there is no potential for exceedance of environmental standards with effects on sensitive resources, the findings of this PEA with respect to NEPA compliance would apply. Conversely, if TVA determines that the Proposed Action affects sensitive resources beyond the bounded values assessed in this PEA, the proposed project would be subject to a site-specific environmental review consistent with TVA NEPA procedures.

3.1 Land Use

3.1.1 Affected Environment

Land use addresses both the natural land resources available in a given area as well as how available land is currently used by society. The U.S. Department of Agriculture (USDA) has identified land resource regions and major land resource areas (MLRA) that categorize land areas across the nation based on physiography, geology, climate, water, soils, biological resources, and land use. MLRAs are tiered from land resource regions and provide more local information for a region. The MLRAs in which TVA's coal sites are located are presented in **Table 3-1**, along with a description of the primary land uses of the MLRA.

Table 3-1. MLRA Classifications at TVA Properties

MLRA Name	Land Use Description	Location
Southern Mississippi River Alluvium	Consists of nearly level to gently undulating, thick, fertile alluvial deposits. Used extensively for cash and grain crop production. Woody wetlands comprise the largest land use, followed by soybeans.	ALF
Southern Mississippi Valley Loess	Consists of loess bluffs and moderate to steeply dissected hills with thinning soils toward the east. Agricultural use varies based on the location within the MLRA, ranging from cash and grain crops to livestock and forestry. Deciduous forest comprises the largest land use, followed by woody wetlands.	SHF
Kentucky and Indiana Sandstone and Shale Hills and Valleys, Southern Part	Characterized by loess-covered residuum from sandstone and shale. Used for row crop agriculture, livestock production, and forestry depending on the topography. Deciduous forest comprises the largest land use and surface coal mines make up a small percentage.	PAF
Highland Rim and Pennyroyal	Characterized by a plateau with low, rolling hills, upland flats, and narrow valleys. Used by small farms that produce crops, livestock, and forage. Deciduous forest comprises the largest land use, followed by grassland/pasture.	CUF, JOF
Nashville Basin	Characterized by steep slopes on the outskirts and undulating topography with many limestone sinks and outcrops on the inner part. Used by small and medium farms for crops, livestock, and forage. Deciduous forest comprises the largest land use, followed by grassland/pasture.	GAF

MLRA Name	Land Use Description	Location
Southern Appalachian Ridges and Valleys	Characterized by long, even ridges, with long, continuous valleys in between, and contains caverns and sinkholes in areas underlain by limestone. Used by small and medium farms, including farm woodlots, and supports mixed hardwood growth. Deciduous forest comprises the largest land use, followed by grassland/pasture.	BRF, COF, JSF, KIF, WBF, WCR

Source: NRCS 2022a, NRCS 2022b

TVA properties are industrial sites with typical industrial uses. Sites are assumed to be in previously disturbed areas and land use would not change.

3.1.2 Environmental Consequences

The potential effects on land use from a given action are assessed by evaluating the potential for an action to interfere with other land uses. Although the extent of land use impacts would vary from site to site, general effects from the alternatives within the TVA PSA are discussed below.

For action alternatives (B, C, D, E), installation of any treatment systems and any actions would occur on pre-disturbed land and no conversion of land use from preexisting conditions would be required, and implementation would not change land use in the vicinity. No additional impacts are anticipated during operations. Therefore, construction and operation would not be expected to adversely affect land use directly or indirectly in the short or long term beyond environmental standards. Overall land use impacts for each action alternative would be minor.

The sections below describe the parameters of disturbance for each alternative that amount to minor impacts.

3.1.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed; therefore, there would be no land use impacts under the No Action Alternative.

3.1.2.2 Alternative B – Enhanced In Situ Treatment

Per the bounding attributes identified in **Table 2-1**, Proposed Actions under Alternative B would require no more than 5 acres of land disturbance for any single treatment technology. Vertical wells would occupy a 2-acre corridor, approximately 3,000 feet in length by 25 feet wide. Horizontal wells would occupy a total of 3 acres, including 0.5 acres of surface disturbance for entry and exit points (approximately 100-feet wide by 100 feet in length each) and approximately 3,000 linear feet of below ground disturbance along the drill path for each nested well path. Installation of the PRB would occur on approximately 5 acres, occupying a trench approximately 3,000 feet long by 75 feet wide. The funnel and gate would require 3.5 acres of land, occupying a corridor approximately 3,000 feet in length by 50 feet in width. Effects on land from disturbance would be permanent, but would be mostly limited to previously disturbed areas and not change land use. Therefore, overall land use impacts would be long-term, minor, neither beneficial or adverse, and direct.

3.1.2.3 Alternative C – Hydraulic Control and Groundwater Treatment

Per the bounding attributes identified in **Table 2-1**, Proposed Actions under Alternative C would require up to 5 acres of land disturbance. Vertical extraction wells would occupy 2 acres or along the perimeter of the Site, as well as 0.5 acre required for the water treatment facility and 2 acres required for the discharge outfalls. Horizontal wells would occur in a long corridor along the downgradient border of the unit, occupying a total of 5 acres, with 0.5 acres required for the water treatment facility and 2 acres for the discharge outfalls. As stated above, overall land use impacts would be similar to Alternative B.

3.1.2.4 Alternative D – Monitored Natural Attenuation

Per the bounding attributes identified in **Table 2-1**, the Proposed Actions under Alternative D would require up to 1.5 acres of land disturbance. Construction effects would include approximately 1.5 acres of disturbance from construction of access roads, monitoring well development, and temporary laydown areas. Operational effects would include approximately 1 acre of impacts from ongoing operational construction disturbance. As stated above, overall land use impacts would be similar to Alternative B.

3.1.2.5 Alternative E – Combination of Corrective Actions

Under Alternative E, up to 6.5 acres of land disturbance would occur. Refer to the bounding analyses in **Table 2-1** for land disturbance impacts associated with each alternative. As stated above, overall land use impacts would be minor, similar to Alternatives B, C and D.

3.2 Geology, Soils, and Prime Farmland

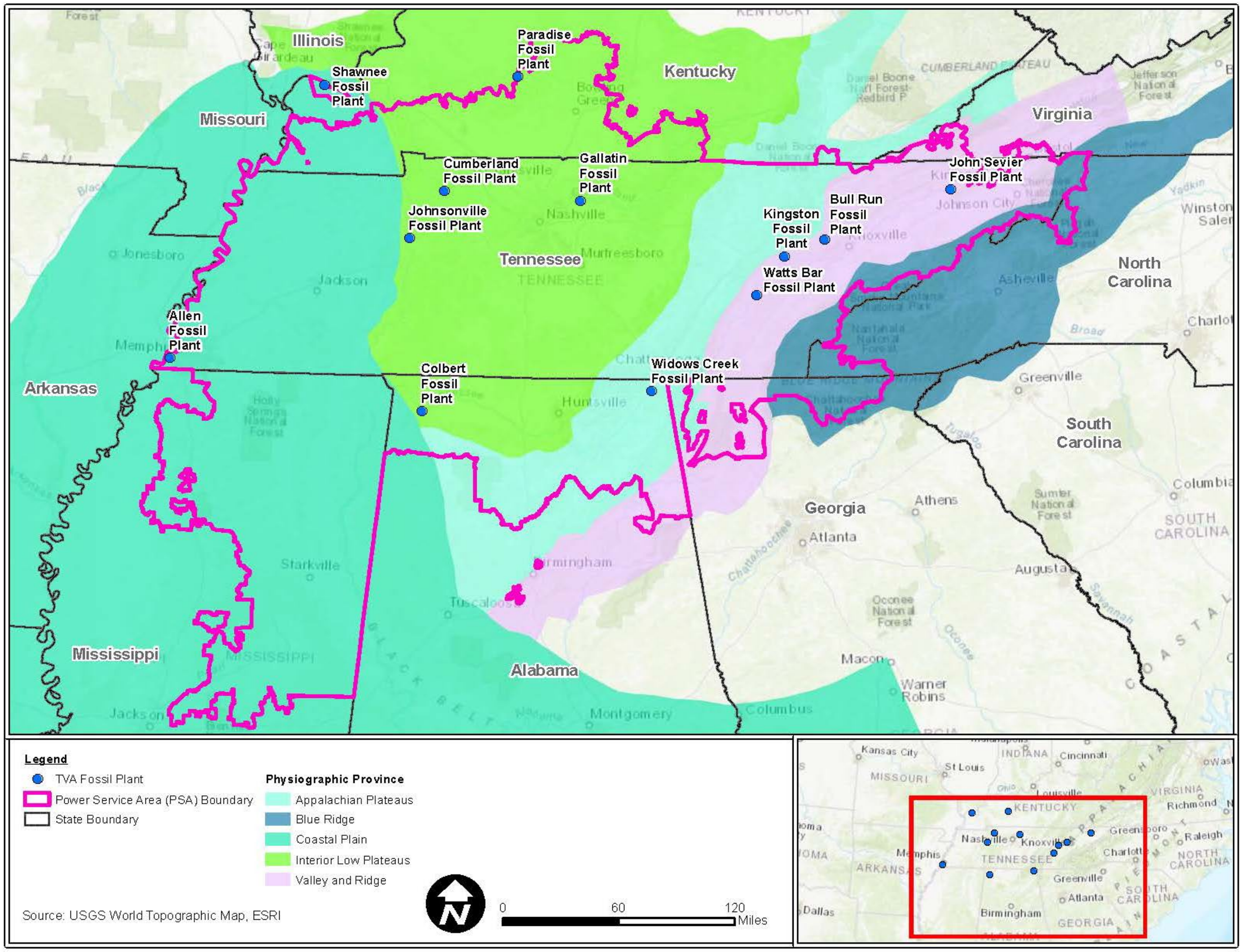
3.2.1 Affected Environment

3.2.1.1 Geologic Setting

The TVA PSA encompasses portions of five major physiographic provinces (**Figure 3-1**). Physiographic provinces are areas of similar land surfaces resulting from similar geologic history. Although the PSA contains five physiographic provinces, the analysis for this PEA is limited to the physiographic provinces overlain by the TVA properties. The TVA properties considered in this PEA are located within the following physiographic provinces (USGS 1946):

- Valley and Ridge
- Interior Low Plateaus
- Appalachian Plateaus
- Coastal Plains

The TVA properties considered in this PEA located furthest to the east are situated within the Valley and Ridge Province, which is characterized by alternating valleys and ridges that trend northeast to southwest. Ridges have elevations up to 3,000 feet above sea level and are generally capped by dolomites and resistant sandstones, while valleys have been formed in less resistant dolomites and limestones (TVA 2024a). The dominant soil types in this province are residual clays and silts derived from weathering. Karst features, such as sink holes, caves, springs, and underground drainage systems which are formed by the dissolution of high-carbonate rocks, are common throughout this province (USGS 1999).



Source: USGS 1946

Figure 3-1. Physiographic Provinces within the TVA PSA

The Appalachian Plateaus Province is an elevated area between the Valley and Ridge and Interior Low Plateaus Provinces. It consists of two sections, the Cumberland Plateau and the Cumberland Mountains. The Cumberland Plateau rises about 1,000 to 1,500 feet above the adjacent provinces and is formed by layers of horizontal Pennsylvanian sandstones, shales, conglomerates, and coals, and underlain by Mississippian and older shale and limestones. The sandstones are resistant to erosion and have produced a relatively flat landscape cut by deep stream valleys. Toward the northeast, the Cumberland Mountains section is more rugged due to extensive faults and several peaks exceeding 3,000 feet elevation. The province has a long history of coal mining and encompasses the Appalachian coal field (USGS 1996).

Two sections of the Interior Low Plateaus Province occur within the TVA PSA: the Highland Rim section and the Nashville Basin. The Highland Rim Section occupies much of central Tennessee, and parts of Kentucky and northern Alabama. Bedrock in this section includes Mississippian limestones, chert, shale, and sandstone. The terrain varies from hilly to relatively flat in the northwest and southeast. The Nashville Basin is an oval area in middle Tennessee, with an elevation about 200 feet below the surrounding Highland Rim. Bedrock in this section is composed of generally flat-lying limestones. Soil cover is usually thin, and surface streams cut into bedrock. Karst features are well-developed throughout the province (USGS 1996).

The Coastal Plains Province encompasses much of the PSA’s western and southwestern region. The underlying geology is a mix of poorly consolidated gravels, sands, silts, and clays. Soils are primarily derived of windblown and alluvial (deposited by water) nature, have low to moderate fertility, and are easily eroded. The terrain varies from hilly to flat in broad river bottoms. The Mississippi Alluvial Plain section (i.e., Mississippi Embayment) occupies the western edge of the province and much of the historic floodplain of the Mississippi River. The New Madrid Seismic Zone, an area of large prehistoric and historic earthquakes, is located in the northern portion of the section (Shumway 2019).

Table 3-2 summarizes the physiographic province and dominant soil types in which each TVA property is located.

Table 3-2. Summary of Geologic and Soil Characteristics at TVA properties

TVA Property	Physiographic Province	Dominant Soil Types[1]	Prime Farmland[2]
ALF	Coastal Plain	Filled land, sandy (Udorthent, loamy); Crevasse fine sand; Commerce silt loam, Robinsonville fine sandy loam; Robinsonville silt loam; Tunica silty clay; Crevasse silt loam (Bruno overwash)	Yes
BRF	Valley and Ridge	Udorthents; Collegedale-Rock outcrop complex; Armuchee-Montevallo complex; Armuchee silt loam; Salacoa silt loam’ Montevallo channery silt loam	No
COF	Interior Low Plateaus	Fullerton gravelly silt loam; Fullerton-Bodine complex; Urban land; Decatur-Urban land complex	Yes
CUF	Interior Low Plateaus	Bodine gravelly silt loam; Lindell silt loam; Maury silty clay loam; Melvin silt loam, frequently flooded; Sengtown gravelly silt loam	Yes

TVA Property	Physiographic Province	Dominant Soil Types[1]	Prime Farmland[2]
GAF	Interior Low Plateaus	Udorthents; Barfield-Rock outcrop complex; Slickens; Inman flaggy silty clay loam	No
JSF	Valley and Ridge	Holston-Urban land complex; Holston loam; Altavista silt loam; Guthrie silt loam	Yes
JOF	Interior Low Plateaus	Paden silt loam	Yes
KIF	Valley and Ridge	Urban land; Waynesboro loam; Dewey silt loam	No
PAF	Interior Low Plateaus	Fairpoint-Bethesda complex; Dumps, mine; Bethesda-Fairpoint complex; Udorthents	No
SHF	Coastal Plain	Dumps, Coal, and Waste disposal areas; Newark-Lindside complex, frequently flooded; Wheeling silt loam; Urban land-Udorthents complex; Huntington-Combs complex	Yes
WBF	Valley and Ridge	Urban land-Udorthents complex; Apison-Sunlight-Salacoa complex; Townley-Sunlight complex	No
WCR	Appalachian Plateau	Lindside silt loam; Melvin silt loam; Limestone rockland rough; Capshaw silt loam; Etowah silt loam; Greendale cherty silt loam; Huntington silt loam; Taft silt loam; Tupelo silt loam; Waynesboro fine sandy loam, eroded, rolling phase; Fullerton gravelly silt loam; Etowah loam; Cumberland silty clay loam, eroded; Bruno fine sandy loam; Colbert silty clay, eroded	Yes

Sources: USGS 1946, NRCS 2025
[1] The combination of listed soil types covers at least 50 percent of the respective TVA properties.
[2] Row indicates that at least one of the dominant soil types is considered prime farmland.

3.2.1.2 Soils and Prime Farmland

Soil types are categorized locally based on a wide array of unique properties caused by weathering, physical and chemical influences, and differences in parent material. **Table 3-2** identifies dominant soil types at each of the TVA properties considered in this PEA. Overall, soils at these plants are heavily disturbed as a result of industrial development.

Table 3-2 identifies whether any of the dominant soil types are considered prime farmland. Since this table does not include non-dominant soil types, it should not be used as a comprehensive guide as to whether prime farmland may be present at a fossil plant. In compliance with requirements under the Farmland Protection Policy Act of 1981, TVA would determine on a site-specific basis if Proposed Actions would occur in areas containing prime farmland and would subsequently complete Form AD-1006 to determine the farmland conversion impact rating for the site. A score exceeding 160 would indicate the subject farmland needs further consideration for protection or that mitigation should be considered to reduce effects. In most cases, if the Proposed Actions occur within already disturbed areas on a coal plant site, any previously existing prime farmland has already been disturbed and, therefore, no impacts to prime farmland would be anticipated.

3.2.1.3 Geologic Hazards

Karst is a type of topography formed when groundwater dissolves carbonate-rich rocks like limestone and dolomite, resulting in features such as sinkholes, caves, springs, and subterranean drainage networks. Karst topography is common in the Valley and Ridge Province and is also found throughout the Low Plateaus Province. Many of TVA's properties are located in areas known to contain karst; however, the site-specific presence of karst within the boundaries of each corrective action would need to be determined from geotechnical investigations during site-specific planning.

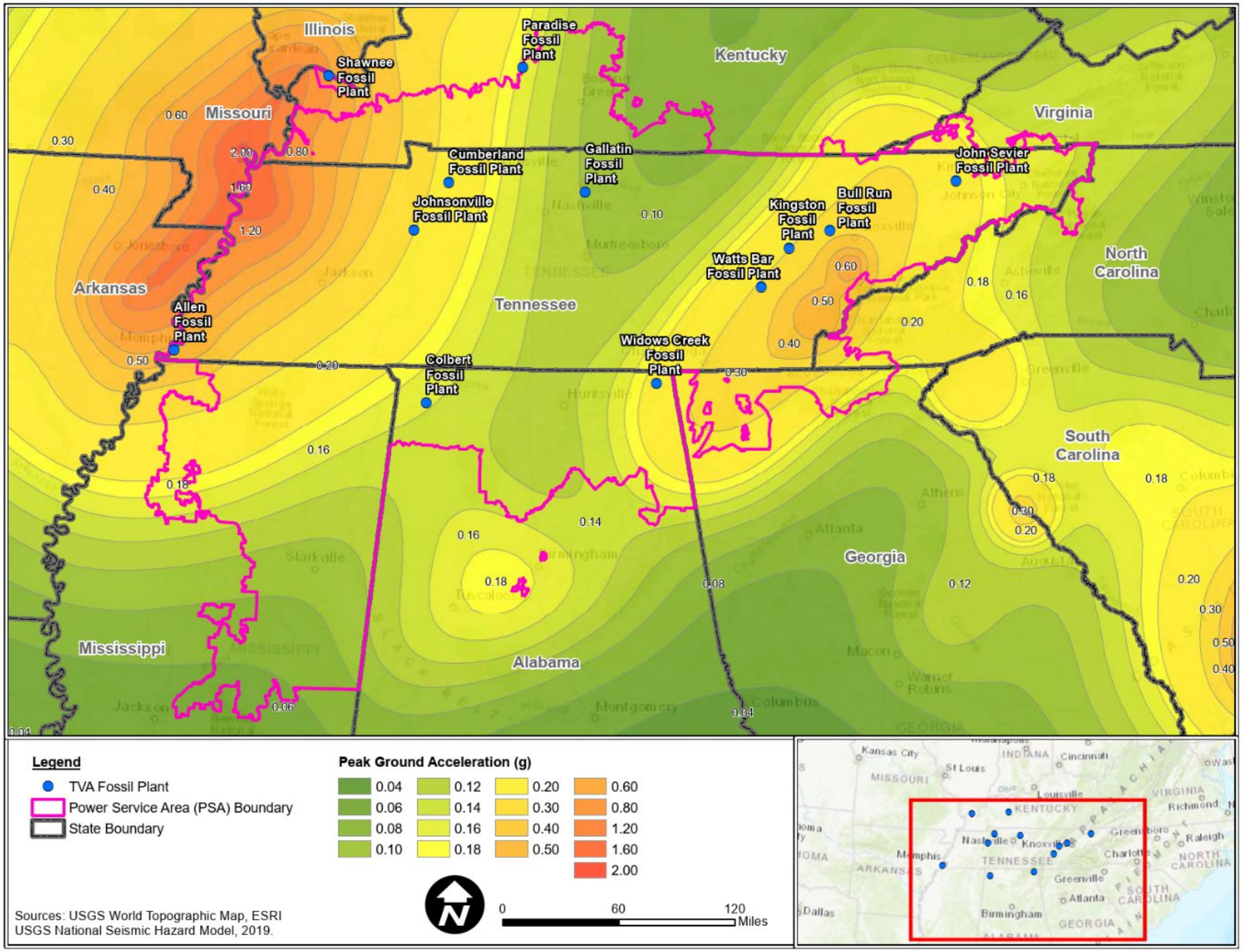
Other geological hazards within the TVA PSA include seismicity and faulting. A seismic zone is used to describe an area where earthquakes tend to focus. Earthquakes are commonly measured in terms of their peak ground acceleration (PGA), which measures the intensity of ground shaking at a specific location and is expressed in terms of gravity. **Figure 3-2** depicts the 2014 National Seismic Hazard Map for the PSA (Shumway 2019). Each of TVA's properties considered in this PEA are located in areas where the expected PGA is 0.1 gravitational pull (g) or greater. For sites located within seismic zones that exceed 0.1 g, or sites for which adjusted values based on conditions exceed 0.1 g, additional analysis would be required to demonstrate that structural components could withstand seismic events.

Table 3-3 identifies the expected PGA at each of TVA's properties considered in this PEA and identifies the seismic zones in which each site is located. The TVA properties in this PEA fall within the influence of three seismic zones: New Madrid Seismic Zone (NMSZ), East Tennessee Seismic Zone (ETSZ), and Wabash Valley Seismic Zone (WVSZ) (USGS 2025). Each physiographic region's specific conditions should be considered when evaluating the seismic hazard risk at a particular TVA property.

Table 3-3. Seismic Characteristics at TVA properties

TVA Property	Peak Ground Acceleration	Seismic Zone
ALF	0.5 to 0.6	NMSZ
BRF	0.3 to 0.4	NMSZ, ETSZ
COF	0.16 to 0.18	NMSZ
CUF	0.2 to 0.3	NMSZ
GAF	0.1 to 0.12	NMSZ, ETSZ
JSF	0.2 to 0.3	NMSZ
JOF	0.2 to 0.3	NMSZ, ETSZ
KIF	0.3 to 0.4	NMSZ, ETSZ
PAF	0.16 to 0.18	NMSZ, WVSZ
SHF	0.6 to 0.8	NMSZ
WBF	0.4 to 0.5	ETSZ
WCR	0.2 to 0.3	NMSZ, ETSZ

Source: USGS 2025



Source: Shumway 2019

Figure 3-2. Seismic Peak Ground Acceleration Factors in the TVA PSA

Consideration of the seismic setting for Proposed Actions, especially for installation of a water treatment facility, should also consider the presence and characteristics of faults. A fault is "a fracture or zone of fractures in any material along which strata on one side have been displaced with respect to that on the other side" (USGS 2018). This definition encompasses both tectonic faults (i.e., formed as a result of deep-seated, crustal scale tectonic processes) and associated secondary faults, as well as nontectonic faults (i.e., those formed as a result of shallow crustal or surficial processes). A review of the U.S. Geological Survey's (USGS) interactive map website, which contains information on Quaternary Faults, indicates no known faults of this age are located under the TVA properties. However, Paradise Fossil Plant is located adjacent to the Fluorspar Area fault complex to the south (USGS 2018).

3.2.2 Environmental Consequences

The potential effects on the geology, soils, and prime farmland from a given action are assessed by evaluating the potential for an action to modify protected geologic resources, to result in soil loss or disturbance, or to reduce the availability of prime farmland for agricultural purposes. Although the extent of geology, soil, and prime farmland impacts would vary from site to site, general effects from the alternatives within the TVA PSA are discussed below.

3.2.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed; therefore, there would be no geology, soils, or prime farmland impacts under the No Action Alternative.

3.2.2.2 Alternative B – Enhanced In Situ Treatment

Construction of EISTs would require soil disturbance, fill, and gravel for access roads. Installation of the PRB would require up to approximately 12,000 cubic yards of soil disturbance based on an assumed footprint of 3,000 feet in length, 10 feet in width, and 60 feet in depth. Construction of a gravel access road and working area around the PRB, with estimated dimensions of 1,000 feet in length, 10 feet in width, and 1 foot in depth, would contribute to further soil disruption. Less than 5 acres would be disturbed.

Vertical and horizontal injection well construction activities are each estimated to impact up to 500 cubic yards of soil within 2.5 acres. As described in the bounding analyses in Section 2.3, fill would also be required within a 100-foot x 100-foot area for storage of the cargo container (Conex) and storage tank required for operations.

For the funnel-and-gate system with vertical injection, both construction and post-construction activities may result in up to 4,000 cubic yards of soil being affected, based on a disturbance area measuring 1,000 feet in length, 10 feet in width, and 60 feet in depth. Less than 3.5 acres would be disturbed.

Collectively, these activities represent substantial soil interaction, which should be considered when assessing potential effects, site restoration requirements, and potential changes to subsurface conditions. All soil, gravel, or other fill would be sourced from a local, permitted, and existing site within 30 miles of the TVA property. Excavated material resulting from well installation is considered solid waste and disposal is discussed in Section 3.15.3.

The presence of unknown karst zones or faults in the vicinity of the corrective action could result in the inability to deliver reagents to the target depth interval and/or the migration of reagents to areas not intended for remediation. This potential risk exists because karst features and faults are typically associated with zones of higher permeability. In the case of karst and fault zones, it is possible that reagents delivered to the subsurface via injection could “daylight” in areas away from the intended injection area. However, proper site characterization prior to the design and implementations of an EIST corrective action alternative should identify any potential karst or fault zones and allow for appropriate mitigation measures before or during implementation. With reasonable planning and approach to injection of subsurface reagents, no daylighting is expected.

Operational effects on geology would be associated with the potential impact of seismic activity on the Proposed Actions, treatment technologies, and proposed water treatment facilities. The actual conditions at each property would be investigated during planning and design. If warranted, seismic considerations may be incorporated into the final design of the corrective action.

Although operation of EISTs would cause minor, localized alterations to site soils, these effects are not anticipated to result in geology, soils, or prime farmland impacts that would exceed environmental standards. All actions would occur within 60 feet of the surface. As such, impacts to these resources associated with the operation of Alternative B are expected to be long-term, minor, adverse, and direct.

3.2.2.3 Alternative C – Hydraulic Control and Groundwater Treatment

Construction of the hydraulic control and groundwater treatments would require minor soil disturbance, fill, and gravel for access roads. Less than 5 acres would be disturbed. Approximately 500 cubic yards of soil would be disturbed but no fill would be required for well installation. As described in the bounding analyses in Section 2.3, fill would be required within a 100-foot x 100-foot area for storage of the cargo container (Conex) and storage tank required for operations. All soil, gravel, or other fill would be sourced from a local, permitted, and existing site within 30 miles of the TVA property. Excavated material resulting from well installation is considered solid waste and is discussed in Section 3.15.3.

The presence of unknown karst zones or faults in the vicinity of the corrective action could result in the inability to recover impacted groundwater from specific areas and/or provide for the recovery of excessive groundwater from areas that are not impacted. This is because karst and faults are typically associated with higher permeability zones. However, like Alternative B, proper site characterization prior to the design and implementation of hydraulic control should identify any potential karst or fault zones and allow for appropriate mitigation measures before or during implementation.

Operational effects on geology and overall impacts of construction and operation would be the same as those described in Alternative B (Section 3.2.3.2), long-term, minor, adverse, and direct.

3.2.2.4 Alternative D – Monitored Natural Attenuation

Under the MNA Alternative, there would be no additional active corrective action; therefore, there would be limited effects on geology, soils, or prime farmland.

Construction associated with the MNA remedy would result in minor soil disturbance and surface modification for installation of two additional monitoring wells. Up to approximately 405 cubic yards of soil may be disturbed during construction activities. In addition, the access road would require the placement of up to 6 inches of gravel over an area of 0.5 acres to facilitate site access. Less than 1.5 acres would be disturbed. No soil disturbance would be required for well development under this alternative. All soil, gravel, or other fill would be sourced from a local, permitted, and existing site within 30 miles of the TVA property. Any excavated material resulting from construction is considered solid waste and is discussed in Section 3.15.3.

Operational effects on geology are not anticipated with the MNA alternative. Overall impacts are expected to be similar to those described in Alternative B (Section 3.2.3.2), long-term, minor, adverse, and direct.

3.2.2.5 Alternative E – Combination of Corrective Actions

Under Alternative E, between approximately 905 and 12,405 cubic yards of soil would be disturbed during construction activities, using a combination of Alternatives C and D, or B and D, respectively. In addition, the access road would require the placement of up to 6 inches of gravel over an area of 0.5 acres to facilitate site access. Less than 6.5 acres would be disturbed. Long-term, minor, adverse, direct impacts would occur from a combination of the specific combined alternatives as described in Sections 3.3.2.2 through 3.3.2.4. Excavated material resulting from well installation is considered solid waste and is discussed in Section 3.16.3.

3.3 Groundwater

The Safe Drinking Water Act of 1974 established the sole source aquifer (SSA) protection program, which regulates certain activities in areas where aquifers (water-bearing geologic formations) provide at least half of the drinking water consumed in the overlying area (i.e., SSA). No SSAs exist in the TVA PSA (USEPA 2025a).

3.3.1 Affected Environment

3.3.1.1 Regional Aquifers

Regional aquifers in the TVA PSA generally align with the major physiographic provinces. The aquifers include (in order of increasing geologic age): Tertiary and Cretaceous age sand aquifers of the Coastal Plain Province; Pennsylvanian sandstone units found mainly in the Appalachian (Cumberland) Plateau section; carbonate rocks of Mississippian, Silurian, Devonian, and Ordovician age of the Interior Low Plateaus section; and Cambrian-Ordovician age carbonate rocks within the Valley and Ridge Province (**Table 3-4**). Quaternary age alluvium is present in the floodplains of major rivers, including the Tennessee and Cumberland Rivers. Published water-bearing characteristics of these formations are summarized on **Table 3-4**.

Table 3-4. Aquifer, Well, and Water Quality Characteristics in the TVA PSA

Aquifer Description	Well Characteristics (common range, maximum)		Water Quality Characteristics
	Depth (feet)	Yield (gpm)	
Quaternary alluvium: Sand, gravel, and clay. May be confined or unconfined.	10–75, 100	20–50, 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.	100–1,300, 1,500	200–1,000, 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.	100–1,500, 2,500	50–500, 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.	100–200, 250	5–50, 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-plane openings. Unconfined or partly confined near land surface; may be confined at depth.	50–200, 250	5–50, 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; confined at depth.	50–150, 200	5–20, 300	Generally hard; some high sulfide or sulfate concentrations in places.
Cambrian-Ordovician carbonate rock: Highly faulted multi-aquifer unit of limestone, dolomite, sandstone, and shale; structurally complex. Unconfined; confined at depth.	100–300, 400	5–200, 2,000	Generally hard, brine below 3,000 feet.
Cambrian-Precambrian crystalline rock: Multi-aquifer unit of dolomite, granite gneiss, phyllite, and metasedimentary rocks overlain by thick regolith. High yields occur in dolomite or deep colluvium and alluvium. Generally unconfined.	50–150, 200	5–50, 1,000	Low pH and high iron concentrations may be problems in some areas.

Note: gpm = gallons per minute
Source: Webbers 2003

Due to the need for large amounts of cooling water, TVA's fossil plants are typically constructed near large surface water bodies, such as the Tennessee, Cumberland, and Ohio Rivers. As a result, most of the Sites that are the subject of this PEA are located on top of unconsolidated geologic materials deposited by those rivers (alluvium). These materials may include silts and clays that are poor transmitters of water, and/or more permeable sand and gravels that form groundwater aquifers. Groundwater corrective actions typically target the shallow sand and gravel aquifers, which have a maximum depth of approximately 60 feet for

Proposed Actions. Groundwater typically flows through the unconsolidated sand and gravel from the Site towards the adjacent river. Because of the proximity of these rivers, the area in which COIs exceed GWPSs with statistical significance is relatively small.

The unconsolidated geologic material deposited by the rivers are underlain by different types of bedrock geology as noted above. However, the Allen Fossil Plant is located on an embayment of the Mississippi River, where the geologic materials deposited by the Mississippi River are very thick and therefore bedrock is located at a substantial depth below the ground surface. At most sites, COIs do not exceed GWPSs in bedrock groundwater. At some sites, COI may exceed GWPSs with statistical significance when the uppermost shallower portions of the bedrock or weathered bedrock are interconnected with the alluvium.

The groundwater conditions are somewhat different at the Paradise Fossil Plant, which is at least partially constructed on fill derived from mining. Groundwater is present in this fill material.

Groundwater Use

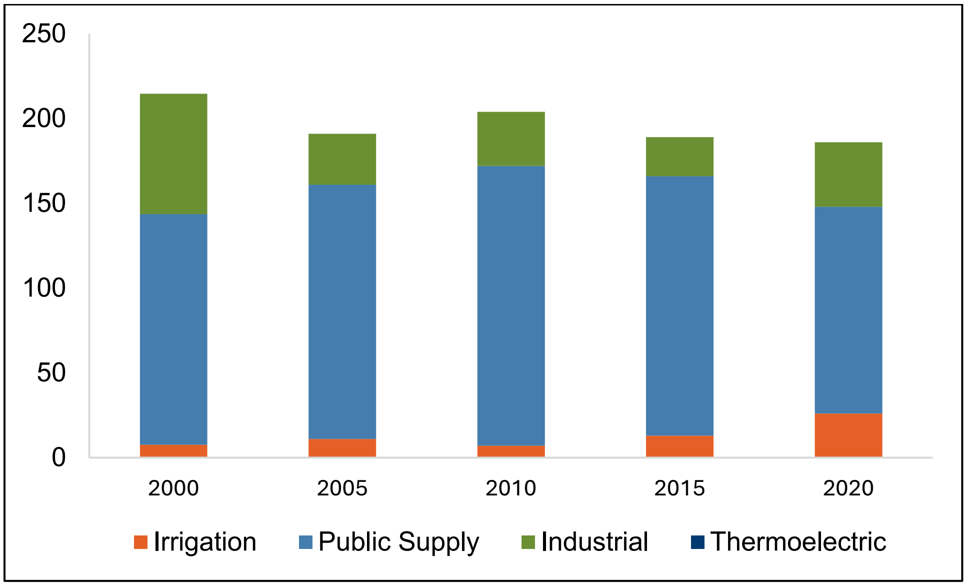
Groundwater data are compiled by the USGS and cooperating state agencies in connection with the national public water use inventory conducted every 5 years. The largest withdrawals of groundwater for public water supply are from the Tertiary and Cretaceous sand aquifers in the Mississippi Embayment and Southeastern Coastal Plains physiographic provinces. These withdrawals account for about two-thirds of all groundwater withdrawals for public water supply in the TVA region (TVA 2024a). In addition, there are numerous sparsely populated, rural counties in the PSA that do not have public water systems but are self-served by individual wells or springs. The Pennsylvanian sandstone and Orodovician carbonate aquifers have the lowest groundwater use (less than 1 percent of withdrawals) and lowest potential for groundwater use.

The majority of water use (97.8 percent) within the TVA PSA comes from surface water withdrawals. The remaining 2.2 percent, or 186 million gallons per day (MGD) in 2020, is obtained through groundwater withdrawals. The largest use of groundwater in the TVA PSA is for public water supply, with approximately 18 percent of the water used for domestic supply and approximately 27 percent of water used for irrigation originating from groundwater. Groundwater is also used for industrial, mining, livestock, and aquaculture purposes (Sharkey and Springston 2022).

The use of groundwater to meet public water supply needs varies across the TVA PSA as the result of several factors, including water availability, quantity, and quality along with development of economic supply and public water demand. Use is the greatest in west Tennessee and northern Mississippi due to groundwater availability, the absence of adequate surface water sources in some areas, and the presence of combined cycle plants that use groundwater for industrial purposes such as fire protection and cooling.

The use of groundwater is shown in **Figure 3-4**, which includes data for the Tennessee River Basin. Total groundwater use for public water supply in 2020 was 122 MGD in the Tennessee River Basin. Groundwater withdrawal for industrial use in the Tennessee River Basin was 38 MGD, or 3.6 percent of total industrial withdrawal. Groundwater use for irrigation was 26 MGD, or 27.2 percent of total irrigation use. Wheeler-Wilson was the Water Use Tabulation Area with the highest groundwater withdrawal, at 43 MGD (Sharkey and Springston 2022). Except for 2010, groundwater use has shown a decreasing trend from 1995 to 2020. In 2020, groundwater withdrawals reached their lowest level since 1995.

Groundwater use in the vicinity of the proposed Sites is variable and generally limited to private water supply wells (TVA 2024a). Groundwater is not used by TVA at any of the Sites. Most offsite wells are located upgradient of Sites, and there are no known wells that could be affected by the Proposed Actions evaluated in this PEA.



Source: Sharkey and Springston 2022

Figure 3-4. Groundwater Use by Category in the Tennessee River Basin, 2000 to 2020

<u>Groundwater Quality</u>

The quality of groundwater in the TVA region largely depends on the chemical composition of the aquifer in which the water occurs (**Table 3-4**). The most notable groundwater quality conditions are associated with elevated iron, sulfates/sulfides, dissolved solids, and areas of low pH. This is further supported by data published in National Water Quality Program-National Water-Quality Assessment Project summaries published by USGS. As examples, in publications *Groundwater Quality in the Valley and Ridge and Piedmont and Blue Ridge Carbonate Rock Aquifers, Eastern United States* and *Groundwater Quality in the Southeastern Coastal Plain Aquifer System, Southeastern United States* (Lindsey and Bruce 2016, Barlow et al. 2016, respectively), both summaries refer to occurrences of elevated iron, dissolved solids and low pH within the aquifer system. While this may not be specific to Sites, it should be considered when evaluating Proposed Actions at Sites. With respect to low pH, precipitation entering the aquifers in site-specific areas can potentially react with the aquifer matrix and influence the observed concentrations of site-specific COIs.

3.3.2 Environmental Consequences

The potential effects on groundwater from a given action are assessed by evaluating the potential for an action to modify protected geologic resources, modify the availability of groundwater, or release constituents to groundwater. Although the extent of effects on geology and groundwater would vary from site to site, general impacts from the alternatives within the TVA PSA are discussed below.

In general, groundwater is not resource that is actively used at any of the TVA properties for either potable or non-potable uses. TDEC Water Use Surveys were conducted as part of the

Environmental Investigation Plans (TVA 2018a, TVA 2018b, TVA 2018c, TVA 2018d, TVA 2018e, TVA 2018f, TVA 2019) for the Tennessee plants to identify and sample usable private water supply wells and surface water sources being used of domestic purposes near the sites. The surveys determined that current and historical CCR management has not affected water supply wells or springs located in the vicinity of the Sites. The results of the surveys are presented in the Environmental Assessment Reports (TVA 2023a, TVA 2023b, TVA 2023c, TVA 2024b, TVA 2024c, TVA 2024d, TVA 2024e, TVA 2025b).

Groundwater generally flows towards surface water bodies. Most groundwater would be extracted from unconsolidated sand and gravel aquifers if necessary. For applicable alternatives, substantial groundwater withdrawals could reduce the volume of groundwater reaching surface water and thus could affect baseflow levels in the surface water (which could affect surface water quality and ecosystems). For all alternatives, if groundwater withdrawal occurs, rates of withdrawal would not be of sufficient quantity to affect nearby streams or nearby groundwater users (if any), and treated groundwater would be discharged to surface water at a permitted outfall. Appropriate permits would be obtained for groundwater withdrawal (e.g., water allocation permits) whose requirements vary by state. For most, if not all, of the TVA properties, the volume of groundwater contribution from any specific Site is considered a *de minimus* contribution to the large surface water bodies (i.e., rivers) on which most of the TVA properties are located.

The purpose of the Proposed Actions is to improve groundwater quality such that it meets state and federal GWPS. Thus, the environmental impact of all of the action alternatives is an improvement in the groundwater resources, i.e. beneficial.

Effects on groundwater are bound by the ROIs discussed in **Table 2-1**, and the estimated ROIs are limited with respect to the overall size of a site and would be less than 20 feet in diameter for Alternatives B and D, and less than 185 feet in diameter for Alternatives C and E. Groundwater quality would be monitored during the corrective action implementation, in accordance with a groundwater monitoring plan. If there are unexpected negative consequences, they would be identified and addressed.

3.3.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed at TVA properties. TVA would continue groundwater corrective actions currently being conducted (Section 2.2.6), and all required groundwater monitoring would continue in conjunction with the CCR Rule, TDEC permits, or as required under TVA's agreement with TDEC. However, no additional corrective action at the specific site in question would take place, thereby possibly resulting in negative effects on groundwater that would make TVA out of compliance with federal and/or state regulations. As such, groundwater impacts would be moderate, adverse, direct, and long-term.

3.3.2.2 Alternative B – Enhanced In Situ Treatment

Under Alternative B, TVA would utilize EIST technologies to immobilize or reduce the concentration of targeted COIs. The use of reagents, in addition to treating groundwater, has the potential to dissolve naturally occurring minerals during treatment, which could represent a degradation in groundwater quality. It is assumed that these possibilities would be considered during design, and that appropriate monitoring would be conducted during implementation. The long-term outcome is an improvement in groundwater quality to meet GWPS. With the implementation of EIST, the possibility exists for potentially substantial changes in groundwater levels, both increasing and decreasing, and both up- and down-gradient. However, little, if any, overall change in the total volume of groundwater flow would result.

Construction Impacts

Construction of a PRB via a continuous trench (with or without a funnel and gate) would involve ground disturbances up to a maximum depth of approximately 60 feet below land surface, depending on the geological characteristics of the Site. Potential effects include temporary disruption of the existing groundwater flow conditions, and disturbance of the geologic materials resulting in localized turbidity of groundwater.

Installation of a treatment zone using vertical or horizontal wells would have less ground disturbance than trenching. The injection wells would be installed with hollow stem auger or sonic drilling methods. The casing for the wells would contain small diameter sealed piping to create multiple injection intervals that decrease the need for further ground disturbance past installation and increase the stability of wells. The potential effects on groundwater would be similar to trenching, but smaller and more localized at drilling targeted areas.

The use of chemicals and equipment that use petroleum fuels, lubricants, and hydraulic fluids during construction may result in the risk of small onsite spills or leaks. In the case of spills, leaks, or other chemical releases, temporary and indirect groundwater quality effects may occur from the contamination of stormwater infiltration. BMPs employed and maintained as required by state-issued construction stormwater permits under the NPDES would prevent, minimize, and mitigate potential stormwater contamination from construction activities, leaks, and spills. SWPPPs or CBMPPs would be used as a way to track the implementation and effectiveness of BMPs. Each BMP would comply with erosion and sediment control handbooks and technical specifications published by the applicable state agency. Site developers would be expected to comply with all appropriate state and federal permit requirements, including the implementation of appropriate BMPs, to help contain and minimize the introduction of pollutants, waste materials, and chemicals to stormwater. Additionally, onsite stormwater basins would aid in treatment and management. Due to the use of BMPs and other preventive measures, indirect groundwater impacts associated with the contamination of stormwater would not be anticipated.

With BMPs in place to minimize negative effects on groundwater quality within the TVA PSA, the overall impacts associated with the ground disturbance during construction would be direct, short-term, and moderate.

Operational Impacts

Operations would aim to immobilize or reduce COIs, overall providing beneficial effects on groundwater quality and fulfilling the purpose of the EIST alternative. Effects on groundwater flow associated with EIST primarily include the displacement of groundwater storage and/or the interference in existing groundwater flow patterns.

Over the design life, replacement of PRB treatment media may be required, constituting similar construction impacts as discussed above, depending on size and need. Reagent injections would be delivered to wells under low pressure to push reagent solution into pore spaces of the surrounding formation, with vertical injection using a gravity feed. The dedicated mixing and delivery system would be used as intended. These effects would be localized to the estimated ROIs for each method.

Chemical additives may be used in the operation or maintenance of EIST technology and would be stored and handled in accordance with all applicable local, state, and federal laws and regulations, including those established by the Occupational Safety and Health Administration (OSHA). Accidental leaks or spills would be handled in an efficient manner and would follow all local, state, and federal laws with respect to agency notification and cleanup practices. Due to the use of standardized handling, storage, and cleanup practices, any potential chemical additives used in the operation of EIST technology would have negligible, negative impacts to groundwater quality.

Given the temporary impact of additives to the groundwater weighed against the moderate, long-term impacts for groundwater improvement, overall groundwater impacts would be long-term, moderate, beneficial, and direct within the targeted implementation area.

3.3.2.3 Alternative C – Hydraulic Control and Groundwater Treatment

Under Alternative C, TVA would extract groundwater to provide for both hydraulic containment and COI mass recovery. Extraction wells would be screened within the aquifer that is targeted for hydraulic control, and extracted groundwater would be pumped through a conveyance pipeline and treated prior to discharge under applicable permit(s). Within TVA's water conveyance infrastructure, treated groundwater could potentially combine with stormwater or other waters and make its way back into the groundwater, though impacts would be minimal.

This alternative is intended to prevent migration of groundwater that does not currently meet GWPS. As a result, groundwater quality downgradient of the extraction system would improve to meet standards. There is potential for substantial changes in water levels, flow rates/directions as groundwater is intercepted and removed for treatment. Direct use of groundwater would not be affected as it is not used by TVA. Although groundwater withdrawal near surface water bodies could reduce baseflow and potentially pull water from nearby surface water bodies, proposed withdrawals would not be of sufficient quantities to affect hydrology or aquatic systems.

Construction Impacts

Construction for Alternative C would involve the installation of horizontal or vertical wells similar to Alternative B, including ground disturbance up to a maximum depth of approximately 60 feet below land surface, depending on the geological characteristics of the Site. Installation of horizontal extraction wells would differ somewhat from the horizontal wells used in Alternative B. Alternative C horizontal wells would require larger boreholes using drilling and supporting equipment (i.e., excavator).

Potential effects of construction include temporary disruption of the existing groundwater flow conditions, and disturbance of the geologic materials resulting in localized turbidity of groundwater. The groundwater effects associated with the ground disturbance during construction would be direct, short-term, and moderate, with BMPs in place to minimize effects.

Similar to Alternative B, indirect groundwater impacts associated with the contamination of stormwater infiltration would not be anticipated due to the use of BMPs and other preventive measures. Overall, construction impacts to groundwater would be short-term, moderate, adverse, and direct.

Operational Impacts

The volumes, rates, and directions of groundwater flow would be affected by the diversion of a portion of the natural groundwater flow volume due to extraction of groundwater under Alternative C. The extent of these changes is defined by the estimated ROIs. Although groundwater withdrawal near surface water bodies could reduce baseflow and potentially pull water from nearby surface water bodies, proposed withdrawals would not be of sufficient quantities to affect hydrology or aquatic systems.

Operations would aim to recover targeted groundwater in the uppermost aquifer, providing beneficial impacts to groundwater quality overall. Over the design life, replacement of pumps and/or recovery wells may be required, constituting similar construction impacts, depending on size and need. These long-term groundwater impacts would be moderate, direct and beneficial within the targeted implementation area.

Any chemical additives related to the treatment of recovered groundwater used in the operation or maintenance of the treatment facility would be stored and handled similarly to those in Alternative B, and in accordance with all applicable local, state, and federal laws and regulations, and BMPs. Overall groundwater impacts would be long-term, moderate, beneficial, and direct.

3.3.2.4 Alternative D – Monitored Natural Attenuation

Under Alternative D, TVA would develop plans to monitor the physical, chemical, or biological processes that occur naturally in groundwater to reduce the concentration or mobility of site COIs. MNA would be evaluated in phases following the USEPA tiered approach for exposure and risk assessment. Additional groundwater monitoring wells would likely be installed to meet the objectives of the groundwater monitoring plan. The construction impacts would be similar to those for well installation in Alternative B or C, although two monitoring wells would likely require less ground disturbance than those alternatives. Installation of monitoring wells would be a minor, short-term, adverse, and direct.

This alternative would include Adaptive Site Management strategies to identify potential alternate remedies should MNA not meet short- and long-term performance goals as planned. Operational impacts are more difficult to ascertain given adaptive management. There are negligible impacts to the actual monitoring of the sites, but any effects would need to be evaluated on a case-by-case basis. Overall groundwater impacts, including operational impacts, would be long-term, moderate, beneficial, and direct.

3.3.2.5 Alternative E – Combination of Corrective Actions

Under Alternative E, TVA would utilize a combination of Alternatives B, C, and/or D to meet the purpose and need of the project. As such, this Alternative could have larger effects than the other alternatives, as they could be additive depending on choices for installation, or if done with concurrent use in mind may not be. Any combination of activities would need to be evaluated on a case-by-case basis for scale, but overall, construction impacts to groundwater would be short-term, moderate, adverse, and direct, with operational effects being long-term, moderate, beneficial, and direct, with continuous need for operation to maintain corrective actions.

3.4 Surface Water and Soil Erosion

3.4.1 Affected Environment

Surface water resources within the TVA PSA support a variety of beneficial uses, including habitat for aquatic life, recreation, domestic and industrial water supply, waste assimilation, and agriculture. The PSA encompasses portions of several major river systems, notably the Tennessee, Cumberland, and Mississippi Rivers. Freshwater is abundant throughout the region and generally supports water-contact recreation (e.g., swimming) and aquatic ecosystems. The quality of surface waters, such as streams, rivers, lakes, and reservoirs, is a critical factor to the protection of human health and maintaining ecological integrity. Overall, water quality within the TVA PSA, including the 12 sites considered in this PEA, is generally fair to good (TVA 2025c).

Surface water resources primarily consist of water bodies such as rivers, lakes or reservoirs, and tributary streams that collect, retain, and convey precipitation from the surrounding landscape. In some cases, groundwater contributes to surface water flow where hydrologic connectivity exists, such as through springs or other geologic features. The quality and characteristics of these surface waters vary considerably based on land use (e.g., industrial, agricultural, urban, or conservation), soil types, precipitation patterns, and interactions with groundwater, all of which can also affect rates of soil erosion. As discussed in Appendix E, Section 404 of the CWA, jointly implemented by the USEPA and the U.S. Army Corps of Engineers, regulates the discharge of dredged or fill material into waters of the U.S., including wetlands. Surface waters in the TVA PSA are regulated by the CWA, with oversight provided by USEPA and implementation responsibilities often delegated to state agencies.

Point and non-point sources of pollution contribute to water quality degradation within watersheds. Common sources include thermal discharges from utility and industrial operations, which may release heated effluent into streams and lakes, potentially impacting aquatic ecosystems. Wastewater discharges from municipal treatment systems, industrial facilities, and aging infrastructure can also introduce pollutants such as nutrients, bacteria, and trace metals. In addition, physical alterations to waterways—such as channelization and removal of riparian vegetation—can disrupt habitat conditions and exacerbate erosion and sedimentation.

Nonpoint source runoff from agricultural operations, urban development, landfills, and legacy mined lands introduces a range of pollutants, including sediments, fertilizers, pesticides, and hydrocarbons. Atmospheric deposition further contributes to water quality concerns, as airborne pollutants such as mercury and nitrogen compounds can be deposited directly into surface waters via precipitation (TDEC 2024a). TVA construction and maintenance activities follow state-mandated stormwater management practices consistent with the *TDEC Erosion Prevention and Sediment Control Handbook*. The updated 2024 chapters (1–2) provide guidance on stormwater management and planning, while Chapters 3–9 (2012 version) continue to inform field-level BMP selection and implementation (TDEC 2024b, TDEC 2012).

The alternatives could affect surface waters across several hydrologic subregions, including those associated with the Tennessee River, Mississippi River, Cumberland River, Ohio River, and Green River. **Table 3-5** identifies the TVA properties considered in this PEA and their associated major rivers or reservoirs.

Table 3-5. TVA Properties and Associated Surface Waters with 303(d) Status and Water Quality Reports

TVA Property	Associated Surface Waters	Most Recent Water Quality Report	Most Recent 303(d) Report
Allen Fossil Plant	Mississippi River, McKellar Lake (Mississippi River)	2023 MLGW Water Quality Report (Memphis, TN)	2024 Mississippi 303(d) List
Bull Run Fossil Plant	Melton Hill Reservoir (Clinch River), Bull Run Creek	2023 TDEC Annual Compliance Report	2024 Tennessee 303(d) List
Colbert Fossil Plant	Pickwick Landing Reservoir (Tennessee River)	2022 ADEM Integrated Report	2024 Alabama 303(d) List
Cumberland Fossil Plant	Barkley Reservoir (Cumberland River)	2022 Kentucky Integrated Report	2024 Kentucky 303(d) List
Gallatin Fossil Plant	Old Hickory Reservoir (Cumberland River)	2023 Nashville Metro Water Report	2024 Tennessee 303(d) List
John Sevier Fossil Plant	John Sevier Detention Reservoir (Holston River)	2023 TDEC Annual Compliance Report	2024 Tennessee 303(d) List
Johnsonville Fossil Plant	Kentucky Reservoir (Tennessee River)	2023 TDEC Annual Compliance Report	2024 Tennessee 303(d) List
Kingston Fossil Plant	Watts Bar Reservoir (Tennessee River), Clinch River, Emory River	2023 TDEC Annual Compliance Report	2024 Tennessee 303(d) List
Paradise Fossil Plant	Green River	2023 Green River Water District Report	2024 Kentucky 303(d) List
Shawnee Fossil Plant	Metropolis Lake (Ohio River), Little Bayou Creek,	2022 Kentucky Integrated Report	2024 Kentucky 303(d) List
Watts Bar Fossil Plant	Chickamauga Reservoir (Tennessee River), Walton’s Shoals	2023 TDEC Annual Compliance Report	2024 Tennessee 303(d) List
Widows Creek Fossil Plant	Guntersville Reservoir (Tennessee River), Widows Creek	2022 ADEM Integrated Report	2024 Alabama 303(d) List

3.4.1.1 Tennessee River Watershed

The Tennessee River watershed covers approximately 41,000 square miles across 129 counties in Tennessee, Alabama, Kentucky, Georgia, Mississippi, North Carolina, and Virginia. The river originates at the confluence of the Holston and French Broad Rivers in Knoxville, Tennessee, and flows southwest, gaining water from major tributaries such as the Little Tennessee, Clinch, Hiwassee, Elk, and Duck Rivers before entering the Ohio River near Paducah, Kentucky.

Key TVA-managed waterbodies in this watershed include Melton Hill Reservoir (Bull Run Fossil Plant), Pickwick Landing Reservoir (Colbert Fossil Plant), Kentucky Reservoir (Johnsonville Fossil Plant), Watts Bar Reservoir (Kingston Fossil Plant), Chickamauga Reservoir (Watts Bar Fossil Plant), and Guntersville Reservoir (Widows Creek Fossil Plant). These surface waters are used extensively for navigation, recreation, aquatic habitat, and cooling water for energy generation.

According to the 2024 Tennessee 303(d) list, the Clinch River, Emory River, and Watts Bar Reservoir remain impaired for mercury and polychlorinated biphenyls (PCBs) in fish tissue, resulting in fish consumption advisories (TDEC 2024). Similarly, Alabama's 2024 303(d) list identifies Guntersville Reservoir for mercury-related fish tissue contamination, with atmospheric deposition identified as the primary source (ADEM 2024). Portions of Pickwick Reservoir and adjacent tributaries are also impaired due to biological integrity issues and legacy discharges (ADEM 2024).

Sources of impairment across these segments include urban and agricultural runoff, industrial and legacy waste discharges, channel modifications, and atmospheric deposition of mercury and other toxics (TDEC 2024, ADEM 2024). TVA manages these waters through a network of dams and reservoirs that influence flow, temperature, and aquatic conditions across the basin.

3.4.1.2 Cumberland River Watershed

The Cumberland River originates in Letcher County, Kentucky, and flows nearly 700 miles to its confluence with the Ohio River, draining a watershed of approximately 18,000 square miles. The river passes through Tennessee for more than 300 miles, collecting runoff from 11,000 square miles of mixed-use landscape. TVA facilities along the Cumberland River include Barkley Reservoir (Cumberland Fossil Plant) and Old Hickory Reservoir (Gallatin Fossil Plant). These waters support navigation, power generation, water supply, and recreational use. According to the 2024 Kentucky Integrated Report, multiple reaches of the Cumberland River and its tributaries are impaired for E. coli, nutrients, and sediment, with the primary contributors being livestock runoff, cropland erosion, and failing septic systems (KEEC 2024). In Tennessee, the Gallatin-area segment is listed for nutrients, E.coli, and sediment/siltation (TDEC 2024).

Statewide total maximum daily loads (TMDLs) have been adopted for bacterial pathogens, and watershed-specific implementation plans are in progress for sediment and nutrient management. While large reservoir segments remain supportive of aquatic life, several localized impairments affect smaller tributaries and near-shore zones.

3.4.1.3 Lower Ohio River Watershed

The Ohio River originates in Pittsburgh, Pennsylvania, at the confluence of the Allegheny and Monongahela Rivers and flows 981 miles southwest to its confluence with the Mississippi

River at Cairo, Illinois. The lower portion of the watershed drains a 204,000-square-mile area and forms the northern boundary of Kentucky for over 650 miles. TVA's Shawnee Fossil Plant is located near the confluence of Little Bayou Creek and the Ohio River, adjacent to Metropolis Lake, a backwater feature of ecological interest. These waters support barge traffic, water intake, fishing, and thermal effluent dilution.

The 2024 Kentucky Integrated Report identifies the Ohio River as impaired for fish consumption due to legacy contaminants such as PCBs, mercury, and chlordane, with fish tissue advisories spanning the full reach of the river in Kentucky (KEEC 2024). Little Bayou Creek and Metropolis Lake are also impaired for pathogens, nutrients, and low dissolved oxygen, with sources linked to agricultural runoff, onsite treatment failures, and channelization (KEEC 2024). These waters remain listed under Category 5, and while some watershed plans exist, TMDL development is pending due to regional coordination needs with Ohio River Valley Water Sanitation Commission and multi-jurisdictional agencies.

3.4.1.4 Green River Watershed

The Green River originates in Lincoln and Casey Counties in Kentucky and flows 330 miles to the Ohio River near Henderson, draining 9,273 square miles—of which 377 square miles are in Tennessee. The upper basin includes rugged hills, while the central and western portions lie within karst topography interspersed with caves and subsurface flow systems. TVA's Paradise Fossil Plant is located along the middle portion of the Green River. This section of the river is used for navigation, recreation, and riparian water withdrawal.

According to the 2024 Kentucky Integrated Report, segments of the Green River are impaired for E. coli, total suspended solids, nutrients, and biological integrity, primarily due to row crop farming, pasture runoff, and urban nonpoint pollution (KEEC 2024). The karst system contributes to variable flow paths and complex pollutant transport dynamics. Several TMDLs are in place or under development in the basin, targeting sediment and nutrient reduction. Despite these challenges, the mainstem Green River generally supports aquatic life and recreational uses.

3.4.1.5 Mississippi River Watershed

The Mississippi River flows 2,350 miles from Minnesota to the Gulf of Mexico and drains 1.2 million square miles, making it the fourth-largest watershed in the world. In Tennessee, the river forms the western boundary of the State and receives industrial and municipal discharges from the Memphis area, including effluent from TVA's Allen Fossil Plant. Adjacent to the plant is McKellar Lake, a slackwater embayment subject to urban and industrial influence.

The 2024 Tennessee 303(d) list identifies McKellar Lake as impaired for low dissolved oxygen, nutrients, chlordane, dioxin, mercury, PCBs, E. coli, and sediment/siltation, with urban runoff, combined sewer overflows, and historical industrial discharges cited as primary causes (TDEC 2024). Mississippi's 2024 303(d) list also classifies nearby lower river segments as impaired for nutrient enrichment, siltation, and reduced aquatic life support (MDEQ 2024). These waters remain under long-term monitoring and remediation efforts, with TVA and local partners implementing BMPs and supporting watershed planning efforts to reduce pollutant loads and improve water quality.

3.4.2 Environmental Consequences

Construction and implementation of Proposed Actions could result in localized surface water and soil erosion impacts for all action alternatives, as construction activities are similar in type for all alternatives, though not extent or footprint necessarily. Disturbances associated with excavation, grading, and installation of treatment systems, such as trenches, wells, pipelines, or other infrastructure, can increase the potential for erosion and sedimentation, especially during initial site preparation activities. These effects may be most pronounced during precipitation events when exposed soils contribute to increased sediment loads in surface runoff.

Vegetation clearing and the introduction of impervious surfaces (e.g., roads, foundations, and equipment pads) could alter site hydrology by increasing surface runoff and reducing infiltration. In turn, these hydrologic changes may contribute to erosion and adversely affect surface water quality if proper controls are not implemented.

Direct impacts to water resources would be avoided by project design. Indirect impacts could result from stormwater runoff during construction, which would be adequately managed with adherence to BMPs to capture sediment prior to leaving the site. Potential effects could occur directly or indirectly due to modification of the riparian zone and stormwater runoff resulting from construction activities. Potential effects due to removal of vegetation may increase erosion and siltation, loss of instream habitat, and increased stream temperatures, though this is not anticipated. A potential indirect effect of routine maintenance includes potential herbicide runoff into streams.

To mitigate these potential effects, TVA would implement BMPs in accordance with site-specific SWPPPs and applicable state erosion and sediment control regulations (e.g., CBMPP in Alabama) to avoid potential adverse effects to water quality and aquatic life. Additionally, each BMP would comply with erosion and sediment control handbooks and technical specifications published by the applicable state agency. With implementation of these measures, surface water and soil erosion impacts are expected to be minor and localized, and generally short-term in duration. Specifically, BMPs are expected to provide guidance for activities occurring in or around watersheds to minimize the amount and length of disturbance to water bodies and maintain natural stream buffers. An NPDES stormwater construction permit would likely apply. This permit requires the preparation of a SWPPP that outlines measures that would be implemented to avoid or reduce adverse effects to local waters.

The nature and extent of effects would vary depending on the alternative selected and site-specific factors such as soil erodibility, slope, and proximity to surface waters. Potential environmental consequences of each alternative are discussed in the following subsections.

3.4.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed; therefore, there would be no soil or surface water impacts under the No Action Alternative. Because no new soil disturbance or construction activities would take place, no short-term erosion or sedimentation impacts are anticipated under this alternative. However, if groundwater COIs continue to migrate or discharge to surface waters under this alternative, indirect effects such as long-term degradation of water quality or sediment contamination could occur at some sites. These potential effects would depend on the hydrogeologic connectivity between groundwater and surface water systems and the persistence of contamination; impacts from Alternative A would be minor to moderate depending on site-specific conditions.

3.4.2.2 Alternative B – Enhanced In Situ Treatment

Under Alternative B, effects on surface water and soil erosion would primarily be associated with site preparation and excavation during construction, which could disturb soil stability and increase erosion. BMPs described in the project-specific SWPPP would be implemented during site preparation and maintained through construction. Additionally, each BMP would comply with erosion and sediment control handbooks and technical specifications published by the applicable state agency.

Construction activities may generate limited wastewater, such as equipment wash water, dust control runoff, or hydrostatic test water. These would be managed in accordance with site-specific permits and BMPs. Following construction, all disturbed areas would be stabilized to reduce the potential for long-term erosion. Overall and given BMPs, short-term, minor, adverse (possibly beneficial for erosion), and direct (erosion) or indirect (surface water) impacts to surface water and erosion are anticipated from construction.

During operations, EIST systems would not generate surface discharges or alter runoff patterns or temperatures. Therefore, operational impacts to soil erosion and surface water would be short-term, negligible to minor, adverse, and indirect.

3.4.2.3 Alternative C – Hydraulic Control and Groundwater Treatment

Under Alternative C, effects on surface water and soil erosion would primarily be associated with site preparation, excavation, construction of above-ground treatment systems and associated infrastructure, and the discharge of treated water. BMPs described in the project-specific SWPPP would be implemented during site preparation and maintained through construction. Additionally, each BMP would comply with erosion and sediment control handbooks and technical specifications published by the applicable state agency. Therefore, only minor surface water impacts are anticipated.

All ground disturbance would be stabilized upon completion of construction to prevent potential for long term erosion. Wastewater generated during the proposed project may include non-detergent equipment washing, dust control and hydrostatic test discharges. BMPs would be determined by local ordinances and state regulations. Permits would be obtained and/or modified as necessary. Therefore, this alternative would have construction impacts to erosion and surface waters similar to those described for Alternative B.

During operations, water extracted via treatment technologies, including extraction wells and associated conveyance systems, would be discharged to nearby surface waters via permitted outfalls after filtration and/or other treatment . It is possible that conveyance infrastructure and above-ground treatment may result in changes to the temperature or physical and chemical characteristics such as nutrient concentrations, dissolved oxygen levels, or conductivity of the discharged water relative to ambient surface water conditions. While such changes are expected to be minor, even slight shifts could affect localized aquatic conditions, particularly in sensitive habitats. Therefore, TVA would evaluate potential thermal, physical, and chemical water quality effects during permitting and design and incorporate mitigation measures as appropriate (e.g., passive cooling, controlled discharge timing, or diffuser structures). Permits for groundwater withdrawal and discharge (e.g., NPDES and state water allocation) would be obtained or modified as required, ensuring TVA continues to meet discharge requirements and water quality standards. With implementation of appropriate BMPs and permit conditions, surface water and erosion impacts from operations are expected to be short-term, minor, adverse, and indirect.

3.4.2.4 Alternative D – Monitored Natural Attenuation

Under Alternative D, effects on surface water and soil erosion associated with construction may result from installation of two monitoring wells. These impacts would be localized and minor; little soil disturbance is expected. Ground disturbance would be stabilized upon completion of construction to prevent potential long-term erosion. Limited wastewater would be generated during well installation. Overall and given appropriate BMPs, soil erosion and surface water impacts during construction would be temporary and minor.

During operations, the proposed project would have no water discharge and would not cause a change in runoff volume or temperature from preconstruction conditions. Operational impacts to soil erosion and surface water would be short-term, minor, adverse, and indirect.

3.4.2.5 Alternative E – Combination of Corrective Actions

Under Alternative E, effects on surface water and soil erosion would primarily be associated with site preparation, excavation, and construction of above-ground treatment systems and associated infrastructure. BMPs described in the project-specific SWPPP would be implemented during site preparation and maintained through construction. Impacts to surface water or soil erosion from construction from Alternative E would be similar to those described for Alternatives B, C, and D above; only minor impacts to surface water or soil erosion are anticipated. Similarly, operational impacts to soil erosion and surface water would be similar to those described for Alternatives B, C, and D above and therefore be minor to moderate, depending on the implementation of the water treatment facility and resulting discharges.

3.5 Floodplains

3.5.1 Affected Environment

A floodplain is the relatively level land area along a stream or river that is subject 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. To ensure that the project is consistent with the requirements of EO 11988 (Floodplain Management), evaluating development in the floodplain area is necessary. For certain “critical actions,” the minimum floodplain of concern is the 500-year floodplain. The U.S. Water Resources Council defines “critical actions” as “any activity for which even a slight chance of flooding would be too great” (U.S. Water Resources Council 1978). Critical actions can include facilities producing hazardous materials (such as liquefied natural gas terminals), facilities whose occupants may be unable to evacuate quickly (such as schools and nursing homes), and facilities containing or providing essential and irreplaceable records, utilities, and/or emergency services (such as large power-generating facilities, data centers, hospitals, or emergency operations centers).

Existing CCR units are protected by dikes, containment walls, or riprap bank stabilization to elevations meeting or exceeding the 500-year flood elevation at those locations, or the CCR are in locations on ground that is naturally higher than the 500-year flood elevation, thus meeting the criteria for critical actions.

3.5.2 Environmental Consequences

Although the extent of impacts to floodplains would vary from site to site, general effects from the alternatives within the TVA PSA are discussed below. TVA plans to avoid the FEMA 100-year floodplain for permanent above-ground structures and the ground below the 100-year flood elevation.

3.5.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed. Therefore, Alternative A would result in no additional development within 100-year floodplains, and thus no changes within floodplains, which would be consistent with EO 11988 (Floodplain Management).

3.5.2.2 Analysis of Alternatives B, C, D, and E

As stated in Section 2.3, TVA would evaluate each proposed action alternative or a combination of the previous three alternatives against the applicable bounding analysis table. TVA would also conduct site-specific analyses to identify the presence and location of onsite floodplains. Under Alternatives B, C, D, and E, as per the bounding analysis table, flood-damageable structures, facilities, or activities would be constructed in areas outside 100-year floodplains as delineated on FEMA flood insurance rate maps and/or on contour maps showing known 100-year flood elevations.

However, wells could be constructed within 100-year floodplains. Groundwater wells are not considered repetitive actions in the floodplain (TVA 1981). Should they be installed within the 100-year floodplain, installation of the wells would include anchoring the well casings in a small concrete pad and installing bollards to protect the wells. The wells could contain instrumentation, transducers and sampling pumps and water-tight well caps would be installed to protect any monitoring equipment. To appropriately monitor and/or treat impacted groundwater, there is no practicable alternative to the installation of certain wells within the 100-year floodplain. All work would be completed in coordination with the TDEC – Division of Remediation or other regulator, as appropriate.

Under Alternatives B, C, D, and E, standard BMPs would be implemented to minimize adverse impacts to floodplains. Except where further review is needed, by implementing the measures associated with the applicable bounding analysis table, the Proposed Actions would be consistent with EO 11988 (Floodplain Management) and have only short-term, minor, adverse, indirect and direct impacts on floodplains and their natural and beneficial values.

3.6 Wetlands

3.6.1 Affected Environment

Wetlands are areas inundated by surface or groundwater such that vegetation adapted to saturated soil conditions is prevalent. Wetlands are typically transitional habitats between terrestrial and aquatic communities and include swamps, marshes, bogs, sloughs, potholes, wet meadows, mud flats, and natural ponds. These ecosystems are ecologically important because of their beneficial effects 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 (USEPA 2002). As discussed in Appendix E, Section 404 of the CWA, regulates the discharge of dredged or fill material into waters of the U.S., including wetlands.

The TVA properties evaluated in this PEA intersect all or portions of 14 Hydrologic Unit Code (HUC)-8 sub-basins (**Table 3-6**). Within these sub-basins, wetlands comprise less than 9 percent (roughly 1,522 square miles) of the total land cover. Wetlands identified on National Wetlands Inventory (NWI) maps include riverine and lacustrine features as well as palustrine forested/shrub and emergent wetlands. As described by Cowardin et al. (1979), palustrine wetlands are nontidal wetlands dominated by trees, shrubs, persistent emergent vegetation, and emergent mosses or lichens. These wetlands include bottomland hardwood forests and upland swamps (forested wetlands), shrub-scrub wetlands, beaver ponds (aquatic-bed or emergent wetlands), wet meadows and marshes (emergent wetlands), and highland bogs. Lacustrine (i.e., related to a lake) and riverine (i.e., river related) systems consist of aquatic beds containing floating or submersed aquatic plants and are more common in the western portion of the TVA PSA.

Overall, riverine and lacustrine features represent roughly 67 percent of wetlands classified within the TVA PSA (**Table 3-6**). Palustrine freshwater forested/shrub (roughly 31 percent) and emergent (roughly 2 percent) wetlands represent less than half of wetland types within the PSA. Wetlands are most prevalent in the Lower Mississippi- Memphis (49 percent), the Lower Ohio (19 percent), and Kentucky Reservoir (16 percent) watersheds. Palustrine wetland types are most prevalent in the Pickwick Reservoir and Horn Lake-Nonconnah Watersheds, where freshwater forested/shrub and emergent wetlands account for roughly 58 percent and 61 percent of wetlands classified, respectively.

The project areas would be located on previously disturbed lands within existing industrial infrastructure at each Site. Site-specific wetland delineations have not yet been conducted within the areas proposed for corrective action and NWI mapping generally is not detailed at the scale necessary to determine whether wetlands occur in the project footprints. If wetlands exist within the project areas, they would generally be associated with low-lying, poorly drained areas, floodplains and riparian zones of streams and rivers, groundwater seepage areas, and marginal areas associated with ponds and reservoirs. Most of the project areas occur on disturbed land, modified from natural conditions due to a history of industrial and nonindustrial land uses and soil disturbances. Site-specific wetland delineations would be conducted as necessary at each TVA property proposed for corrective action to aid in wetland avoidance during site design and planning.

Table 3-6. Wetland Characteristics by HUC-8 Sub-basin

TVA Property	Watershed[1]	Area (square miles)[1]	Watershed Characteristics[1]
Tennessee			
Cumberland Fossil Plant; Stewart County	Lower Cumberland River	2,333.7	Wetlands account for roughly 6% of the total land area of the Lower Cumberland watershed. Roughly 77% of wetlands are classified as riverine, lake, and freshwater pond. Roughly 20% are classified as freshwater forested/shrub wetland and roughly 3% are classified as freshwater emergent wetland.
Watts Bar Plant [2] Rhea County	Middle Tennesee-Chuckamauga	1685.6	Wetlands account for roughly 6% of the total land area of the Middle Tennesee-Chuckamauga watershed. Roughly 91% are classified as riverine, lake, and freshwater pond. 8% are classified as freshwater forested/shrub wetland and roughly 0.7% are classified as freshwater emergent wetland.

TVA Property	Watershed[1]	Area (square miles)[1]	Watershed Characteristics[1]
Watts Bar Plant [2]; Rhea County	Watts Bar Reservoir	1253.6	Wetlands account for roughly 8% of the total land area of the Watts Bar Reservoir watershed. Roughly 95% are classified as riverine, lake, and freshwater pond. 5% are classified as freshwater forested/shrub wetland and roughly 0.4% are classified as freshwater emergent wetland.
Johnsonville Fossil Plant; Humphreys County	Kentucky Reservoir	1,185.0	Wetlands account for roughly 16% of the total land area of the Kentucky Reservoir watershed. Roughly 70% of wetlands are classified as riverine, lake, and freshwater pond. Roughly 28% are classified as freshwater forested/shrub wetland and roughly 2% are classified as freshwater emergent wetland.
John Sevier Fossil Plant; Hawkins County	Holsten River	1000.0	Wetlands account for roughly 7% of the total land area of Hoston watershed. Roughly 95% are classified as riverine, lake, and freshwater pond. Roughly 3% are classified as freshwater forested/shrub wetland and roughly 2% are classified as freshwater emergent wetland.
Gallatin Fossil Plant; Sumner County	Lower Cumberland-Old Hickory Reservoir	985.7	Wetlands account for roughly 5% of the total land area of the Lower Cumberland-Old Hickory Reservoir watershed. Roughly 91% of wetlands are classified as riverine, lake, and freshwater pond. Roughly 8% are classified as freshwater forested/shrub wetland and roughly 1% are classified as freshwater emergent wetland.
Kingston Fossil Plant; Roane County	Emory River	866.2	Wetlands account for roughly 3% of the total land area of Emory watershed. Roughly 82% are classified as riverine, lake, and freshwater pond. Roughly 17% are classified as freshwater forested/shrub wetland and roughly 1% are classified as freshwater emergent wetland.
Bull Run Fossil Plant; Anderson County	Lower Clinch River	636.2	Wetlands account for roughly 4% of the total land area of the Lower Clinch watershed. Roughly 89% are classified as riverine, lake, and freshwater pond. 10% are classified as freshwater forested/shrub wetland and roughly 1% are classified as freshwater emergent wetland.
Allen Fossil Plant [2]; Shelby County	Lower Mississippi-Memphis	596.1	Wetlands account for roughly 49% of the total land area of the Lower Mississippi- Memphis watershed. Roughly 46% are classified as riverine, lake, and freshwater pond. 52% are classified as freshwater forested/shrub wetland and roughly 2% are classified as freshwater emergent wetland.
Allen Fossil Plant [2]; Shelby County	Horn Lake-Nonconnah	228.6	Wetlands account for roughly 7% of the total land area of the Horn Lake- Nonconnah watershed. Roughly 39% are classified as riverine, lake, and freshwater pond. 56% are classified as freshwater forested/shrub wetland and roughly 4% are classified as freshwater emergent wetland.
Kentucky			
Paradise Fossil Plant; Muhlenberg County	Middle Green River	1,027.6	Wetlands account for roughly 5% of the total land area of the Middle Green watershed. Roughly 50% are classified as riverine, lake, and freshwater pond. Roughly 46% are classified as freshwater. forested/shrub wetland and roughly 4% are classified as freshwater emergent wetland.

TVA Property	Watershed[1]	Area (square miles)[1]	Watershed Characteristics[1]
Shawnee Fossil Plant; McCracken County	Lower Ohio River	923.6	Wetlands account for roughly 13% of the total land area of the Lower Ohio watershed. Roughly 48% are classified as riverine, lake, and freshwater pond. Roughly 49% are classified as freshwater forested/shrub wetland and roughly 3% are classified as freshwater emergent wetland.
Alabama			
Colbert Fossil Plant; Colbert County	Pickwick Reservoir	2,282.4	Wetlands account for roughly 11% of the total land area of Pickwick Reservoir. Roughly 42% are classified as riverine, lake, and freshwater pond. Roughly 54% are classified as freshwater forested/shrub wetland and roughly 4% are classified as freshwater emergent wetland.
Widow's Creek Fossil Plant; Jackson County	Guntersville Reservoir	1,997.5	Wetlands account for roughly 8% of the total land area of Guntersville Reservoir. Roughly 83% are classified as riverine, lake, and freshwater pond. Roughly 16% are classified as freshwater forested/shrub wetland and roughly 1% are classified as freshwater emergent wetland.
Combined Wetlands			
TVA PSA Total Land Cover		76,870	Within above-mentioned HUC-8 sub-basins, wetlands account for roughly 9% of the total land area. Roughly 66% are classified as riverine, lake, and freshwater pond. Roughly 32% are classified as freshwater forested/shrub wetland and roughly 2% are classified as freshwater emergent wetland. Wetlands within these sub-basins account for roughly 2% of the total land cover of the TVA PSA.
Total Land Cover in HUC-8 sub-basins surrounding TVA Properties		18,464	
Total wetlands in HUC-8 sub-basins surrounding TVA Properties		1,522	

Source: [1]USFWS 2025a; Watts Bar Fossil Plant and Allen Fossil Plant are both located in 2 watersheds.

3.6.2 Environmental Consequences

The potential effects on wetlands from a given action are assessed by evaluating the potential for an action to result in dredging or filling of jurisdictional wetlands through site grading, construction, or other activities. Although the extent of wetland impacts would vary from site to site, general effects from the alternatives within the TVA PSA are discussed below.

Regardless of which alternative is selected for corrective action, TVA would aim to avoid and minimize effects on streams or wetlands to the extent practicable. Any unavoidable disturbances would be minimized and/or permitted through the appropriate federal and state agencies. Compensatory mitigation would be purchased, if necessary.

3.6.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed; there would be no wetland impacts under the No Action Alternative.

3.6.2.2 Analysis of Alternatives B, C, D, and E

Each of the four corrective action alternatives (Alternatives B, C, D, and E) would entail similar activities, including land clearing and grading; installation of injection wells, extraction wells, or monitoring wells; access road construction; and corrective action employee vehicle travel on site. Therefore, the types of potential effects on wetlands would be similar among all four corrective action alternatives. The magnitude of disturbance and potential effects would be specific to each site, depending on site-specific conditions (e.g., presence of wetlands, extent and type of vegetative cover, siting/location of access road), and the magnitude of activities (e.g., area of disturbance, number of wells installed). Site-specific conditions and the required magnitude of corrective action activities are expected to determine wetland impacts to a greater extent than the corrective action alternative implemented.

Per the bounding attributes identified in **Table 2-1**, Proposed Actions would occur within previously disturbed areas on existing TVA properties and not exceed 6.5 acres (the maximum disturbance footprint across all alternatives). Given avoidance and minimization measures, actual wetland impacts could be much less.

Implementing Alternative D would have the least total potential land disturbance (1.5 acres), while implementing a combination of corrective actions (Alternative E) would have the largest total potential land disturbance (6.5 acres) of the four action alternatives. However, implementation of corrective actions within a smaller footprint (e.g., Alternative D) could potentially have greater wetland impacts than corrective actions implemented within a larger footprint, if, for example, the site with the smaller footprint involves wetland impacts and the larger footprint does not.

Construction of the Proposed Actions may require minor alterations to potential wetlands and streams located at each Site. Despite being sited in previously disturbed, industrial properties, some wetlands and streams could still be present within project footprints. As part of its site-specific screening process using the Environmental Screening Checklist, TVA would determine if wetlands were present within the proposed project area and if there would be potential adverse effects on wetlands. TVA would avoid wetland impacts to the extent practicable. Any unavoidable disturbances would be minimized and if necessary, temporary wetland crossings would be utilized together with BMPs to minimize impacts. Work in wetlands would be conducted in compliance with EO 11990 (Protection of Wetlands). As necessary, appropriate CWA Section 404/401 permits would be obtained through consultation with appropriate federal and state agencies. Compensatory mitigation would be purchased, if necessary.

Construction of each of the corrective action alternatives is expected to have adverse direct and indirect impacts to wetlands and streams; however, because the proposed project sites would be located on previously disturbed TVA properties with little known existing natural wetland habitat, impacts are expected to be minor to moderate and may be temporary or permanent. Operation of the corrective action could have short-term, minor, adverse, indirect impacts on wetlands, if access roads and work areas require regular maintenance.

3.7 Habitat, Ecology, and Threatened and Endangered Species

3.7.1 Affected Environment

3.7.1.1 Terrestrial Habitat and Vegetation

The TVA properties evaluated in this PEA occur within five level III ecoregions, including the Mississippi Alluvial Plain, Interior Plateau, the Ridge and Valley, the River Valleys and Hills, and the Southwestern Appalachians (Omernik 1987; Griffith et al. 2001) (**Table 3-7**). These ecoregions support a diverse array of plant communities, from southern floodplain and oak hickory forests in the River Valleys and Hills to upland mixed oak and mesophytic forest in the Southwestern Appalachians. Many specific plant communities occur throughout these ecoregions including bottomland hardwood and oak, southern floodplain forest, Appalachian oak forest, upland oak-hickory, and swamp forests, along with an array of herbaceous plant habitats (**Table 3-7**).

Table 3-7. Level III and IV Ecoregions of TVA Properties Considered in the PEA

Site Name	Ecoregion (III)	Ecoregion (IV)	Vegetation
ALF	Mississippi Alluvial Plain	Northern Holocene Meander belts	Mostly broad, flat floodplains (bald cypress (*Taxodium distichum*), water tupelo (*Nyssa aquatica*)). Mesic, bottomland hardwood Oak-hickory forests in dryer areas (sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), water hickory (*Carya aquatica*), swamp chestnut oak (*Quercus michauxii*)).
CUF JOF	Interior Plateau	Western Highland Rim	Oak-hickory Forest (white oak (*Quercus alba*), hickories (*Carya sp*), northern red oak (*Quercus rubra*), tuliptree (*Liriodendron tulipifera)*); somewhat transitional between the more xeric oak-hickory forest to the west and the more mesic mixed mesophytic forest (sweetgum, sycamore (*Platanus occidentalis*), hackberry (*Celtis occidentalis*), pin oak (*Quercus palustris*)) to the east.
COF	Interior Plateau	Eastern Highland Rim	Mostly oak-hickory, but transitional between the more xeric oak-hickory forest to the west and the more mesic mixed mesophytic forest to the east (white oak, hickories, red oaks, Virginia pine (*Pinus virginiana*)); some areas of cedar glades and bottomland hardwoods (sweetgum, cottonwood (*Populus deltoides*), silver maple (*Acer saccharinum*)).
GAF	Interior Plateau	Outer Nashville Basin	Mostly oak-hickory, but transitional between the more xeric oak-hickory forest (white oak, hickory, northern red oak, tuliptree, eastern red cedar (*Juniperus virginiana*), black locust (*Robinia pseudoacacia*)) to the west and the more mesic mixed mesophytic forest (sycamore, red maple, river birch (*Betula nigra*), sweetgum) to the east.
KIF BRF WBF	Ridge & Valley	Southern Limestone/Dolomite Valleys and Low Rolling Hills	Appalachian oak forest (mixed oaks, hickory, pine, poplar, birch, maple); bottomland oak and mesophytic forests; cedar barrens.
JSF	Ridge & Valley	Southern Shale Valleys	Appalachian oak forest (mixed oaks, hickory, pine, poplar, birch, maple).
SHF	Interior River Valleys & Hills	Wabash-Ohio Bottomlands	Southern floodplain forest (dominants: oaks, tupelo, cypress)/ Bottomland mixed deciduous forests. Bottomland oak forests in wettest areas that are often flooded: bald cypress –water tupelo forests.

Site Name	Ecoregion (III)	Ecoregion (IV)	Vegetation
PAF	Interior River Valleys & Hills	Green River-Southern Wabash Lowlands	Oak-hickory Forest/ On uplands: oak forest often dominated by white oak with post oak (*Quercus stellata*), southern red oak (*Quercus falcata*), cherrybark oak (*Quercus pagoda)*, and shingle oak (*Quercus imbricaria*). On mesic sites: forests dominated by tuliptree, sugar maple (*Acer saccharum*), and northern red oak. On bottomland: bottomland oak forests with overcup oak (*Quercus lyrata*), pin oak, silver maple, pecan (*Carya illinoinensis*), slippery elm (*Ulmus rubra*), sweetgum, and red maple. In wettest areas that are often flooded: bald cypress.
WCR	Southwestern Appalachians	Sequatchie Valley	Mixed mesophytic forest (oak, elm, hickory, ash, maple, tupelo, pine, sweetgum, basswood (*Tilia americana*), beech (*Fagus grandifoila*)).

Sources: Griffith et al. 1998, Griffith et al. 2001, Woods et al. 2002

Allen Fossil Plant is located within the Mississippi Alluvial Plain Ecoregion. This ecoregion is comprised of mostly broad, flat floodplains. The flat terrain contains poorly drained soils which provide ideal conditions for wetlands. Over the last few centuries, many of these wetlands have been drained and transformed for agricultural purposes. Dominant species depend on the elevation and the amount of water present. In areas with standing water, bald cypress and water tupelo are common. In slightly dryer areas the mesic oak hickory forests are common (USGS 2016).

The Interior Plateau Ecoregion occupies much of central Tennessee and parts of Kentucky and Northern Alabama and includes the Cumberland, Johnsonville, and Gallatin Fossil Plants in Tennessee and the Colbert Fossil Plant in Alabama (**Table 3-7**). This Ecoregion includes a series of grassland plateaus and forested uplands with flat, carbonate bedrock and thin soil with globally uncommon ecosystems. Forests are predominantly mesophytic, with a high proportion of American beech, American basswood, and sugar maple. Approximately 38 percent of the Interior Plateau is forested, 50 percent is agricultural land, and 9 percent is developed (USGS 2016; USGS 2021).

The Ridge and Valley Ecoregion occupies much of eastern Tennessee and includes the Kingston, Bull Run, Watts Bar, and John Sevier Fossil Plants. The landscape is characterized by a series of complex folds and faults with alternating valleys and ridges trending northeast to southwest. Roughly 56 percent of the land cover is forested, with mesophytic and Appalachian oak forest as the dominant sub-types (Dyer 2006; USGS 2016).

Widows Creek Fossil Plant is located within the Southwestern Appalachian Ecoregion. This ecoregion ranges northeast to southeast across Alabama, Tennessee, and Kentucky. The bedrock is a sequence of near horizontal Pennsylvanian sandstones, shales, conglomerates, and coals, underlain by Mississippian and older shale and carbonates. The area underlain by the resistant Pennsylvania sandstones has produced a “table-top” landscape. These low mountains contain a mosaic of forest and woodland with some cropland and pasture. Mixed mesophytic forest is restricted to the deeper ravines and escarpment slopes, and the summit or tableland forests are dominated by mixed oaks with shortleaf pine (*Pinus echinata*) (Griffith et al. 2001).

The Paradise and Shawnee Fossil Plants are located within a small portion of the Interior River Valley and Hills Ecoregion. This ecoregion can be found in northwest Kentucky, where it is made up of nearly level lowlands dominated by agriculture and forested hills. Bottomland deciduous forests and swamp forests were once extensive on poorly drained, nearly level, lowland sites, but most have been replaced by cropland and pastureland. Hilly uplands remain mostly forested (USGS 2016; USGS 2021).

Invasive plants are prevalent on most lands in the TVA PSA. According to the Tennessee Invasive Plant Council's Invasive Plants of Tennessee list, which encompasses much of the TVA PSA, there are 64 invasive plant species considered to be an established or emerging threat in Tennessee (TN-IPC 2025). Listed invasive plant species include tree-of-heaven (*Ailanthus altissima*), Asian bittersweet (*Celastrus orbiculatus*), autumn olive (*Elaeagnus umbellata*), Chinese privet (*Ligustrum sinense*), kudzu (*Pueraria montana*), common reed (*Phragmites australis*), Eurasian water milfoil (*Myriophyllum spicatum*), multiflora rose (*Rosa multiflora*), and tall fescue (*Festuca arundinacea*). Common reed is known to occur in impoundments at several TVA properties but is otherwise uncommon in the TVA PSA. In recent years, the non-native eelgrass rockstar hybrid (*Vallisneria × pseudorosulata*) has displaced native aquatic plants in several TVA reservoirs (TVA 2024a). The non-native eelgrass reproduces rapidly and has spread easily, impacting electricity generation and recreational uses in reservoirs. TVA's aquatic plant management team works with partners to remove invasive species via harvesters and targeted herbicide application, and educates the public to prevent species spread (TVA 2025d). Not all non-native species pose threats to natives. Naturalized additions to the ecosystem are considered to be non-native, non-invasive species and have minor negative impacts to native vegetation. Examples include Queen Anne's lace (*Daucus carota*) and dandelion (*Taraxacum* sp.).

For this analysis, the affected environment is considered to be the TVA properties listed in **Table 1-1**. Most of these sites are heavily disturbed by prior construction and operation of the TVA property. They typically have limited vegetation, although there may be some small patches of grassy areas or small trees within maintained grounds. Plant communities present consist of ruderal/early-successional vegetation, maintained lawn/turf associated with berms, denuded and unvegetated lands (e.g., parking lots, riprapped berms, etc.) and fringing scrub and sapling trees. Vegetation is typically dominated by non-native plants with little to no conservation value.

3.7.1.2 Aquatic Ecology

The TVA PSA encompasses portions of several major river systems including all of the Tennessee River drainage and portions the Cumberland, Ohio, and Mississippi River drainages (see also Section 3.4, Surface Waters). These watersheds drain a diverse physiography and associated topography providing abundant habitats occupied by an extremely diverse group of aquatic faunas and represent important commercial and recreational fisheries (TVA 2005). These systems are recognized as a globally important area for freshwater biodiversity due to the large variety of freshwater fishes and invertebrates (e.g., freshwater mussels, snails, crayfish and insects) they support (TVA 2016).

Many rivers in the TVA PSA have been substantially altered by human activity affecting the available aquatic habitat and species compositions. For example, construction of the Tennessee River dam and reservoir system fundamentally altered the aquatic habitat of the Tennessee and Clinch rivers. 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 of the waterway. By converting free-flowing riverine ecosystems into lake-like reservoir ecosystems, dams shape the available aquatic habitats and associated aquatic communities upstream and downstream. Impounded sections expanded some species' ranges in these river systems, primarily shad (*Alosa sapidissima*) and sunfishes (*Lepomis* sp.). Conversely, undammed sections support a much higher diversity of aquatic life including federally and state-listed species.

Reservoirs in the TVA PSA, in general, have an ecological structure and function linked to water residence time. Phytoplankton, periphyton, and macrophytes supply most of the organic matter to the food web in impounded waters. Due to fluctuating water levels, phytoplankton production dominates most impoundments; however, rooted and floating macrophytes can dominate where water levels are stable in a reservoir (TVA 2016). Fish, amphibians, reptiles, birds and mammals are found in and around reservoirs in the PSA during some portion of their life cycle (TVA 2016). Fish populations comprise forage fishes, including shads and silversides (*Atheriniformes* sp.) in reservoirs and sunfishes in impoundments, while the dominant predators in reservoirs are typically basses (TVA 2016). Common invertebrate species found in area reservoirs include rotifers, protozoans, and crustaceans. Larvae of true midges and oligochaete worms are the dominant macroinvertebrates in the benthos of most reservoirs (TVA 2016). Many benthic organisms have narrow habitat requirements that are not always met in reservoirs or tailwaters below dams. Further downstream from dams, the number of benthic species increases as natural reaeration occurs and dissolved oxygen and temperatures rise.

Each TVA property under consideration has a major reservoir or river adjacent to the site that provides aquatic habitat (**Table 3-8**). Smaller streams, lakes, ponds, and other drainages also provide potential aquatic habitats at each site; however, the dominant aquatic habitats are provided by the major systems and associated reservoirs.

Table 3-8. Proposed Project Area(s) and Associated Aquatic Habitats

TVA Properties	Associated Major Aquatic Habitats
Allen Fossil Plant	Mississippi River, McKellar Lake
Bull Run Fossil Plant	Melton Hill Reservoir (Clinch River); Bull Run Creek
Colbert Fossil Plant	Pickwick Landing Reservoir (Tennessee River)
Cumberland Fossil Plant	Barkley Reservoir (Cumberland River)
Gallatin Fossil Plant	Old Hickory Reservoir (Cumberland River)
John Sevier Fossil Plant	John Sevier Detention Reservoir (Holston River)
Johnsonville Fossil Plant	Kentucky Reservoir (Tennessee River)
Kingston Fossil Plant	Watts Bar Reservoir (Tennessee River); Clinch River; Emory River
Paradise Fossil Plant	Green River
Shawnee Fossil Plant	Metropolis Lake (Ohio River); Little Bayou Creek
Watts Bar Fossil Plant	Chickamauga Reservoir (Tennessee River)
Widows Creek Fossil Plant	Guntersville Reservoir (Tennessee River); Widows Creek

<u>Tennessee River Basin</u>

The Tennessee River drainage basin is the dominant aquatic system within the TVA PSA, and most TVA properties are within this watershed.

Mainstem Reservoir Habitat

Reservoirs on the Tennessee River are relatively shallow, have continuous flows, and retain the water for short periods of time. Although dissolved oxygen in lower reservoir levels is often reduced, it is seldom depleted. Winter drawdowns on mainstem reservoirs are less severe, so bottom habitats generally remain wetted all year. This benefits benthic organisms and promotes the growth of aquatic plants in the extensive shallow overbank areas of some reservoirs. Tennessee River mainstem reservoirs generally support healthy fish communities, ranging from approximately 50 to 90 species per reservoir. Good to excellent sport fisheries exist, primarily for black bass (*Micropterus salmoides*), crappie (*Pomoxis* sp.), sauger (*Sander canadensis*), striped bass (*Morone saxatilis*), sunfish (Centrarchidae), and catfish (*Ictalurus sp.)*. The primary commercial species are channel catfish (*Ictalurus punctatus*), blue catfish (*I. furcatus*), and buffalo (*Ictiobus* sp.) (TVA 2016).

TVA facilities located on mainstem reservoirs of the Tennessee River include Colbert, Johnsonville, Kingston, Watts Bar, and Widows Creek Fossil Plants.

Tributary Reservoirs and Tailwaters Habitat

Tributary reservoirs are typically deep and retain water for long periods of time. The results from retention time and water depth include thermal stratification, the formation of an upper layer that is warmer and well oxygenated, an intermediate layer of variable thickness and a lower layer that is colder and poorly oxygenated. These aquatic habitats are simplified compared to undammed streams and fewer species are found. Aquatic habitats in the tailwater can also be impaired due to a lack of minimum flows and low dissolved oxygen levels which may restrict movement, migration, reproduction, and the available food supply for fish and other aquatic organisms. Dams on tributary rivers affect the habitat of benthic invertebrates, which are a vital part of the food chain of aquatic ecosystems. Benthic life includes worms, snails, crayfish, aquatic insects, mussels, and clams. However, many benthic organisms have narrow habitat requirements that are not always met in reservoirs or tailwaters below dams.

Facilities on tributary reservoirs include the Bull Run Fossil Plant (Melton Hill Reservoir) and John Sevier Fossil Plant (John Sevier Detention Reservoir).

<u>Other Basins</u>

The other major drainages within the TVA PSA (the Cumberland and Ohio River drainages) share a diversity of aquatic life equal to or greater than the Tennessee River drainage. As with the Tennessee River, these river systems have seen extensive human alteration including construction of reservoirs, navigation channels, and locks. Despite these changes, remarkably diverse aquatic communities are present in each of these river systems.

Facilities located in other watersheds include Allen Fossil Plant on the Mississippi River, Cumberland and Gallatin properties on the Cumberland River, Paradise Fossil Plant on the Green River, and Shawnee Fossil Plant on the Ohio River.

<u>TVA Aquatic Monitoring Program</u>

TVA began a systematic program to monitor the ecological conditions of its reservoirs in 1990. Reservoir and stream monitoring programs were combined with TVA's fish tissue and bacteriological studies to form an integrated Vital Signs Monitoring Program (Cariker 1999). The Vital Signs Monitoring Program activities focus on (1) physical/chemical characteristics of waters; (2) physical/chemical characteristics of sediments; (3) benthic macroinvertebrate community sampling; and (4) fish assemblage sampling (TVA 2016). Decades of TVA monitoring data show no effects on aquatic species and ecosystems resulting from regular CCR management activities at TVA's plants.

3.7.1.3 Wildlife

The TVA PSA contains portions of nine ecoregions, five of which contain the 12 TVA properties (see Section 3.7.2.1, Terrestrial Habitat and Vegetation) that provide a mixture of wildlife habitat, ranging from bottomland hardwood and cypress swamps in the floodplains of the Mississippi Alluvial Plain to high elevation spruce-fir and northern hardwood forests in the Blue Ridge (USGS 2016). This diverse mixture of habitats supports approximately 77 species of mammal, 56 reptiles, 70 amphibians, and 340 birds in Tennessee alone (TWRA 2021). Although some species have widespread distributions, others have restricted ranges unique to specific ecoregions.

Many wide-ranging species occur throughout the TVA PSA, and most that are tolerant to humans have stable or increasing populations. Loss and modification of habitats due to agriculture, hydrologic modification (e.g., construction of reservoirs and dams), and municipal discharges (TWRA 2021) have greatly altered wildlife populations. While some species flourish under these changes, others show marked declines. Grassland-dependent and woodland-dependent birds, for example, have shown dramatic decreases in their numbers (NABCI 2022). Over 30 species of birds breeding in the TVA PSA are considered to be of conservation concern (TVA 2020b). Conversely, some species of wildlife are of management concern because of overly abundant populations, leading to damage to natural ecosystems and human interests (e.g., double-crested cormorant [*Nannopterum auritum*]) (USFWS 2024).

Review of the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) website indicated 24 migratory bird species of conservation concern (BCC) have the potential to occur at the 12 TVA properties evaluated in this PEA (**Table 3-9**). Suitable foraging or nesting habitat for these species could occur within many of the TVA properties proposed for corrective action, particularly in areas where ecologically important sites occur on or near the plant sites. The number of BCCs potentially occurring within individual plant sites ranges from five species within the Widows Creek property to 17 species within the Johnsonville and Shawnee Fossil Plants, respectively. Three species, the Kentucky warbler (*Geothylpis formosa)*, prairie warbler (*Setophaga discolor)*, and red-headed woodpecker (*Melanerpes erythrocephalus*) have the potential to occur at all 12 TVA properties (**Table 3-9**).

Table 3-9. Birds of Conservation Concern in the Vicinity of TVA Properties

Common Name	Scientific Name	TVA Property[1]
Swifts		
Chimney swift	*Chaetura pelagica*	ALF, BRF, COF, CUF, GAF, JSF, JOF, PAF, SHF, WBF, WCF
Woodpeckers		
Red-headed Woodpecker	*Melanerpes erythrocephalus*	All
Nightjars		
Eastern Whip-poor-will	*Antrostomus vociferus*	BRF, COF, CUF, JOF, PAF, SHF
Chuck-will's-widow	*Antrostomus carolinensis*	BRF

Common Name	Scientific Name	TVA Property[1]
Shorebirds		
Lesser Yellowlegs	*Tringa flavipes*	ALF, COF, GAF, JOF, PAF, SHF
Semipalmated Sandpiper	*Calidris pusilla*	ALF, GAF, JOF, PAF, SHF
Least Tern	*Sternula antillarum antillarum*	ALF, JOF, SHF
Black-billed Cuckoo	*Coccyzus erythropthalmus*	BRF, JSF, JOF, SHF
American Golden Plover	*Pluviallis dominica*	ALF
Pectoral Sandpiper	*Calidris melanotos*	ALF
Little Blue Heron	*Egretta caerulea*	ALF
Perching Birds		
Rusty Blackbird	*Euphagus carolinus*	ALF, BRF, COF, CUF, JSF, JOF, KIF, PAF, SHF, WCF
Wood Thrush	*Hylocichla mustelina*	ALF, BRF, COF, CUF, GAF, JSF, JOF, KIF, PAF, SHF, WBF
Bobolink	*Dolichonyx oryzivorus*	BRF, COF, JOF, KIF, SHF
Brown-headed Nuthatch	*Sitta pusilla*	JOF
Warblers		
Kentucky Warbler	*Geothylpis formosa*	All
Prairie Warbler	*Setophaga discolor*	All
Prothonotary Warbler	*Protonotaria citrea*	ALF, BRF, COF, CUF, GAF, JSF, JOF, KIF, PAF, SHF, WBF
Cerulean Warbler	*Setophaga cerulea*	ALF, BRF, JSF, KIF, SHF
Canada Warbler	*Cardellina canadensis*	BRF, KIF
Golden-winged Warbler	*Vermivora chrysoptera*	BRF, KIF, WBF
Sparrows		
Field Sparrow	*Spizella pusilla*	COF, CUF, GAF, JOF, PAF, SHF
Grasshopper Sparrow	*Ammodramus savannarum perpallidus*	COF, GAF, JOF, PAF, SHF
Henslow's Sparrow	*Centronyx henslowii*	BRF, PAF, SHF
Le Conte's Sparrow	*Ammospiza leconteii*	ALF, COF, JOF

Source: USFWS 2025b

[1] TVA property names are as follows: ALF= Allen Fossil Plant, BRF= Bull Run Fossil Plant, COF= Colbert Fossil Plant, CUF=Cumberland Fossil Plant, GAF= Gallatin Fossil Plant, JSF=John Sevier Fossil Plant, JOF=Johnsonville Fossil Plant, KIF= Kingston Fossil Plant, PAF= Paradise Fossil Plant, SHF= Shawnee Fossil Plant, WBF= Watts Bar Plant, WCF= Widows Creek Fossil Plant.

In general, gulls (Laridae), wading birds, waterfowl, raptors, game birds, game mammals, and small mammals — are generally stable or increasing throughout the TVA PSA (TVA 2011, TVA 2020b). Notably, white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), and beaver (*Castor canadensis*) have shown population increases. Species linked with river corridors such as bald eagle, (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), herons and egrets (Ardeidae), and Canada geese (*Branta canadensis*) have also shown notable recoveries. This rebound is especially evident along the Tennessee River, where breeding populations of these birds had been relatively limited in portions of northwest Alabama or northeast Tennessee until the late 1990s (TVA 2011, TVA 2020b). In recent years, however, their breeding ranges have expanded into these areas and have become more evenly distributed throughout the PSA. Shorebirds and waterfowl communities are particularly diverse in portions of the PSA, especially during autumn and spring migrations. In contrast, several species of songbird, particularly those dependent on grasslands or unfragmented forests, continue to decline in the region (TVA 2011, TVA 2020b).

TVA manages a wide network of reservoirs throughout the PSA. The development of these reservoir systems by both TVA and the U.S. Army Corps of Engineers has expanded suitable habitats for a variety of bird species including waterfowl, herons, egrets, ospreys, gulls, and shorebirds, particularly in the central and eastern regions, where such environments were previously scarce. TVA also manages its own Regional Natural Heritage database with support from The Nature Conservancy. TVA Natural Heritage database results for each of the TVA properties evaluated in this PEA indicate osprey and/or bald eagle nests are known within 3 miles of the TVA properties (TVA 2025e). Riparian zones along the Tennessee River and its tributaries serve as critical habitats for a wide range of wildlife. These areas, enhanced by distinctive natural features like vernal pools, oxbow lakes, bluffs, and islands, support a rich variety of nesting and feeding opportunities (TVA 2011). The USFWS maintains a list of all species protected by the MBTA at 50 CFR § 10.13; this list includes over one thousand species of migratory bird, including eagles, ospreys, and other raptors, waterfowl, shorebirds, seabirds, wading birds, and songbirds. Relative to TVA actions, nesting birds have the greatest potential for impacts due to the potential for disturbance and habitat loss during construction activities.

Caves are widespread throughout the TVA PSA, especially in north Alabama, northwest Georgia, and the eastern half of Tennessee. These sites provide a unique mix of microhabitats used by a diverse array of cave-dependent species, some endemic to single-cave systems. Cave and karst systems are present at high elevations, in forested landscapes, along river and reservoir shorelines, and across agricultural settings. Due to the abundance of karst and cave features across the PSA in both developed and undeveloped settings, caves may occur at or near the TVA properties. The TVA Natural Heritage database results indicate caves are known to exist within 3 miles of the Bull Run, Colbert, Gallatin, John Sevier, Watts Bar, and Widows Creek Fossil Plants (TVA 2025e).

The TVA properties evaluated in this PEA are heavily disturbed with little to no remaining natural habitat. Early-successional vegetative habitats, forested edge habitat, and forest are present in the surrounding landscape but are generally located at a greater distance from the TVA properties. Because the disturbed terrestrial and aquatic habitat near the Sites is regularly subject to high levels of noise disturbance and vehicle traffic, only small numbers of common wildlife species are likely to occur within the immediate areas.

State-Listed Species

Each of the three states for the TVA properties evaluated in this PEA also maintains databases of listed species. Websites for these databases are provided in **Table 3-10**. Based on review of the state databases as well as TVA's Natural Heritage database, over 1,800 state-listed special-status species have been documented within the TVA PSA (TVA 2014a). A listing of state-level endangered, threatened, and species of conservation concern within the TVA PSA can be found in Appendix G of the Final Supplemental Programmatic Environmental Impact Statement for the Update of TVA's Natural Resource Plan (TVA 2020b). TVA would use these database resources in the site-specific Environmental Screening Checklist process to determine the potential for effects on state-listed species (TVA 2014a).

Table 3-10. Websites for State-listed Species within TVA Properties Evaluated

State	Web Address
Alabama	https://www.auburn.edu/cosam/natural_history_museum/alnhp/data/index.htm
Kentucky	https://eec.ky.gov/Nature-Preserves/biodiversity/Pages/Species-and-Natural-Community-Reports.aspx
Tennessee	https://www.tn.gov/environment/program-areas/na-natural-areas/na-natural-heritage-inventory-program.html

Federally Protected Species

Thirty-five species of plant and 170 species of animal in the TVA PSA are listed under the ESA as endangered or threatened or formally proposed for listing by USFWS. Across the TVA PSA, there are also 54 areas designated as critical habitat essential to the conservation of listed species (USFWS 2025b). The highest concentrations of terrestrial and aquatic species listed under the ESA occur in the Blue Ridge, Appalachian Plateaus, and Interior Low Plateau regions. In contrast, the Coastal Plain and Mississippi Alluvial Plain regions support relatively fewer ESA-listed species. Among the taxonomic groups, fish and mollusks represent the highest percentages of listed species. This is largely due to the region's high number of endemic species and alterations to their habitats from reservoir development and water pollution. The Tennessee and Cumberland river systems are particularly notable for their high numbers of listed aquatic species. 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, Tennessee coneflower (*Echinacea tennesseensis*), and snail darter (*Percina williamsi))* or their listing status has been downgraded from endangered to threatened (e.g., large-flowered skullcap (*Scutellaria montana*) and small whorled pogonia (*Isotria medeoloides*)). However, some listed species' populations continue to decline due to a multitude of factors. The formerly common northern long-eared bat (*Myotis septentrionalis*) was listed in 2015 under the ESA as threatened but upgraded to an endangered classification in 2022 due to recent dramatic population declines caused by the fungal disease white-nose syndrome. Likewise, the formerly common tricolored bat (*Perimyotis subflavus)* is proposed to be listed as endangered under the ESA and the little brown bat (*Myotis lucifugus)* is under review for federal listing due to the same pathogen. In the TVA PSA, white-nose syndrome was first reported in 2009. Population trends of many other listed species in the TVA PSA are poorly understood (TVA 2024a).

The USFWS IPaC website was queried for the TVA properties evaluated in this PEA in May of 2025. The IPaC results indicate there is potential for 47 federally protected species to occur in these areas, including four mammals, two bird species, one reptile, one amphibian, five fishes, 30 clam species, one snail species, one insect and three plant species. Results from each site-specific IPaC are included in **Table 3-11**. Additionally, designated critical habitat is mapped across the John Sevier Fossil Plant for the purple bean mussel (*Ivillosa perpurpurea*); the Shawnee Fossil Plant falls within the critical habitat area for the rabbitsfoot mussel (*Quadrula cylindrica cylindrica*); and the Colbert Fossil Plant falls within the critical habitat of the spectaclecase mussel (*Cumberlandia monodonta*). Prior to taking corrective actions, TVA would review the IPaC website for an updated species list during the site-specific Environmental Screening Checklist process to determine the potential for effects on federally listed and protected species, and coordinate with appropriate agencies as required.

Table 3-11. Federally Protected Species within the Vicinity of TVA Properties Evaluated in this PEA

Common Name	Scientific Name	Federal Status[1]	Location[2]
Mammals			
Gray Bat	*Myotis grisenscens*	E	All
Indiana Bat	*Myotis sodalis*	E	BRF, COF, CUF, JSF, KIF, PAF, SHF, WCF
Northern Long-eared Bat	*Myotis septentrlonalis*	E	CUF, KIF, PAF, WAF, WCF
Tricolored Bat	*Perimyotis subflavus*	PE	All
Birds			
Bald Eagle	*Haliaeetus leucocephalus*	DM	BRF, COF, CUF, GAF, JSF, JOF, KIF, PAF, SHF, WCF
Whooping Crane	*Grus americana*	EXPN	BRF, COF, CUF, GAF, JOF, KIF, PAF, SHF, WAF WCF
Reptiles and Amphibians			
Alligator Snapping Turtle	*Macrochelys temminckii*	PT	ALF, JOF
Eastern Hellbender	*Cryptobranchus alleganiensis alleganiensis*	PE	BRF, COF, WCF
Fish			
Pallid Sturgeon	*Scaphirhynchus albus*	E	ALF
Sickle Darter	*Percina williamsi*	T	KIF
Slender Chub	*Erimystax cahni*	T	BRF, JSF, KIF
Spotfin Chub	*Erimonax monachus*	T	JSF, KIF
Yellowfin Madtom	*Noturus flavipinnis*	T	BRF, KIF
Mollusks			
Alabama Lampmussel	*Lampsilis virescens*	E, EXPN*	BRF, COF*, KIF
Birdwing Pearlymussel	*Lemios rimosus*	EXPN*	COF*
Clubshell	*Pleurobema clava*	EXPN*, E	COF*, PAF, SHF
Cracking Pearlymussel	*Hemistena lata*	EXPN*	COF*
Cumberland Bean (pearlymussel)	*Villosa trabalis*	EXPN*	COF*
Cumberland Moccasinshell	*Medionidus conradicus*	PE	JSF
Cumberland Monkeyface (pearlymussel)	*Theliderma intermedia*	EXPN*	COF*
Cumberland Combshell	*Epioblasma brevidens*	EXPN*	COF*
Dromedary Pearlymussel	*Dromus dromas*	EXPN*	COF*
Fanshell	*Cyprogenia stegaria*	E	COF, PAF, SHF
Fat Pocketbook	*Potamilus capax*	E	ALF, SHF
Finerayed Pigtoe	*Fusconaia cuneolus*	EXPN*	COF*
Fluted Kidneyshell	*Ptychobranchus subtentus*	E	JOF
Longsolid	*Fusconaia subrotunda*	T	COF, JOF, PAF, SHF, WAF
Orangefoot Pimpleback (pearlymussel)	*Plethbasus cooperianus*	E	PAF, SHF
Oyster Mussel	*Epiolasma capsaeformis*	EXPN*	COF*
Pink Mucket (pearlymussel)	*Lampsilis abrupta*	E	BRF, COF, JOF, KIF, PAF, SHF, WAF, WCF
Purple Bean[3]	*Villosa perpurpurea*	E	JSF, KIF
Purple Cat's Paw (Purple Cat's Paw Pearlymussel)	*Epioblasma obliquata*	EXPN*	COF*
Rabbitsfoot[4]	*Quadrula cylindrica cylindrica*	T	SHF
Ring Pink	*Obovaria retusa*	E	PAF, SHF
Rough Pigtoe	*Pleurobema plenum*	E	BRF, PAF, SHF
Sheepnose Mussel	*Plethobasus cyphyus*	E	COF, SHF

Common Name	Scientific Name	Federal Status[1]	Location[2]
Shiny Pigtoe	*Fusconaia cor*	EXPN*	COF*
Snuffbox Mussel	*Epioblasma triquetra*	E	PAF
Spectaclecase (mussel) [5]	*Cumberlandia monodonta*	E	BRF, COF, KIF, PAF, SHF
Tennessee Clubshell	*Pleurobema oviforme*	PE	KIF
Tennessee Pigtoe	*Pleuronaia barnesiana*	PE	JSF, KIF
White Wartyback (pearlymussel)	*Plethobasus cicatricosus*	E	COF
Winged Mapleleaf	*Quadrula fragosa*	EXPN*	COF*
Snails			
Anthony's Riversnail	*Athearnia anthonyi*	E, EXPN*	BRF, COF*, KIF, WCF
Insects			
Monarch Butterfly	*Danaus plexippus*	PT	All
Plants			
Price's Potato-bean	*Apios priceana*	T	CUF, WCF
Virginia Spiraea	*Spiraea virginiana*	T	KIF
White Fringeless Orchid	*Platanthera integrilabia*	T	KIF, WCF

Source: USFWS 2025b
[1] Federal Status Codes: PE=Proposed Endangered, PT= Proposed Threatened, E=Endangered, T=Threatened, DM = Delisted, Recovered, and Being Monitored, EXPN=Experimental Population.
[2] Location names are as follows: ALF= Allen Fossil Plant, BRF= Bull Run Fossil Plant, COF= Colbert Fossil Plant, CUF=Cumberland Fossil Plant, GAF= Gallatin Fossil Plant, JSF=John Sevier Fossil Plant, JOF=Johnsonville Fossil Plant, KIF= Kingston Fossil Plant, PAF= Paradise Fossil Plant, SHF= Shawnee Fossil Plant, WAF= Watts Bar Fossil Plant, WCF= Widows Creek Fossil Plant.
[3] JSF within critical habitat area for this species.
[4] SHF within critical habitat area for this species.
[5]COF within critical habitat area for this species.
Asterisk (*) denotes corresponding location and federal status code.

During the summer season, the four federally protected bat species roost singly or in colonies either in caves and cave-like structures, or underneath bark and in crevices of both live and dead trees of varying size, age, and species (ACDNR 2025). These species overwinter in caves and cave-like structures such as mines and railroad tunnels. Some species (e.g. gray bat) will roost in large caves year-round, while others may also roost in hollow trees, foliage, brush piles, barns, dams, and storm drains (e.g. tricolored bat). While caves and ideal summer roosting habitat likely do not occur within the project footprint at the TVA properties evaluated in this PEA, roosting habitat is abundant nearby, with caves occurring within 3 miles from many of the Sites.

The monarch butterfly, whooping crane, hellbender, and alligator snapping turtle have a low-to-moderate likelihood of occurrence at and in the vicinity of the Sites proposed for corrective action. Some of the proposed work areas include habitat which could be suitable for these species.

3.7.2 Environmental Consequences

The potential effects on terrestrial habitat and vegetation, aquatic ecology, or wildlife from a given action are assessed by evaluating the potential for the action to adversely impact special status species. Adverse impacts are those that would violate a legal standard for protection of a special status species or its critical habitat; degrade the viability or significance of a special status species or its critical habitat; or measurably change the population size or change the distribution of a special status species. Although the extent of impacts to these resources would vary from site to site, general effects from the alternatives within the TVA PSA are discussed below.

3.7.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no improvements to regional groundwater quality would occur; therefore, there would be potential for short and long term indirect adverse impacts to habitat and vegetation, aquatic ecology, or wildlife under the No Action Alternative.

3.7.2.2 Analysis of Alternatives B, C, D, and E

Each of the four corrective action alternatives (Alternatives B, C, D, and E) would entail similar activities, including land clearing and grading; installation of injection wells, extraction wells, or monitoring wells; access road construction; and corrective action employee vehicle travel on site. Therefore, the types of potential effects on vegetation and habitat, aquatic ecology, and wildlife, would be similar among all four corrective action alternatives. The magnitude of disturbance and potential effects would be specific to each site, depending on site-specific conditions (e.g., extent and type of vegetative cover, species potentially present), and the magnitude of activities (e.g., area of disturbance, number of wells installed). Site-specific conditions and the required magnitude of corrective action activities are expected to determine impacts to habitat, wildlife, and threatened and endangered species to a greater extent than the corrective action alternative implemented.

Per the bounding attributes identified in **Table 2-1**, Proposed Actions for each alternative would occur within previously disturbed areas on existing TVA properties and not exceed 6.5 acres (the maximum disturbance footprint across all alternatives). Given avoidance and minimization measures, actual impacts to biological resources would be much less.

Implementing Alternative D would have the least total potential land disturbance (1.5 acres), while implementing a combination of corrective actions (Alternative E) would have the largest total potential land disturbance (6.5 acres) of the four action alternatives. However, implementation of corrective actions within a smaller footprint (e.g., Alternative D) could potentially have a greater impact to habitat, wildlife, and threatened and endangered species than corrective actions implemented within a larger footprint, if, for example, the site with the smaller footprint has higher quality habitat or a greater prevalence of special status species in the area. Site-specific conditions and potential effects on these resources would be determined on a case-by-case basis as part of the Environmental Screening Checklist process, as Proposed Actions are identified for each site. Each of the corrective action alternatives is expected to have short- and long-term, minor-to-moderate, adverse, direct and indirect effects on habitat, wildlife, and threatened and endangered species, as described in the following sections.

A general description of potential effects follows. As previously discussed, the nature and magnitude of impacts would be similar across the four corrective action alternatives.

<u>Terrestrial Habitat and Vegetation</u>

The majority of the proposed corrective action implementation areas would be within disturbed or maintained grassy areas. As such, development within these zones would result in minimal to no impact on native plant species or unique vegetative communities. Minimal tree clearing would be required and forested lands are expected to be minorly altered. Therefore, the action alternative’s impact on regional forest resources would be considered negligible in scale relative to the overall extent of the forest cover in the regional landscape.

Prior to implementing Proposed Actions, TVA would review the TVA Natural Heritage Database and the USFWS IPaC website during the site-specific Environmental Screening

Checklist process to determine the potential for effects on any sensitive plant communities or designated critical habitat, and coordinate with appropriate agencies as required.

Potential removal of trees and effects on existing vegetation could make adjacent plant communities more vulnerable to erosion, both directly and indirectly. Prior to grading and construction, standard soil erosion and sediment control BMPs would be installed to minimize these effects. Following grading and construction, disturbed areas would be re-seeded to prevent erosion. Installation of the corrective action and access road would result in some minor loss of herbaceous habitat for the duration of the action alternative's operation. This long-term loss of herbaceous vegetation would be minor because these habitats are currently dominated by non-native species and have no appreciable conservation value.

Minimizing the probability of spreading noxious or invasive species would be accomplished by ensuring that construction vehicles and equipment do not introduce or spread propagules (e.g., seeds and spores) from non-native species by cleaning of construction equipment between sites. Additionally, TVA would manage re-vegetation to support a native plant community that reduces or competes with non-native species.

It is expected that the Proposed Actions would have minor impacts on vegetation and forested lands. Any areas that would be disturbed would be reseeded or revegetated with noninvasive and/or native plants after GWPS are met and treatment technologies removed. Minimal tree removal is anticipated. However, if tree removal is deemed necessary, the removal would occur according to TVA's Guidelines for Conducting Biological and Cultural Surveys and Impact Analysis (TVA 2025a).

Aquatic Ecology

Potential effects on aquatic ecology may occur due to slight increases in erosion and sedimentation during construction and operational activities. Runoff could enter nearby streams, causing siltation which can be particularly harmful to aquatic organisms. To mitigate these risks, standard soil erosion and sediment control BMPs would be employed and maintained throughout all phases of the action alternative. As a result, any changes in water quality or sediment load are expected to be minor and temporary.

Streams and tributaries located near proposed structures or intersected by access roads may be affected by surface water runoff, which could increase siltation in receiving waters. To minimize these effects, access road layout would avoid stream crossings and ground disturbance would be limited to the extent practicable. All construction activities would adhere to BMPs outlined in TVA's BMP guidance (TVA 2022).

Overall, potential impacts to aquatic resources are expected to be short-term, minor to negligible, adverse, and indirect, primarily resulting from temporary increases in erosion and sedimentation during construction. In the long term, beneficial impacts to water quality in aquatic habitats may occur due to improved local groundwater quality associated with the corrective action, thereby possibly resulting in long-term, minor to moderate, beneficial, indirect impacts to aquatic ecology.

Wildlife

While habitat quality is generally low within the Sites, prior to implementing the corrective action, TVA would review the TVA Natural Heritage database and the USFWS IPaC website to determine habitat availability and potential presence of either state- or federally protected species prior to beginning construction activity as part of the site-specific review. If potential habitat for rare or protected species is identified, and if TVA determines there is potential to adversely affect listed or protected species, measures to avoid, minimize, or eliminate the potential for adverse impacts would be developed and implemented. However, in the event TVA determines that these measures would not be practicable or effective in eliminating the potential for adverse effects on listed or protected species (e.g., resulting in the potential take of a federally protected species), TVA would conduct a site-specific NEPA review for that site and would consult with the appropriate state regulatory agency or initiate ESA Section 7 consultation with the USFWS, as appropriate. The site-specific review could incorporate by reference relevant parts of this PEA.

Among federally listed or protected terrestrial animal species documented within the TVA PSA, the greatest potential for adverse effects is to those species that are widespread across the TVA PSA (e.g., the bald eagle, Indiana bat, northern long-eared bat, and tricolored bat). Potential impacts to these species are addressed below.

All activities associated with implementing the corrective action would comply with the MBTA and BGEPA. To the extent practicable, construction activities would occur at least 660 feet from any known active bald eagle nests; should this not be feasible, a Bald Eagle Disturbance Permit would be obtained. Should osprey nests, heronries, or other migratory bird nests occur within 660 feet of construction activities, seasonal avoidance measures would be implemented to the extent practicable. If seasonal avoidance measures are not feasible and construction must occur during the breeding/active season of osprey or other migratory BCCs, TVA would coordinate with appropriate state and federal agencies, as necessary on a site-specific basis. Because appropriate BMPs would be implemented during construction, operation, and maintenance, and because all appropriate permits would be obtained, any direct or indirect impacts to migratory bird species are anticipated to be minor.

A *Project Review Form - TVA Bat Strategy* would be completed prior to implementing Proposed Actions. Conservation measures would be implemented and a review of bat records in proximity of each Site by a terrestrial zoologist would be conducted as required for the site-specific activities. Additionally, potential effects on bats would be avoided by observing seasonal restrictions.

ns on tree clearing and avoiding effects on potentially suitable roost trees, caves, water bodies, sinkholes, buildings, and bridges. Removal of suitable habitat for the Indiana bat, northern long-eared bat, and tricolored bat has the potential to adversely affect these species, primarily if tree removal occurs when these bats are birthing and rearing pups (May 15 – July 31). However, any required tree removal is proposed to occur during the winter period. Because winter period dates for bats vary by location, a determination of suitable (winter) dates would be conducted for each site, prior to beginning any tree removal. Construction, operation, and maintenance of the action alternatives would avoid effects on caves and cave-like structures, water bodies, sinkholes, buildings, and bridges. With the use of these identified conservation measures, the action alternatives would cause minimal impacts to gray bat, Indiana bat, or northern long-eared bat. In addition, the action alternatives would not jeopardize the continued existence of tricolored bat.

In 2023, TVA updated the Programmatic Biological Assessment for Evaluation of the Impacts of Tennessee Valley Authority’s Routine Actions on Federally Listed Bats (TVA 2023d). The Biological Assessment identified the above measures to minimize impacts to bats from its actions. In response, USFWS provided a Biological Opinion, which states that by implementing minimization strategies, including restricting tree removal to the winter-time period, all TVA routine actions combined (including those that would be implemented under the Proposed Action) are not likely to jeopardize the continued existence of special-status bats that may be present within and proximal to Sites (USFWS 2023).

The monarch butterfly, hellbender, and alligator snapping turtle are proposed, or candidate species, for listing under the Endangered Species Act. Whooping crane occurs as an experimental, non-essential population. Pre-construction surveys would be conducted as required by TVA. TVA would consult with USFWS on appropriate avoidance or mitigation measures if necessary.

To the extent practicable, construction activities would avoid disturbance to listed species and their habitat. However, if TVA determines there is potential to adversely affect listed species, TVA would conduct pre-construction surveys and consult with USFWS on appropriate avoidance or mitigation measures as necessary, on a site-specific and species-specific basis.

Minor, short-term effects on mobile wildlife that use the Sites are anticipated as they might be deterred from using the areas at and proximal to project sites by the presence of construction activities, vehicles, and equipment. Minor to moderate, long-term effects on some wildlife individuals could occur due to displacement since less-mobile wildlife species may not be able to relocate to a safe distance from the construction areas. However, due to the presence of suitable habitat adjacent to most Sites, these impacts are expected to be further reduced. The number of species and individuals displaced would vary, dependent in part on the degree of difference between pre-development habitat (e.g., mowed field) and post-development habitat.

Since the Proposed Actions would be designed and scheduled to avoid impacts to any federally and state-listed species, these action alternatives are not likely to adversely affect these species or their critical habitats. The action alternatives would minimally to minorly impact federally or state-listed plant species.

3.8 Cultural and Historic Resources

3.8.1 Affected Environment

Cultural resources are properties and places that illustrate aspects of prehistory or history or have long-standing cultural associations with established communities or social groups. Cultural resources may include archaeological sites, unmodified or modified landscapes, discrete natural features, human-made objects, structures such as bridges or buildings, and groups of any of these resources, sometimes referred to as districts.

3.8.1.1 Cultural Resources in the TVA PSA

Archaeological resources typically are identified through Phase I archaeological surveys conducted for compliance with Section 106. Numerous surveys have been conducted along reservoir shorelines, within reservoirs, and on power plant reservations. Some TVA transmission line corridors and associated access routes have also been surveyed. Across all these types of areas, through hundreds of surveys, TVA has identified many thousands of archaeological sites, representing the entire time range of known human habitation of the Tennessee Valley including historic periods.

3.8.1.2 Archaeological Resources in the TVA PSA

Archaeological sites occur throughout the TVA fee-owned lands in a variety of environmental contexts. Archaeological sites are rarely found in areas of extreme slope, wet areas, or areas that have been heavily disturbed by modern construction activities or mining.

Within the boundaries of TVA's properties, CCR units are typically located near the coal-fired plant and in or near floodplains, on heavily disturbed industrial lands. Therefore, there is usually a very low potential for important cultural resources to be present within the CCR unit footprints. CCR units are unlikely to contain resources that are potentially eligible or listed on the NRHP.

TVA has completed archaeological surveys on 100 percent of land with potential for archaeological sites on TVA fee-owned property at the following TVA properties: Allen, Cumberland, Gallatin, John Sevier, Johnsonville, Kingston, and Paradise Fossil Plants. TVA has completed surveys on nearly all of the Bull Run Fossil Plant, and on large portions of the Colbert, Shawnee, Watts Bar, and Widows Creek Fossil Plants. Most modern surveys identified archaeological resources and resulted in a recommendation regarding the NRHP eligibility of each resource. TVA consulted on these survey reports with the appropriate SHPOs and federally recognized Indian tribes. A number of archaeological sites within the TVA property boundaries were recorded in the early twentieth century prior to plant construction. Some of these sites have been destroyed by construction, or are unable to be accessed due to their location underwater or in a contaminated area and have not been assessed for their NRHP eligibility.

3.8.1.3 Historic Structures and Sites

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 NRHP as defined by the Secretary of the Interior criteria for evaluation (36 CFR 60.4). Approximately 5,000 structures, buildings, power plants, and infrastructure have been identified and recorded on TVA fee-owned lands. TVA, in consultation with the various state SHPOs, has evaluated all of its coal-fired plants for NRHP eligibility. Of the proposed TVA properties, Bull Run, John Sevier, and Shawnee Fossil Plants have previously been determined eligible for listing in the NRHP; the Shawnee Fossil Plant is TVA's only plant listed in the NRHP. In the case of these three plants, the powerhouse, switchyard, original coal-handling equipment, and other original structures were all considered eligible under Criterion A and C. The John Sevier Fossil Plant has been retired and demolished; the Bull Run Fossil Plant has been retired and is currently in the process of being demolished. TVA continues to operate the Shawnee Fossil Plant. The remaining plants within the fossil fleet have been determined ineligible in consultation due to a loss of integrity from removal of original structures and installation of modern emissions-control equipment, and all of these but Cumberland, Gallatin, and Kingston have been retired and demolished. TVA has decided, after completing environmental reviews and Section 106 consultation, to retire Kingston Fossil Plant by 2027 and Cumberland by 2028.

3.8.2 Environmental Consequences

The potential effects on cultural or historic resources from a given action are assessed by evaluating the potential for an action to directly damage, or indirectly modify the context, of a protected resource. Although the extent of impacts to cultural or historic resources would vary from site to site, general effects from the action alternatives are discussed below. Other than Shawnee Fossil Plant, Proposed Actions are assumed to be located in previously disturbed areas where no NRHP-listed or -eligible archaeological sites are present and outside the viewshed of any NRHP-listed or -eligible historic architectural properties.

For action Alternatives B, C, D, and E, the following applies: Pursuant to 36 CFR 800.4(b)(2), due to the large land areas involved and complexity of the siting and design processes, TVA would use a phased process for identifying historic properties in any proposed APE and evaluating potential project effects. TVA would initiate consultation with the SHPO and tribes to determine the APE, identify historic properties in the APE, and assess the potential effects of the proposed action on any NRHP-listed or -eligible properties in the APE in consultation with the SHPOs and Tribes. In siting any laydown yards or above-ground structures, TVA would seek an existing disturbed location, or an area that past archaeological surveys have shown do not contain NRHP-listed or -eligible archaeological sites, to ensure that no such sites would be affected by the action. TVA would complete any surveys needed for historic architecture, assess potential adverse effects on any identified NRHP-listed or -eligible historic architectural properties, and seek ways to avoid such adverse effects, in consultation with the appropriate SHPO as project plans are developed. Should avoidance of adverse effects on historic properties prove to be infeasible, TVA would work with the appropriate consulting parties to develop a MOA for the resolution of the adverse effects, pursuant to §800.6(b)(1). Execution of the MOA would signify completion of TVA's Section 106 compliance responsibilities. Therefore, TVA does not anticipate that any action alternative would fall outside these bounded potential effects on cultural resources or historic properties at this time, thereby not resulting in any potentially long- or short-term, moderate, adverse, direct or indirect impacts to cultural resources or historic properties.

3.8.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, there would be no impacts to cultural resources because this alternative does not include ground-disturbing activities or changes in the visual character of the APE.

3.8.2.2 Analysis of Alternatives B, C, and E

Under these alternatives, TVA proposes that the APE would be the area of ground disturbance where physical effects could occur within Sites and adjacent areas, as well as areas within a 0.5-mile radius and direct line-of-sight of newly proposed above-ground structures.

Were TVA to propose siting a mixing and delivery system with a storage tank or water treatment facility on the Shawnee Fossil Plant, which represents the only Site eligible for or listed in the NRHP, these Alternatives would not include modifications or removal of any of its character-defining features or any of the contributing buildings or structures. TVA would also choose a location that would not result in adverse visual effects on the Shawnee Fossil Plant.

3.8.2.3 Alternative D – Monitored Natural Attenuation

Under Alternative D, TVA proposes that the APE be the area of ground-disturbance where physical effects could occur in relation to well installation and access road and laydown area construction.

3.9 Visual Resources

3.9.1 Affected Environment

Visual resources are the visual characteristics of a place and include both natural and manmade attributes. To many observers, including residents and visitors, visual resources of a particular location provide the context of historical and culturally significant settings. Visual resources can vary and are influenced by land uses, making visual quality subjective. The human response to visual changes in the landscape can vary dramatically depending on the setting. For example, changes in agricultural and rural settings solicit different feelings in an observer than those in urban or industrial areas.

The visual landscape of an area is formed by physical, biological and man-made features that combine to influence both landscape identifiability and uniqueness. The U.S. Forest Service (USFS) has developed a Scenery Management System (SMS) that can be used to determine the value and importance of visual aesthetics (USFS 2025). According to the SMS, 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 (USFS 2010). 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.

The scenic visibility of a landscape may be described in terms of three distance contexts: (1) foreground, (2) middleground and (3) background (USFS 2010). In the foreground, considered to be an area within 0.5 miles of the observer, individual details of specific objects are important and easily distinguished. In the middleground, from 0.5 miles 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. Effects on visual and aesthetic resources associated with a particular action may occur because 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 impacts on visual resources. However, potential changes to the visual character of or surrounding cultural resources are evaluated separately in Section 3.8.

For this analysis, the affected environment is considered to include the project area within the 12 TVA properties evaluated in this PEA (Sites) and surrounding areas, which encompasses both permanent and temporary impact areas, as well as the physical and natural features of the landscape. Proposed Actions would occur on previously disturbed lands and within existing industrial infrastructure. Principal features in the foreground would include industrial power structures such as the powerhouse, coal-handling system, emissions stacks, generators, switchyards, or major transmission corridors. Most of the Sites have limited amounts of vegetation, although there may be some grassy landscaped areas within the sites, or forested areas surrounding the sites. Each Site considered in this PEA is adjacent to a river. Therefore, scenic attractiveness of the affected environment is considered to be minimal to common, given the combination of unattractive industrial features with more scenic natural features. The scenic integrity is considered to be low.

Since TVA properties are located in mostly remote, rural areas, groups that would likely have direct views of the Sites include authorized employees, contactors, and visitors to the Site. Views of the project area are generally restricted to the foreground (i.e., within a half mile) in all directions, however that may be buffered by nearby vegetation and the local topography.

3.9.2 Environmental Consequences

The potential effects on the visual environment from a given action are assessed by evaluating the potential for changes in the SMS ratings based upon landscape scenic attractiveness, integrity and visibility. The location and context of the setting, the sensitivity of viewing points available to the public, their viewing distances and visibility of the alternatives 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. Although the extent of impacts on visual resources would vary from site to site, general visual effects from the alternatives within the TVA PSA are discussed below.

Effects on visual resources due to reasonably foreseeable future action during construction would likely consist of increased traffic as the sites in question are in rural areas and are not heavily populated or traversed. As the sites are so dispersed throughout 80,000 square miles, reasonably foreseeable future actions would have to be investigated for each individual site as part of the Environmental Screening Checklist prior to commencing construction. Any reasonably foreseeable future actions that may impact visual resources would be addressed during separate site-specific analyses but are expected to be minor.

3.9.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed. Therefore, there would be no impacts to visual resources under the No Action Alternative

3.9.2.2 Alternative B – Enhanced In Situ Treatment

Construction

Under Alternative B, construction equipment would include up to 4 drill rigs, 2 dump trucks (17 cubic yards), 2 skid steers, and 10 work vehicles, for a duration of less than 1 year. The injection wells (vertical or horizontal) would be placed close together and close to the CCR pond at each site. Therefore, construction activities would take place in an already disturbed area of an industrial nature.

Onsite observers (foreground), such as construction workers and site employees would experience changes to the viewshed of a temporary and minor nature. The existing industrial viewshed would not change considerably. Offsite observers (middleground), such as boaters or people travelling along roads, would also experience minor and temporary changes to the viewshed due to the existing industrial nature of the sites. Offsite observers (background) would likely experience no impacts to visual resources due to the size of the construction equipment in comparison with the existing site structures such as the powerhouse, coal-handling system, emissions stacks, generators, switch yards, or major transmission corridors.

Impacts on visual resources due to increased traffic, including construction worker vehicles and supply and waste delivery, would be short-term, minor, adverse and direct, as current site operations would also have traffic of this nature.

<u>Operations</u>

During operations under Alternative B, impacts to visual resources would be minor. Site activities would consist of 2 workers sampling monitoring wells on a monthly or quarterly basis. This would involve the use of pickup trucks and sampling equipment, neither of which would be visually intrusive to onsite nor offsite observers. A storage tank for mixing and delivery of the injection treatment system would be removed after construction and operation, which combined would be up to 4 years. Therefore, impacts on visual resources would be short-term, minor, adverse and direct.

3.9.2.3 Alternative C –Hydraulic Control and Groundwater Treatment

<u>Construction</u>

Under Alternative C, construction equipment would include up to 2 drill rigs, 1 dump truck (17 cubic yards), 1 skid steer, 5 work vehicles, 1 crane, and 1 telehandler. Impacts to visual resources would be similar to Alternative B, with the exception of the use of a crane. The crane would potentially be observed by onsite and offsite observers due to its height in relation to the existing structures at the sites. However, it would only be in use during the construction and demolition of the water treatment facility; therefore, impacts to visual resources would be similar to those under Alternative B.

<u>Operations</u>

During operations, impacts to visual resources would be similar to those under Alternative B, short-term, minor, adverse and direct. Activities would consist of groundwater sampling and equipment maintenance, requiring one or two pickup trucks periodically. If the water treatment facility needed a major overhaul, impacts to visual resources would be similar to those during construction.

3.9.2.4 Alternative D – Monitored Natural Attenuation

Under Alternative D, the installation of two additional monitoring wells at each site would require similar equipment to Alternatives B and C and would take up to a week to accomplish. Therefore, impacts during construction would short-term, minor, adverse and direct.

During operations, impacts to visual resources would be similar to those under Alternative B, as operations would consist of regular groundwater sampling.

3.9.2.5 Alternative E – Combination of Corrective Actions

Under Alternative E, depending on the combination decided upon, impacts to visual resources would be short-term, minor, adverse and direct and indirect, with the most impacts arising from the possible use of a crane if a water treatment plant is required.

During operations, impacts to visual resources would be short-term, minor, adverse, and direct, similar to other action alternatives.

3.10 Natural Areas, Parks, and Recreation

3.10.1 Affected Environment

Managed areas include lands such as natural areas, parks, and recreation sites, held in public ownership that are managed by an entity (e.g., TVA, USDA, USFS, State of Tennessee) to protect and maintain certain ecological and recreational features. Natural areas include ecologically significant sites; federal, state, or local park lands; national or state forests; wilderness areas; scenic areas; wildlife management areas; recreational areas; greenways; trails; Nationwide Rivers Inventory streams; and wild and scenic rivers. Ecologically significant sites are either tracts of privately owned land that are recognized by resource biologists as having environmental resources or identified tracts on TVA lands that are ecologically significant but not specifically managed by TVA's Natural Areas program.

Numerous natural areas, parks and recreation sites of various sizes, from a few acres to thousands of acres, occur throughout the TVA PSA (see **Figure 1-1**). Many of these managed areas cross state boundaries or are managed cooperatively by multiple agencies, including Tennessee Wildlife Resources Agency, Alabama Department of Conservation and Natural Resources, and Office of Kentucky Nature Preserves. Some managed areas are found on or near TVA generating plant properties, especially in the case of hydroelectric plants, where portions of the original dam and reservoir lands have been developed into state and local parks. Recreational uses of these managed areas include fishing, boating, paddling, swimming, hunting, bird watching, hiking and other outdoor recreation activities.

3.10.2 Environmental Consequences

The potential effects on managed areas from a given action are assessed by evaluating the potential for changes in access or use of the lands. As part of its site-specific screening process using the Environmental Screening Checklist, TVA would determine if a property proposed for corrective action has managed, natural, or recreational areas present within 0.1 mile. If there is potential for effects on nearby managed, natural, or recreational areas, TVA Natural Areas and Recreation Subject Matter Experts would make a determination for whether additional environmental review is needed.

3.10.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed, and there would be no changes to any existing corrective actions. Therefore, there would be no impacts to natural areas, parks, and recreation resources under the No Action Alternative

3.10.2.2 Analysis of Alternatives B, C, and E

Under these alternatives, natural areas, parks, or recreation areas within 0.1 mile of a given site may experience indirect impacts such as construction noise, and increased traffic during construction. However, construction impacts would be temporary and would be minimized through use of BMPs. Because construction would be contained within TVA project sites, it is anticipated that impacts would be minor and limited to natural areas, parks and recreational areas directly adjacent or in proximity to the sites. The construction and operation of Alternatives B, C, and E would be limited to existing utility corridors or previously disturbed industrial areas and would not encroach upon public parks, trails, or designated natural areas. No long-term restrictions to recreational access or changes in land use are expected. Permanent structures such as above-ground tanks would be sited to avoid encroachment into publicly accessible areas. Therefore, although users of recreational facilities on TVA properties could be directly impacted if these amenities were closed during construction, these impacts would be short-term, minor, adverse and direct as facilities likely would reopen once construction is complete. No impacts are anticipated during operation.

3.10.2.3 Alternative D – Monitored Natural Attenuation

Under Alternative D, impacts are anticipated to be less than those under Alternatives B, C, and D, due to its minimal footprint for installation of two monitoring wells. Regardless, natural areas, parks, or recreation areas within 0.1 mile of a given site may experience short-term, minor, adverse and indirect impacts during construction, and no impacts are anticipated during operation.

3.11 Noise

3.11.1 Noise Fundamentals and Regulatory Framework

Sound occurs when vibrations travel through a medium, such as air, and are interpreted by biological components of the ear. Noise is unwanted 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 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. For instance, higher sensitivities to noise would be expected during the quieter late night periods at noise-sensitive receptors such as residences.

Potential facilities considered in this PEA could be located on any of the TVA properties listed in **Table 1-1**. Only one of the counties in which these TVA properties are located (Anderson County, Tennessee) has established quantitative sound-level regulations, specifying environmental sound-level limits based on the land use of the property receiving the noise. Per the Anderson County Zoning Ordinance, Residential (R-1) districts have the most stringent regulations, and noise cannot exceed 60 A-weighted decibels (dBA) during daytime hours (7 a.m. to 10 p.m.) or 55 dBA during the night (10 p.m. to 7 a.m.), measured at the closest adjacent property line. The Bull Run Fossil Plant is located in an area that has been zoned for heavy industrial use by Anderson County. Allowable noise levels from areas zoned for heavy industrial use cannot exceed 80 dBA at the adjacent property line. Construction activities are exempt from the noise regulations (Anderson County 2021).

3.11.2 Affected Environment

Coal-fired and natural-gas power plant operations and ancillary activities are the primary source of background noise at most operational TVA facilities. Operations at operating coal-fired power plants generate varying amounts of environmental noise and can include noise generating activities associated with turbines, generators, barge operations, coal unloading activities and heavy equipment operations associated with coal pile management, truck operations and occasional rail operations. Operations at the natural gas plants generate localized noise through operation of gas or steam turbines, generators, mechanical draft cooling towers, and other ancillary equipment. Existing noise emission levels associated with these activities typically range from 59 to 87 dBA (TVA 2014b).

Ambient noise at those coal-fired power plants that are no longer operational would be characterized by adjacent roadway traffic and general environmental background noise which would be relatively low as most coal-fired power plants are located in rural settings. Noise sources common to activities evaluated in this PEA include noise from operating industrial and utility facilities, transportation noise, and construction noise.

3.11.3 Environmental Consequences

Construction and operation at Sites could result in effects on noise in the immediate vicinity.

3.11.3.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed, and there would be no changes to any existing corrective actions. Therefore, there would be no impacts from noise under the No Action Alternative.

3.11.3.2 Analysis of Alternatives B, C, D, and E

Potential noise impacts associated with implementation of Alternative B, C, D, or E would occur primarily during construction. Heavy equipment such as drill rigs, dump trucks, and skid steers, could produce noise exceeding 85 decibels; however, such noise decreases as distance from its source increases, and noise levels would decrease to approximately 66 dBA at 0.25 miles (FHWA 2017). Thus, construction activities could contribute temporary, short-duration noise to the ambient sound environment around each project site for construction duration, up to one year. However, construction activities would occur during daylight hours, when people are generally less disturbed by noise. Should any sensitive receptors be identified in the Environmental Screening Checklist, a site-specific analysis would be completed to determine the potential perceived noise from construction to sensitive receptors. Overall, impacts from noise during construction are expected to be short-term, minor, adverse, and direct.

Operational activity producing noise is anticipated to be limited to equipment maintenance and personal vehicle operation resulting in no noticeable change to ambient noise. Overall, no additional impacts over ambient noise levels are expected from operation.

3.12 Air Quality

Air quality is a vital resource that impacts us in many ways. Poor air quality can affect human health, ecosystem health, forest and crop productivity, economic development and enjoyment of scenic views. This section summarizes current conditions and trends over the past 35 years for key air quality issues. Air quality within the TVA PSA has steadily improved over the past 35 years (TVA 2025f).

In this PEA, the affected environment is the 12 TVA properties proposed for groundwater corrective actions in Alabama, Kentucky, and Tennessee as shown in **Figure 1-1**. The primary air quality parameters of concern for this PEA are National Ambient Air Quality Standard (NAAQS) criteria air pollutants, hazardous air pollutants and volatile organic compounds.

Under the CAA, the Prevention of Significant Deterioration program was designed to preserve, protect and enhance air quality in designated mandatory federal Class I areas (i.e., national wilderness areas and national memorial parks that exceed 5,000 acres and national parks that exceed 6,000 acres) (USEPA 2025b). There are no Class I protected areas within the vicinity of the properties proposed in this PEA. The closest Class I area to any site is located approximately 32 miles southeast of Colbert Fossil Plant.

3.12.1 Affected Environment

Table 3-12 details the county-wide attainment statuses for the 12 TVA properties evaluated in this PEA.

Table 3-12. NAAQS Attainment Status by County

TVA Property	Location	NAAQS Status[1]
Allen Fossil Plant	Shelby County, Tennessee	Attainment
Bull Run Fossil Plant	Anderson County, Tennessee	Attainment
Colbert Fossil Plant	Colbert County, Alabama	Attainment
Cumberland Fossil Plant	Montgomery County, Tennessee	Attainment
Gallatin Fossil Plant	Sumner County, Tennessee	Attainment
John Sevier Fossil Plant	Hawkins County, Tennessee	Attainment
Johnsonville Fossil Plant	Humphreys County, Tennessee	Attainment
Kingston Fossil Plant	Roane County, Tennessee	Attainment
Paradise Fossil Plant	Muhlenberg County, Kentucky	Attainment
Shawnee Fossil Plant	McCracken County, Kentucky	Attainment
Watts Barr Fossil Plant	Rhea County, Tennessee	Attainment
Widows Creek Fossil Plant	Jackson County, Alabama	Attainment

[1] As stated in Section 3.1.1, unclassifiable and unclassifiable/attainment statuses are treated as attainment with NAAQS for planning and permitting purposes.
Sources: USEPA 2025c, USEPA 2025d, USEPA 2025e

3.12.2 Environmental Consequences

The potential effects on air quality from a given action are assessed by evaluating the potential for an action to generate air or dust emissions in excess of federal, state, or local regulations. Although the extent of air emission impacts would vary from site to site, general effects from the alternatives within the TVA PSA are discussed below.

3.12.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, there would be no change to regional air quality or emissions from TVA properties within the TVA PSA.

3.12.2.2 Alternatives B, C, D and E

During construction, ground-disturbing activities result in fugitive dust emissions. Fugitive dust may also result if construction vehicles travel on unpaved roads. Fugitive dust produced from construction activities can be controlled using standard construction practices, such as watering of exposed surfaces and covering of disturbed areas. Dust emissions from construction traffic can be controlled by limiting speed limits. In addition, when there are periods of high wind during excavation and grading, temporary suspension of those activities would reduce the volume of fugitive dust experienced during high winds.

Equipment used during the construction phase would include trucks, drill rigs, and other heavy equipment. Low ground-pressure-type equipment (e.g., tracked vehicles) would be used in specified locations (e.g., areas with soft ground) to reduce the potential for environmental impacts, per TVA BMPs. Combustion of gasoline and diesel fuels by internal combustion engines (e.g., vehicles, generators, and construction equipment) would generate local emissions of carbon monoxide, ozone, nitrogen oxides, particulate matter, sulfur dioxide, and volatile organic compounds. Air quality impacts from construction would be temporary (up to one year) and would be minimized through use of BMPs (e.g., dust control measures) as required to reduce offsite emissions. Overall, air quality impacts from construction-associated activities would be short-term, minor, adverse, direct and localized, and would not affect regional air quality standards.

Operation or maintenance of the treatment technologies, given equipment uses described for Alternatives B, C, D, and E, would result in negligible air emissions and therefore would have short-term, minor, adverse, direct impact to air quality.

3.13 Greenhouse Gas and Climate Change

3.13.1 Affected Environment

Like the glass in a greenhouse, certain gases, primarily carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride, absorb heat that is radiated from the surface of the Earth. The common term for this phenomenon is the "greenhouse effect," and these gases are typically referred to as greenhouse gas (GHG). The majority of the scientific community agrees that since the Industrial Revolution, human-related activities, which include the burning of fossil fuels to produce energy and deforestation, have contributed to elevated concentration of GHGs in the atmosphere. The human production and release of GHGs to the atmosphere have caused an increase in the average global temperature. While the increase in global temperature is known as g*lobal warming*, the resulting change in a range of global weather patterns is known as *global climate change*.

The USEPA defines climate change as *"*significant changes in average conditions—such as temperature, precipitation, wind patterns, and other aspects of climate—that occur over years, decades, centuries, or longer*"* (USEPA 2025f). Climate change includes major changes in temperature, precipitation, or wind patterns, among others, which occur over decades or longer. These changes are caused by numerous natural factors, including oceanic processes, variations in solar radiation received by Earth, plate tectonics and volcanic eruptions, as well as anthropogenic activities.

3.13.2 Environmental Consequences

The potential effects on GHG emissions and global climate change from a given action are assessed by evaluating the potential for an action to generate GHG emissions in excess of federal, state, or local regulations. Although the magnitude of such emissions would vary from site to site, general effects from the alternatives within the TVA PSA are discussed below.

3.13.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed, therefore, there would be no impacts, adverse or beneficial, to climate change resulting from changes to GHG emissions under the No Action Alternative.

3.13.2.2 Alternatives B, C, D, and E

Under these alternatives, construction activities are expected to result in a temporary, minor increase in construction-related emissions from internal combustion engines. As the construction period is temporary and short term, GHG emissions and associated impacts to climate change are *de minimis*. Per the bounding analysis (**Table 2-1**), the treatment technologies would be located on previously disturbed areas with minimal impacts to forested lands. Therefore, there would be no notable loss of carbon sequestration.

Operation of the treatment technologies would result in emissions from mobile sources that include two workers commuting for monthly and quarterly sampling. However, these emissions would be minor in comparison to regional emissions and would not impact climate change. Therefore, overall impacts to greenhouse gas emissions and climate change would be short-term, minor, adverse, and direct.

3.14 Transportation and Navigation

3.14.1 Affected Environment

This section describes the transportation and navigation infrastructure that could be affected by the project alternatives. The approach taken in this programmatic review focuses on a regional scale rather than a site-specific scale. In this analysis, transportation refers to how raw materials for construction or operation reach the intended facilities, or waste is removed by both permanent and temporary staff and workers commuting to and from the site. Methods of transportation evaluated in this PEA include road transportation. No rail or barge transportation is anticipated to be utilized at the time of this PEA.

The principal modes of transportation within the TVA PSA includes thousands of miles of highways, roads, and bridges. Public road managers in the TVA PSA include state departments of transportation, conservation, forestry; county highway departments; and municipal road departments. Road access to the plants varies from two-lane roads to four-lane divided highways and is via at-grade intersections, some of which are controlled by traffic signals.

3.14.2 Environmental Consequences

The potential effects on transportation from a given action are assessed by evaluating the potential for an action to interfere with existing traffic, or to cause the potential for safety hazards associated with traffic. Although the extent of transportation impacts would vary from site to site, general effects from the alternatives within the TVA PSA are discussed below. In accordance with the bounding analysis (**Table 2-1**), work vehicles are considered trucks or other vehicles dedicated to onsite work. For the alternatives, it is assumed that the maximum distance from the project areas to a major four-lane divided highway is 20 miles.

For all action alternatives, where construction occurs traffic is expected to be distributed during a peak morning period (to the property) and a peak evening period (away from the property) and it is assumed that there would generally be one person per commuting vehicle and some ride sharing. It is assumed that these motorists would use interstate highways or major arterial roadways as much as possible but would likely have to use collectors and local roads closer to Sites. The construction workforce traveling to and from a Site would contribute to the traffic on the local transportation network. Due to Site distance from major highways, minor impacts to local access roads are anticipated. These impacts are expected to occur during construction and installation as a result of increased vehicular traffic. However, once traffic merges onto a major roadway, the additional traffic would be dispersed and would not result in congestion or the degradation of existing traffic patterns of the regional transportation network.

Additional truck traffic would also occur near the project area during the construction phase due to material and equipment deliveries. However, because this increase would primarily occur during the mobilization and demobilization phases, long-term impacts to the surrounding transportation network during the construction phase are not anticipated.

3.14.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed; therefore, there would be change to existing traffic conditions or to the overall transportation network.

3.14.2.2 Alternative B – Enhanced In Situ Treatment

Under Alternative B, effects on transportation would occur from construction and operation workforce and construction deliveries. The daily workforce during construction is expected to be up to 14 workers per day per Site. There would be a daily morning inbound and outbound traffic volume of 10 work vehicles per day for a total of 20 trips per day. Overall, the traffic volume generated by the construction workforce would be minor and temporary as it would be contained to the 1-year construction period and generally limited to the morning and evening peak periods.

During early construction, equipment (four drill rigs, two dump trucks of 17-cubic yard capacity) would need to be transported onto the site and up to four truckloads (eight truck trips) per day may occur for material deliveries and waste disposal. Additionally, there may be up to 150 truck trips per day for up to 150 days per year for borrow material transportation.

Operation of the EIST would require approximately two workers for monthly or quarterly sampling. Operation and maintenance of the facilities are not anticipated to change the existing levels of service on the surrounding road network since most operation monitoring would be conducted remotely. Therefore, overall transportation and navigation impacts are expected to be short-term, negligible to minor, adverse and direct for construction and operation.

3.14.2.3 Alternative C – Hydraulic Control and Groundwater Treatment

Under Alternative C, effects on transportation would be comparable to Alternative B but the daily workforce trips per day would be only 10. There would be more equipment to be transported to the Site (two drill rigs, one dump truck, one skid steer, one crane, and one telehandler). During early construction, up to two flatbed truck loads (four truck trips) per day may occur for material deliveries and waste disposal, along with one 18-wheeler/flatbed truck for delivery of water treatment facility. Alternative C would not require borrow material transportation.

Operation of Alternative C would require approximately four operators, two per shift, during the treatment duration (approximately three years), with the facility operable 24 hours per day, seven days per week for a maximum of 365 operating days. Additionally, up to four workers for monthly or quarterly sampling would be required. Similar to Alternative B, levels of service on the surrounding road network are not expected to change. Therefore, overall transportation and navigation impacts for construction and operation are expected to be similar to Alternative B.

3.14.2.4 Alternative D – Monitored Natural Attenuation

Under Alternative D, the daily workforce trips would be 10 and effects to traffic patterns would be similar to those described for Alternative C. Additional truck traffic for material and equipment deliveries and waste disposal would be similar to Alternative C with the exception of the crane delivery. Alternative D would not require borrow material transportation.

Monitoring operations would require approximately two workers for monthly or quarterly sampling. Adaptive management of the sites may lead to more actions needing to be completed, similarly impacting traffic as when original construction or monitoring is completed. This would be sporadic or as needed; therefore, impacts would be minor and temporary.

Alternative D generates minor construction traffic and does not include intensive long-term operational activity. Therefore, overall, transportation and navigation impacts are expected to be similar to Alternative B.

3.14.2.5 Alternative E – Combination of Corrective Actions

Using a combination of alternatives would not result in additive effects, as some crews may complete multiple tasks from alternatives, or implementation of alternatives may be completed sequentially. The daily workforce during the approximately 12-month construction or installation phase is expected to be up to 21 workers per day. With multiple treatment technologies being employed, truck trips would increase over other alternatives but would not exceed 42 trips daily. Operations would require up to eight workers, depending on the treatment technologies implemented. As Alternatives B, C, and D are anticipated to have similar transportation and navigation impacts, Alternative E would likely also result in short-term, minor, adverse and direct impacts.

3.15 Hazardous Materials and Solid Waste

3.15.1 Affected Environment

3.15.1.1 Hazardous Materials

Hazardous waste, as defined by the Resource Conservation and Recovery Act (RCRA), is any solid waste that exhibits one or more of the following characteristics: ignitability, corrosivity, reactivity, or toxicity. Common examples include paints, solvents, corrosive liquids, and discarded chemicals. At TVA properties, hazardous wastes include PCBs, which are historically used in insulating fluids for electrical equipment as well as a variety of hazardous materials used as part of daily operations. Consequently, most TVA fossil plant properties are classified as small quantity generators of hazardous waste under RCRA, generating between 5 and 34 tons of hazardous waste per year (TVA 2024a). The proper management of these materials and wastes is performed in accordance with established procedures and applicable regulations.

3.15.1.2 Solid Waste

Solid waste encompasses a wide range of materials that include refuse, sanitary wastes, contaminated environmental media, scrap metals, non-hazardous wastewater treatment plant sludge, non-hazardous air pollution control wastes, various non-hazardous industrial wastes, and other materials (solid, liquid, or contained gaseous substances). Solid wastes are regulated by RCRA Subtitle D, with regulatory authority given to each state for the handling and disposal of solid waste according to federal regulations and other state requirements.

Some solid wastes are of special types that are challenging or hazardous to manage, including sludges, bulky wastes, pesticide wastes, industrial wastes, combustion wastes, friable asbestos, and certain hazardous wastes exempted from RCRA Subtitle C requirements (TDEC 2025). Such waste, if generated by TVA, would be disposed of according to state and federal regulations.

The physical and chemical properties of CCR vary depending on factors such as the type of coal combusted, the design and operation of the generating unit, and the specific pollution control technologies employed. CCR are regulated as solid wastes by 40 CFR Part 257, Subpart D, and 40 CFR Part 261. Even though CCR are not designated as a hazardous waste, they can contain hazardous substances in varying amounts. During normal operations, solid wastes are removed from coals plants with both dry and wet disposal methods. Dry disposal involves transferring disposal wastes to a storage silo or outdoor storage area for transport and containment at an approved landfill or sent off site to be processed into beneficial byproducts. Wet disposal involves sluicing bottom ash and fly ash into surface impoundments for storage and treatment, as regulated under 40 CFR Parts 257 and 261 (USEPA 2024b). In 2022, TVA generated approximately 1.5 million tons of CCR, of which 80 percent was utilized or marketed for alternative uses. The active TVA power generating facilities at Cumberland, Gallatin, Kingston, and Shawnee have been converted to dry handling and storage systems for CCR. TVA is currently implementing closure of the legacy CCR surface impoundments at these sites in accordance with federal regulations and its internal environmental commitments (TVA 2024a).

3.15.2 Environmental Consequences

The effects associated with hazardous materials or solid waste from a given action are assessed by evaluating the potential for an action to use, store, generate, spill, or dispose of these materials. Although the extent of hazardous material or solid waste impacts would vary from site to site, the general effects from the alternatives within the TVA PSA are discussed below.

Action Alternatives B, C, D, and E would potentially generate small quantities of hazardous or special waste in the form of waste oil or solvents resulting from onsite maintenance of construction equipment. No hazardous waste would be generated from the corrective measures themselves. TVA requires on-site disposal of CCR material, when available, or off-site special waste disposal. All waste that may be generated would be managed in accordance with applicable federal, state, and local laws and regulations.

3.15.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed; therefore, no additional impacts associated with solid and hazardous waste generation are anticipated.

3.15.2.2 Alternative B – Enhanced In Situ Treatment

Under Alternative B, construction activities are expected to result in a minor increase in construction-related debris, including packaging waste and domestic garbage. As the construction period would be temporary, solid waste generation is anticipated to be less than or equal to 3 cubic yards, primarily resulting from material packaging. The increase in solid waste would be minor and not affect the capabilities or capacity of waste disposal services.

Solid wastes that would be generated from operation during EIST are expected to be minor and include paper and plastics from packaging of maintenance-related materials, personal protective equipment, oils and lubricants, spent resins, desiccants, batteries, domestic waste and non-hazardous soil cuttings. It is estimated that construction of this alternative would generate 3 cubic yards of solid waste from packaging and up to 1,500 cubic yards of soil cuttings (spoils) from the installation of the wells. This includes overburden and formation materials removed during borehole advancement. It is estimated that operation of this alternative would generate an additional 3 cubic yards of solid wastes biweekly (see **Table 2-1**). The increase in solid waste would be minor and not affect the capabilities or capacity of waste disposal services.

Overall impacts would be short-term, minor, adverse, direct and indirect for construction and operation.

3.15.2.3 Alternative C – Hydraulic Control and Groundwater Treatment

Under Alternative C, construction activities are expected to result in a temporary, minor increase in construction-related debris, including packaging waste and domestic garbage. As the construction period would be temporary, solid waste generation is anticipated to be less than or equal to 3 cubic yards, primarily resulting from material packaging. An additional 1,500 cubic yards of spoils would be generated from installation of the wells. If there is not already a water treatment facility at the site, one would need to be constructed which would generate larger volumes of construction waste.

Solid wastes that would be generated from operation of Alternative C are expected to be minor and include oils and lubricants, solids from the water treatment building, and filter press waste. It is estimated that operation of this alternative would generate approximately 3 cubic yards of solid wastes biweekly from the water treatment facility operation, which includes solid waste from the filter press. In addition, the sand filter material in the treatment tanks would need to be replaced approximately every 3 years. The exact quantity of waste would depend on the size of the treatment tank but is estimated at up to 10 cubic yards total over the 30-year treatment period.

Overall impacts would be similar to Alternative B for construction and operation.

3.15.2.4 Alternative D – Monitored Natural Attenuation

Under Alternative D, solid waste from construction activities is expected primarily from soil spoils from installation of monitoring wells and anticipated to be less than or equal to two 55-gallon drums of waste for both wells. Under the MNA alternative, no additional solid waste would be generated beyond that resulting from routine sampling and analysis of existing groundwater monitoring well. No hazardous waste would be generated specifically from the use of MNA. Overall impacts would be similar to Alternative B for construction and operation.

3.15.2.5 Alternative E – Combination of Corrective Actions

Using a combination of alternatives would likely result in an increase in hazardous and solid wastes generated during construction. Depending which technologies are selected, solid and hazardous waste totals can vary but are not expected to exceed the combined amounts estimated for each alternative combination. It is estimated that operation of this alternative would generate 3 cubic yards of solid wastes biweekly and 1,500 cubic yards of spoils from well installation, plus 10 cubic yards from sand filter replacement every 3 years during operations. Overall impacts would be similar to other action alternatives for construction and operation, short-term, minor, adverse, direct and indirect.

3.16 Public Health and Safety

3.16.1 Affected Environment

The implementation of proper engineering and equipment design, administrative controls such as employee training and compliance with regulatory requirements related to health and safety, would help ensure that the risks associated with Proposed Actions would be minimal. Health risks are also associated with emissions and discharges from the facilities as well as accidental spills/releases and there are comprehensive environmental regulatory programs in place to manage and reduce such risks to acceptable levels.

TVA has a robust, safety-conscious culture that focuses on awareness and understanding of workplace hazards, prevention, intervention, and integration of BMPs to avoid or minimize hazards. Health hazards are associated with the routine operations and maintenance activities at the existing TVA properties. To minimize hazards and ensure workplace safety, activities are performed consistently with OSHA and state standards and requirements and specific TVA guidance. Additionally, TVA has a safety program in place to prevent worker injuries and accidents (TVA 2024a). Personnel at TVA facilities, including TVA authorized contractors, are conscientious about health and safety, having addressed and managed maintenance and operations activities to reduce or eliminate occupational hazards through implementation of safety practices, training and control measures.

Mitigative measures are used to ensure protection of human health which includes the workplace, public and the environment. Applicable regulations and attending administrative codes that prescribe monitoring requirements may include those associated with emergency management, environmental health, drinking water, water and sewage, pollution discharge, air pollution, hazardous waste management and remedial action.

Although wastes generated by operation of active TVA fossil plants pose a health hazard; hazardous waste would not be generated by Proposed Actions. Wastes streams for construction and operation are discussed in Section 2.5. TVA is committed to complying with all applicable regulations, permitting, and monitoring requirements.

There is access to emergency room services, including hospitals, urgent care, law enforcement, and fire protection services near each Site. The maximum distance to medical services from the 12 TVA properties identified to potentially implement Proposed Actions is approximately 12.6 miles. The maximum distance to law enforcement and fire protection services is approximately 12.8 miles and 7.0 miles respectively.

3.16.2 Environmental Consequences

The potential effects on public health and safety from a given action are assessed by evaluating the potential for construction or operations to be accessible to the general public, and the extent to which site employees would be trained and operate in accordance with regulations and industry standards. Although the extent of these impacts would vary from site to site, general effects from the alternatives within the TVA PSA are discussed below.

3.16.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed. If ground water quality is further diminished under this alternative, there may be negative health and safety effects as a consequence of no groundwater corrective action. As such, groundwater could continue to pose a risk to public health and safety through exposure. However, if there are no water wells in the immediate area of an observed exceedance, then there would be little chance of direct exposure and/or ingestion and impacts to public health and safety would be considered minor. Therefore, overall public health or safety impacts from actions under the No Action Alternative are expected to be minor.

3.16.2.2 Analysis of Alternatives B, C, and E

Although construction work has known hazards, it is TVA's policy that contractors establish and maintain site-specific health and safety plans in compliance with OSHA regulations. The site-specific health and safety plans emphasize BMPs to minimize potential risks to workers. Examples of BMPs include employee safety orientations; establishment of work procedures and programs for site activities; use of equipment guards, emergency shutdown procedures, lockout procedures, site housekeeping, and personal protective equipment; regular safety inspections; and plans and procedures to identify and resolve hazards.

Potential public health and safety hazards could result from increased traffic on roadways due to construction or installation of treatment technology. Residential and other human use areas along roadways used by construction traffic to access the TVA properties may experience delays due to increased traffic. Awareness of these residences and establishment of traffic procedures to minimize potential safety concerns would be addressed in the health and safety plans followed by construction contractors.

Chemicals used in injection systems or treatment processes would be nonhazardous or present in low concentrations, and above-ground tanks would include secondary containment and access restrictions to prevent public exposure. Debris and wastes streams associated with construction or installation activities would be managed in accordance with federal, state, and local laws and regulations. An emergency response plan would be developed to address potential accidental spills on site and discussed with local emergency management agencies. Emergency response for each Site would be provided by the local, regional, and state law enforcement, fire, and emergency responders, as described above.

As identified in **Table 2-1**, the corrective action treatment technologies would be located on existing TVA properties, with limited public access. Therefore, the potential for public safety concerns is reduced due to the industrial setting and lack of public access.

Through TVA guidance and regulations, operations of the corrective action treatment technology would adhere to established OSHA and applicable state health and safety requirements. TVA's Safety Standard Programs and Processes would be strictly adhered to as these practices would address and provide management procedures for the reduction or elimination of occupational and public health hazards. It is TVA policy that all contractors have in place a site-specific health and safety plan prior to operation on TVA properties. Increased truck traffic could lead to a slightly higher risk of accidents in the vicinity of the 12 proposed Sites due to the increase in the number of vehicle miles traveled on those roadways. The implementation of Alternative B, C or E as Proposed Actions would be expected to improve local groundwater conditions to GWPS, thereby mitigating the potential for contaminated groundwater reaching water supply wells or surface waters. Likewise, any potential limited exposure of the public to site-specific COIs would also be mitigated with the eventual attainment of GWPS.

The establishment of appropriate BMPs and job site safety plans would address transportation in describing how job safety would be maintained during the project. With the preparation and execution of safety plans and training, overall impacts of construction of Proposed Actions to workers and public safety would be short-term, minor, adverse, direct and indirect. Impacts from operation of Proposed Actions would be long-term, minor, beneficial, and indirect, due to improved groundwater quality.

3.16.2.3 Alternative D – Monitored Natural Attenuation

Implementation of Alternative D would create similar but lesser impacts to those of Alternative B and C, given that construction would be limited to the installation of two wells. Alternative D does not require the use of chemical infrastructure and presents minimal safety concerns. Therefore, the risk of adverse impacts to workers from construction and operation would be minor, and there would be minor but beneficial impacts to public health for operation, similar to Alternative B, C and E.

3.17 Socioeconomics

3.17.1 Affected Environment

This section describes the social and economic conditions in the counties in which the TVA properties considered in this PEA are located. It presents and compares qualitative and quantitative data that characterize the regional human population and associated demographics and economics within the Study Area. The TVA properties are located in 13 counties across three states (Alabama, Kentucky, and Tennessee). **Table 1-1** shows the county and state in which each TVA property is located. These counties comprise the Study Area for socioeconomic effects.

Depending on availability and comparability, Census data has been derived from the U.S. Census Bureau (USCB) 2010 decennial census, the 2020 decennial census, and the most current population estimates from the 2023 American Community Survey (2019-2023 5-Year estimates).

Information on the TVA PSA is also provided as a baseline for comparison to smaller parts of the PSA. The TVA PSA consists of 181 counties and two independent cities across the states of Tennessee, Alabama, Georgia, Kentucky, Mississippi, North Carolina, and Virginia. The most recent socioeconomic data available for the TVA PSA is from the 2022 American Community Survey (2018-2022 5 Year estimates); thus, although these data are not directly comparable given their older vintage, they still provide insight into existing conditions throughout the TVA PSA, and how those conditions may vary across the Study Area in this PEA. Additionally, given the programmatic nature of this PEA, only high-level analysis and comparisons are warranted.

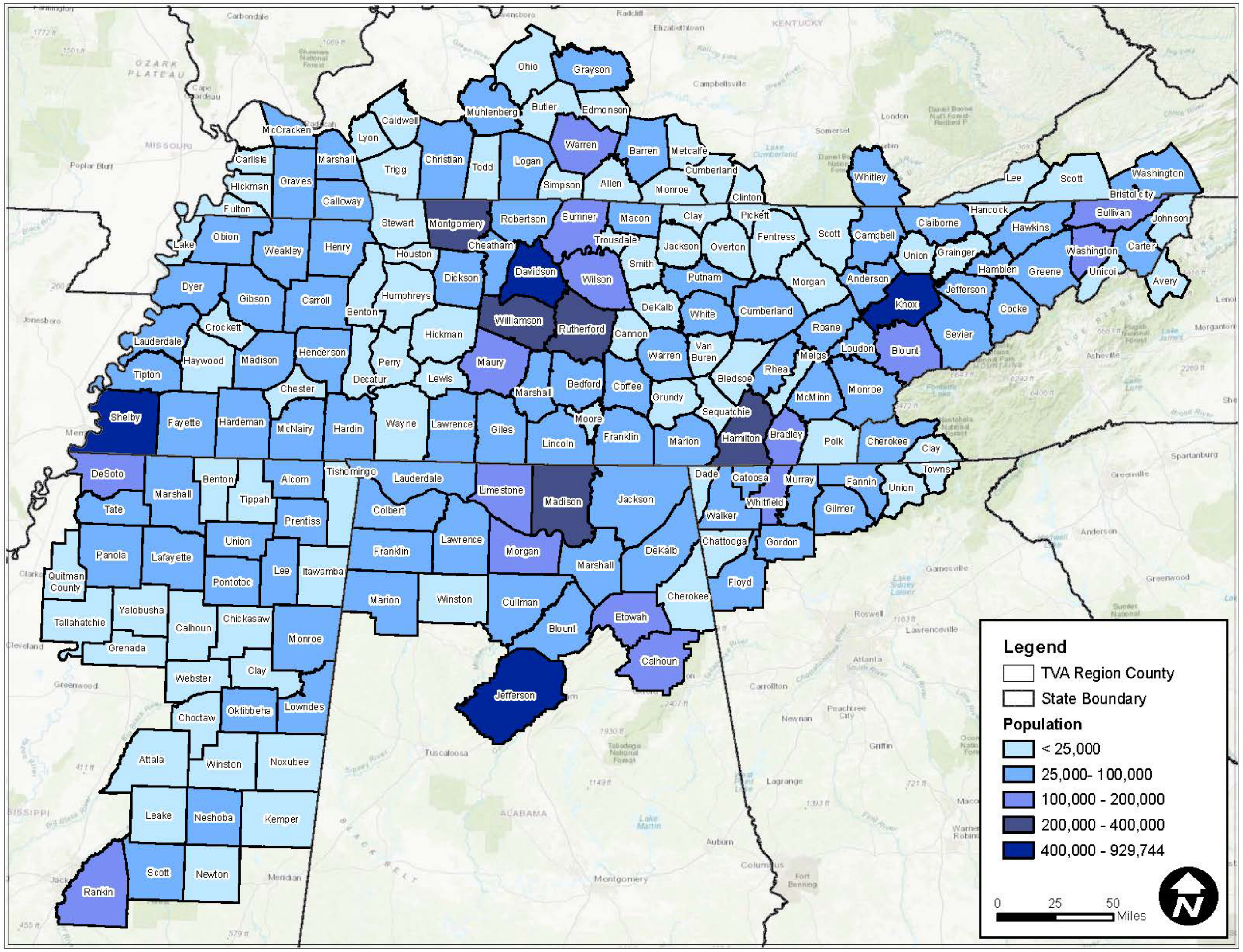
3.17.1.1 Demographic and Economic Characteristics

Various demographic data are presented below for the Study Area in **Figure 3-5** and **Tables 3-14 and 3-15** below. The estimated population of the TVA PSA was 10.5 million in 2020, representing an estimated 7.4 percent increase over the 2010 population (TVA 2024a). The population increase for the TVA PSA occurred at a higher rate than any individual county in the Study Area, except for Sumner County, Tennessee, where the population increased at a rate of 22.2 percent during the same period (USCB 2024a). A total of five counties within the Study Area experienced population declines (Hawkins, Houston, and Roane Counties, Tennessee; Jackson County, Alabama; and Muhlenberg County, Kentucky) (USCB 2024a, USCB 2024b, USCB 2024c).

Population varies greatly among the counties in the PSA, with the larger populations generally concentrated along major river corridors: the Tennessee River from the northeast portion of the state through Knoxville and Chattanooga into north Alabama; the Nashville area around the Cumberland River; and the Memphis area on the Mississippi River (TVA 2024a). Variations in population size throughout the TVA PSA are also reflected in the Study Area, with population sizes in the counties ranging from a maximum of 929,744 people in Shelby County, Tennessee, to 8,283 people in Houston County, Tennessee (USCB 2024a).

Socioeconomic characteristics of the 13 counties within the Study Area are also summarized in **Table 3-14** and **Table 3-15**. Although most of the TVA PSA's total population lives in metropolitan areas (68.2 percent in 2022) (TVA 2024a), only four of the 12 TVA properties considered in this PEA are located in designated metropolitan areas. Although these plants are included within the designated boundaries of the metropolitan areas, they are generally located in the more remote, less populated regions of those areas.

- Colbert Fossil Plant, in the Florence-Muscle Shoals, Alabama metropolitan area.
- John Sevier Fossil Plant, in the Kingsport-Bristol-Bristol, Tennessee-Virginia metropolitan area.
- Kingston Fossil Plant, in the Knoxville, Tennessee metropolitan area.
- Gallatin Fossil Plant, in the Nashville-Davidson-Murfreesboro-Franklin, Tennessee metropolitan area.



Source: USCB 2024a, USCB 2024b, USCB 2024c

Figure 3-5. 2023 Population of Counties in the TVA PSA

Table 3-13. Summary of Demographic Data for Counties in Tennessee with TVA Properties

Demographic Characteristics	State of Tennessee[1]	Anderson County	Hawkins County	Houston County	Humphreys County	Rhea County	Roane County	Shelby County	Stewart County	Sumner County
Population										
Population, 2020	6,910,840	77,123	56,721	8,283	18,990	32,870	53,404	929,744	13,657	196,281
Population, 2010	6,346,105	75,129	56,833	8,426	18,538	31,809	54,181	927,644	13,324	160,645
Percent Change, 2010-2020	8.9%	2.7%	-0.2%	-1.7%	2.4%	3.3%	-1.4%	0.2%	2.5%	22.2%
Persons Under 18 Years	22.0%	21.0%	19.0%	20.9%	20.6%	21.6%	18.8%	25.4%	20.6%	22.8%
Persons 65 Years and Over	17.4%	20.1%	22.1%	20.5%	20.4%	19.8%	23.8%	15.3%	21.1%	17.1%
Racial Characteristics										
White Alone	78.4%	91.0%	95.9%	92.9%	93.4%	94.0%	93.8%	40.6%	93.5%	86.5%
Black or African American	16.5%	4.2%	1.5%	3.4%	3.0%	2.4%	2.9%	54.1%	2.1%	8.8%
American Indian and Alaska Native	0.6%	0.5%	0.4%	0.6%	0.8%	0.7%	0.5%	0.4%	0.8%	0.5%
Asian	2.1%	1.6%	0.6%	0.7%	0.8%	0.7%	0.7%	3.0%	1.0%	1.8%
Native Hawaiian and Other Pacific Islander	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Two or More Races	2.3%	2.6%	1.4%	2.4%	1.9%	2.2%	2.0%	1.8%	2.4%	2.4%
Hispanic or Latino[2]	7.5%	4.3%	2.2%	3.5%	3.1%	6.5%	2.7%	8.9%	3.1%	7.5%
Economic and Employment Characteristics										
Per Capita Income in Past 12 Months	$37,866	$35,460	$29,206	$30,169	$30,868	$28,160	$36,357	$37,666	$29,881	$42,482
Persons Below Poverty Level	14.0%	14.4%	17.2%	17.0%	14.7%	16.0%	13.4%	18.2%	12.9%	8.9%
Civilian Labor Force[3]	3,485,466	35,955	24,175	3,579	8,627	14,519	24,382	463,382	5,872	106,775
Percent Unemployed	4.7%	5.0%	8.4%	6.7%	9.8%	6.3%	4.8%	7.2%	3.0%	3.2%

1. The state of Tennessee is also provided in this table as a reference geography, for comparative purposes with the counties within the state.
2. People with Hispanic or Latino ethnicity may be of any race; therefore, they are also included in the applicable race categories.
3. The civilian labor force measures the labor force participation rate (percent) of the population aged 16 years and over.
Sources: USCB 2024a, USCB 2023

Table 3-14. Summary of Demographic Data for Counties in Alabama and Kentucky with TVA Properties

Demographic Characteristics	State of Alabama[1]	Colbert County	Jackson County	State of Kentucky[1]	McCracken County	Muhlenberg County
Population						
Population, 2020	5,024,279	57,227	52,579	4,505,836	67,875	30,928
Population, 2010	4,779,736	54,428	53,227	4,339,367	65,565	31,499
Percent Change, 2010-2020	5.1%	5.1%	-1.2%	3.8%	3.5%	-1.8%
Persons Under 18 Years	22.1%	21.4%	20.8%	22.5%	21.6%	21.1%
Persons 65 Years and Over	18.3%	21.0%	21.3%	17.8%	20.9%	20.8%
Racial Characteristics						
White	68.9%	80.3%	91.1%	86.7%	84.6%	94.1%
Black or African American	26.6%	15.7%	3.5%	8.8%	11.3%	3.8%
American Indian and Alaska Native	0.7%	0.7%	1.6%	0.3%	0.4%	0.3%
Asian	1.6%	0.8%	0.6%	1.8%	1.0%	0.3%
Native Hawaiian and Other Pacific Islander	0.1%	0.1%	0.1%	0.1%	0.1%	N/A
Two or More Races	2.0%	2.4%	3.1%	2.3%	2.7%	1.5%
Hispanic or Latino[2]	5.7%	3.7%	3.7%	5.0%	3.5%	2.1%
Economic and Employment Characteristics						
Per Capita Income in Past 12 Months	$34,835	$32,685	$28,452	$34,960	$38,598	$31,065
Persons Below Poverty Level	15.6%	15.4%	16.0%	16.4%	15.7%	20.2%
Civilian Labor Force[3]	2,356,889	26,951	22,253	2,148,833	31,362	12,885
Percent Unemployed	4.8%	3.3%	5.4%	4.8%	3.1%	4.1%

1. The states of Alabama and Kentucky are also provided in this table as reference geographies, for comparative purposes with the counties within the state. Colbert County and Jackson County are located in Alabama, and McCracken County and Muhlenberg County are located in Kentucky.
2. People with Hispanic or Latino ethnicity may be of any race; therefore, they are also included in the applicable race categories.
3. The civilian labor force measures the labor force participation rate (percent) of the population aged 16 years and over.
Sources: USCB 2024a, USCB 2024c, USCB 2023

The minority population (i.e., all non-white racial groups combined, and those with Hispanic or Latino ethnicity) of the TVA PSA as of 2022, was approximately 26.7 percent of the region's total population. Within the PSA, the Black or African American population comprised the largest single minority or ethnic group, with 15.7 percent of the total population (TVA 2024a). **Figure 3-6** depicts the overall minority population of each county within the TVA PSA for reference.

Racial characteristics in the Study Area are predominantly white, ranging from 80.3 percent (Colbert County, Alabama) to 95.9 percent (Hawkins County, Tennessee), with the exception of Shelby County, Tennessee, which is the only county in the Study Area that does not contain a majority white population (40.6 percent). In Shelby County, the population is predominantly Black or African American, with this racial group comprising 54.1 percent of the population (USCB 2024a). This group is also the largest minority group across the remainder of the Study Area (USCB 2024b, USCB 2024c).

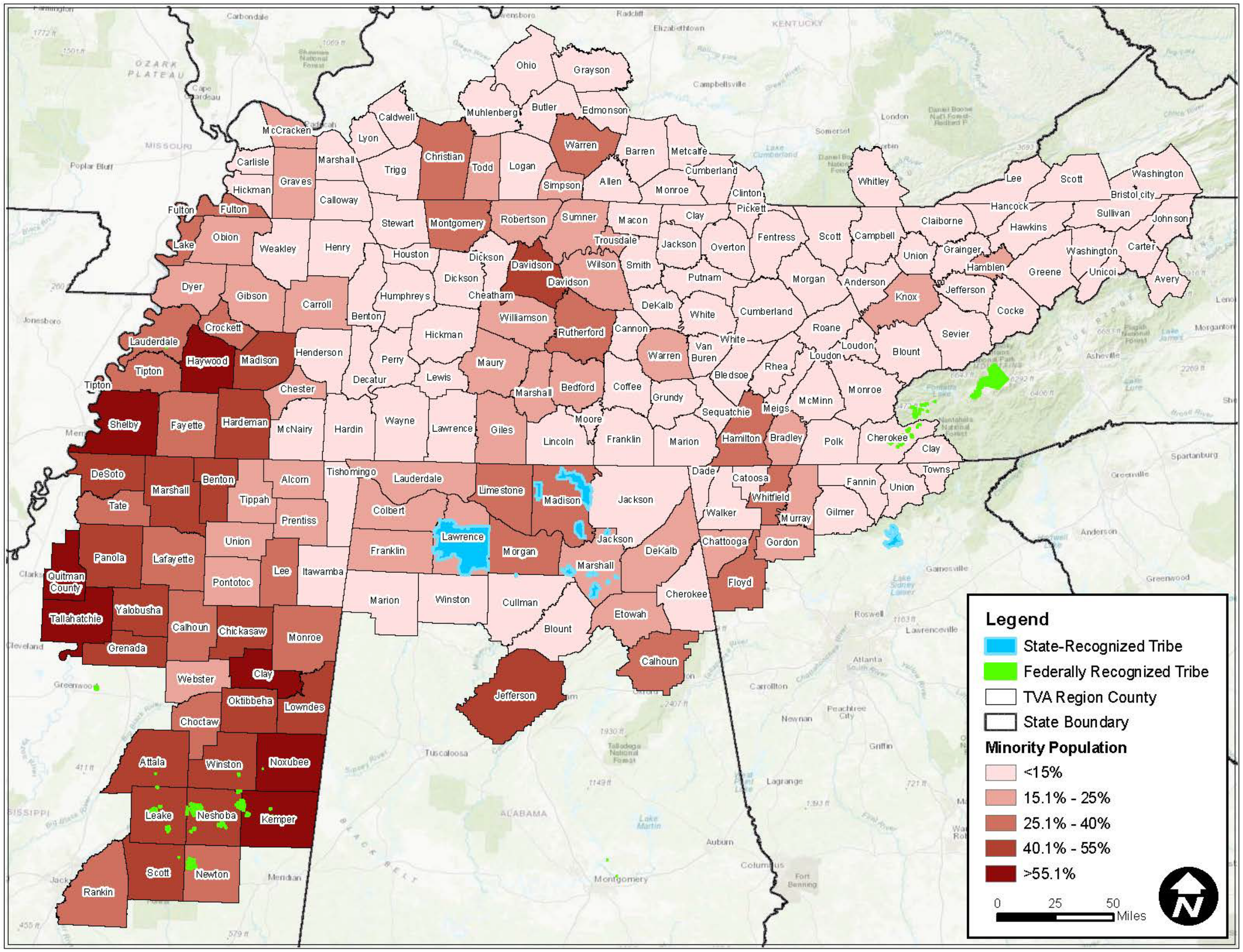
Per capita income in the TVA PSA ranged from $19,695 to $61,451 in 2022 (TVA 2024a). Per capita income in the Study Area ranged from a low of $28,160 in Rhea County, Tennessee, to $42,482 in Sumner County, Tennessee (USCB 2024a), falling in the middle range of the overall TVA PSA. The percentage of the population within the TVA PSA living below the poverty level was 14.8 percent in 2022 (TVA 2024a). In contrast, most of the counties within the Study Area exceeded that percentage; only five counties, all in Tennessee, had poverty levels lower than that of the PSA: Anderson, Humphreys, Roane, Stewart, and Sumner Counties (USCB 2024a). **Figure 3-7** depicts the overall low-income population of each county within the TVA PSA for reference.

The average unemployment rate throughout the TVA PSA was measured at 5.0 percent in 2022 (TVA 2024a). Unemployment rates within approximately half of the Study Area match or are below the unemployment rate in the overall PSA, although six counties have higher unemployment rates: Jackson County, Alabama; and Hawkins, Houston, Humphreys, Rhea, and Shelby Counties, Tennessee (USCB 2024a, USCB 2024b).

3.17.2 Environmental Consequences

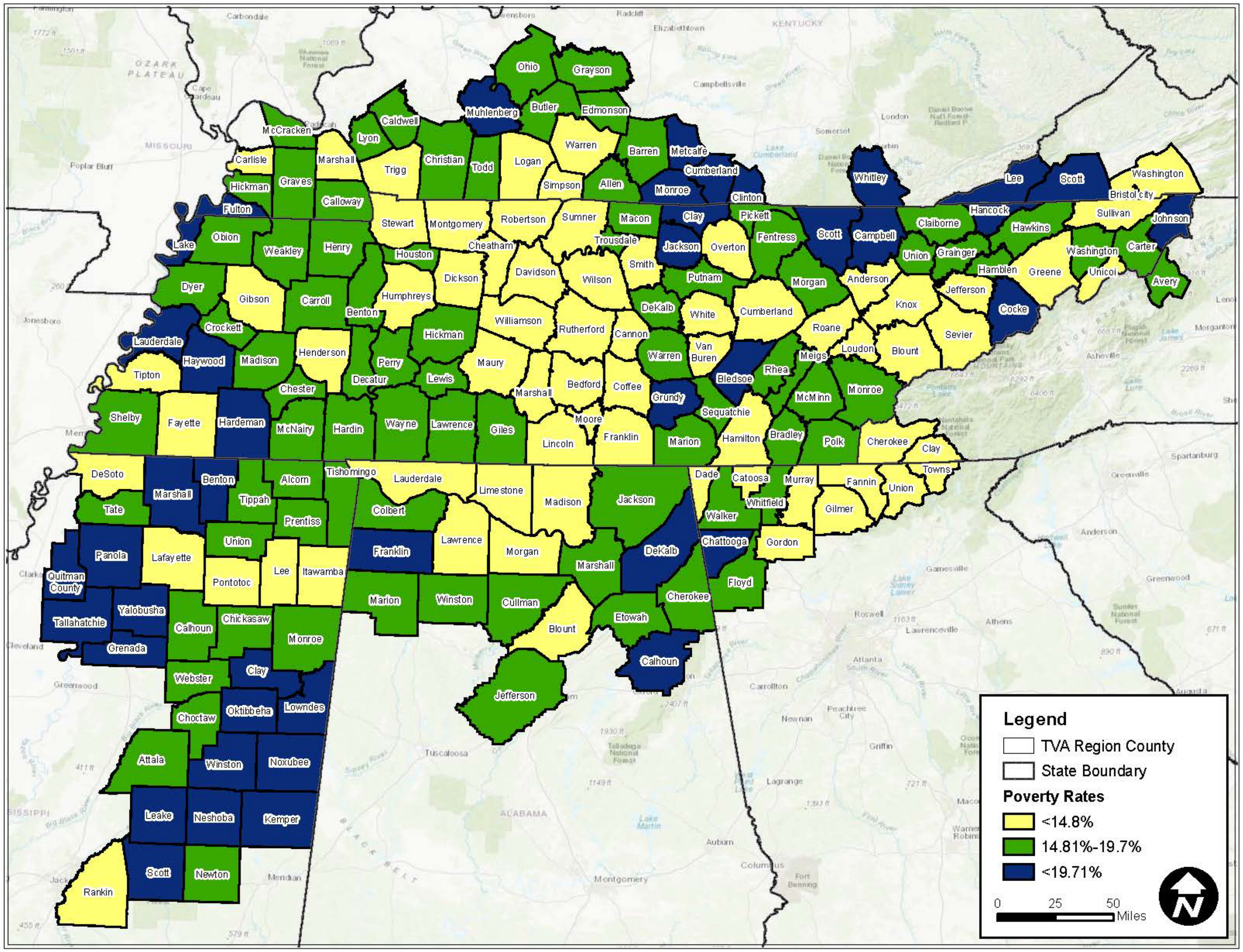
The potential effects associated with socioeconomics from a given action are assessed by evaluating the potential for an action to change existing demographic or economic characteristics of an area or introduce burdens onto specific sectors of the population (such as members of a minority group or those living in poverty) that are not broadly experienced. Although the extent of socioeconomic impacts may vary from site to site, depending on the surrounding conditions, general effects from the alternatives within the TVA PSA are discussed below.

Overall, given the impacts of each resources area, the socioeconomic impacts of construction would be short-term, minor, adverse and beneficial (temporary job creation), and direct and indirect. For operation, overall impacts would be long-term, minor, beneficial and indirect, due to ground water beneficial impacts.



Source: TVA 2024a

Figure 3-6. 2023 Minority Populations of Counties in the TVA PSA



Source: TVA 2024a

Figure 3-7. 2023 Low-Income Populations of Counties in the TVA PSA

3.17.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional corrective actions would be performed. However, there may be diminished groundwater quality, potentially resulting in minor impacts in the form of negative health effects and additional burdens on minority and low-income populations within the Study Area.

3.17.2.2 Alternative B – Enhanced In Situ Treatment

Under Alternative B, Proposed Actions would require a workforce of up to 14 personnel per TVA property over the construction period, which would be expected to last for approximately 1 year. These workers would include drillers, engineers, health and safety officers, truck drivers, and operators, who would be drawn from both local and non-local labor forces depending on the available skill sets of workers near the Sites. Following the construction period, each TVA property would require the long-term employment of two workers to conduct monthly and quarterly sampling to evaluate water quality and residual contamination.

Those workers who would be hired from outside the local region would be expected to relocate to the area near the TVA property, either temporarily to support construction, or long-term to support operational activities. Given the small number of workers needed to support the Proposed Actions and assuming that some proportion of workers would already be living locally, there would be no impact to the overall demographic characteristics of the region near each TVA property.

The construction and installation of EIST would entail a temporary increase in employment and associated construction payrolls, the purchases of materials and supplies, and procurement of additional services. Minor beneficial economic impacts would result from capital costs associated with the purchase of treatment technologies, their installation, expenditure of wages earned by the workforce, and sales tax revenue from workforce purchases. Following construction, the long-term employment of operational personnel would also create some minor beneficial economic impacts. Although increased employment during construction and operation would generate economic benefits, these benefits would be expected to be minimal in comparison to the overall economic conditions present near the TVA properties, given the small number of personnel who would be employed. Overall, there would be minor beneficial economic impacts under Alternative B.

The EIST would be constructed within the boundaries of the existing TVA properties, which are industrial in nature and generally removed from urban and residential areas. Thus, the construction and operation would not have any direct impacts on residential communities. Communities, including minority and low-income communities, near the Sites could experience transportation-related effects, from daily material deliveries and waste disposal; however, only eight truck trips per day and 20 work vehicle trips are anticipated during the construction phase and would not be expected to change traffic patterns or increase congestion on surrounding roadways (see Section 3.14). Additionally, small quantities of solid and hazardous waste may be generated during construction that could be transported through local communities. No waste would be stored onsite and would be managed in accordance with all applicable regulations. No hazardous waste would be generated during operation of the groundwater corrective measures, although small quantities of solid waste would be generated (see Section 3.15). Therefore, with proper treatment and disposal of waste during construction and no hazardous waste generation during operation, nearby communities, including minority and low-income communities, would not be expected to be exposed to hazardous materials. Impacts to communities associated with project-related traffic and solid and hazardous waste are expected to be minor.

3.17.2.3 Alternative C –Hydraulic Control and Groundwater Treatment

Implementation of Alternative C would create similar impacts to those of Alternative B, although activities associated with hydraulic control are generally more complex than those of EIST. Construction would require a temporary workforce of up to seven personnel. Operation would require the long-term employment of four operators (two per shift) for the water treatment facility, and two personnel to conduct monthly and quarterly sampling. As a result, Alternative C would result in a higher amount of long-term employment than Alternative B, and additional economic benefits. Although Alternative C would be expected to generate additional jobs and economic benefits than Alternative B, these beneficial impacts would still be expected to be minor, given the small number of personnel who would be employed in comparison to the overall population surrounding each TVA property. Similar to Alternative B, there would be no impact to the overall demographic characteristics of the region near each TVA property.

Hydraulic control and groundwater treatment technologies would also be contained within the TVA properties and would not have direct impacts on any residential communities. Fewer overall truck trips would be required under Alternative C than Alternative B during the construction phase, so no changes in traffic patterns or congestion would be anticipated in nearby communities. Solid and hazardous wastes would be handled in the same manner as under Alternative B. Impacts to communities, including minority and low-income communities, associated with project-related traffic and solid and hazardous waste are expected to be minor.

3.17.2.4 Alternative D – Monitored Natural Attenuation

Implementation of Alternative D would create similar impacts to those of Alternative B and C. Construction would require a temporary workforce of up to seven personnel. Since MNA is a passive remediation approach that would be operational for approximately 30 years, each TVA property would require the long-term employment of two workers to conduct monthly and quarterly sampling during this time period. Similar to Alternatives B and C, there would be no impact to the overall demographic characteristics near each TVA property, and there would be minor beneficial economic impacts from long-term employment and subsequent expenditures and revenue.

The least amount of construction would be required under Alternative D, in comparison to Alternatives B and C. Only four truck trips and 10 work vehicle trips per day would be expected to occur during construction, and minimal trips would be required during operation given the passive nature of this remediation approach. Moreover, while some solid waste would be generated under Alternatives B and C, no solid waste would be generated under Alternative D. There would be minor impacts to communities, including minority and low-income communities, from traffic, and no impacts from solid and hazardous waste exposure.

3.17.2.5 Alternative E – Combination of Corrective Actions

Use of a hybrid approach of alternatives under Alternative E would create similar impacts to those of Alternatives B, C, and D, since it would leverage a combination of those remedial actions. The number of workers would vary depending on the specific actions implemented, but would range between seven and 14 construction workers, and two to four operational workers. Although Alternative E would not necessarily result in additive effects, bounding values in **Table 2-1** provide maximum values based on the combination of alternatives. As Alternatives B, C, and D have been stated to have similar impacts on socioeconomic conditions and communities, including minority and low-income communities, implementation of Alternative E would likely also result in beneficial, minor impacts.

3.18 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 reduce a potential impact to a level that would be below the threshold of significance as defined by the courts. Impacts associated with the proposed activities have the potential to cause unavoidable adverse effects on natural and human environmental resources.

Impacts associated with Proposed Actions have the potential to cause unavoidable adverse effects on several environmental resources. However, the purpose of the Proposed Actions is to improve groundwater conditions; therefore, impacts would be primarily environmentally beneficial. The magnitude of adverse impacts and the degree to which they can be avoided, minimized, or mitigated would vary by site. Most impacts from Alternatives B, C, D, and E would primarily be construction related.

Activities associated with the use of construction equipment may result in varying amounts of dust, air emissions, and noise that may potentially impact both onsite workers and nearby offsite residences and parks. Emissions from onsite construction activities and equipment would be minimized through implementation of BMPs including proper maintenance of construction equipment and vehicles. During construction, BMPs to minimize runoff would be implemented but there could still be some uncontrolled runoff that could affect nearby outfalls and water bodies.

During construction, there would be an increase in traffic on public roads due to use by the construction workforce and construction-related equipment and materials being transported to the proposed site. Additionally, there would be an increase in traffic on public roadways during operations due to waste materials being transported off site. This additional construction-related traffic would also increase noise and fugitive dust in areas proximate to these roads. Emissions from construction equipment are minimized through implementation of BMPs including proper maintenance of construction equipment and vehicles.

3.19 Relationship of Short-Term Uses and 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. This PEA focuses on the analyses of environmental impacts associated with Proposed Actions. For the purposes of this section, activities associated with installation are considered short-term uses of the environment and the long-term impacts to site productivity are those from operation and activities beyond the life of the project.

Proposed Actions would have a negative effect on all environmental resources based on short-term use as described above. Most of these impacts would be minor; however, moderate impacts are expected to groundwater, wetlands, protected species, and cultural resources. Ground disturbance could alter groundwater conditions, soils, and remove habitat. Access to the Sites would be restricted during construction activities, affecting recreational users such as bank fishermen or birders. Noise from construction may displace some wildlife during the construction period. Cultural resources would be affected primarily from alterations of the viewshed. Most environmental impacts during construction activities would be relatively short-term and would be addressed by programmatic BMPs and mitigation measures. Proposed Actions would have a beneficial short-term impact to the local economies near Sites through the creation of construction, support jobs, and revenue.

There would be no long-term effects to air quality, recreational areas, or from noise. There would be a moderate long-term beneficial impact associated with improved groundwater quality conditions that would allow enhanced long-term productivity for the environment it supports. The cultural resource viewshed would continue to be moderately impacted if proposed water treatment facilities become permanent. Long-term impacts to other resources are minor, and beneficial for public health and socioeconomics from indirect effects of groundwater quality improvement.

3.20 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 timespans, 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 other natural resources and are not necessarily irreversible.

Resources required for the construction of the Proposed Actions, including labor, fill, materials, and fossil fuels would be irretrievably lost. Nonrenewable fossil fuels would be irretrievably lost by gasoline and diesel-powered equipment during construction. Additionally, the materials used for the construction of the water treatment facility would be committed for the life of the facility. While some of these building materials may be irreversibly committed, some metal components and structures could be recycled.

During operation of the Proposed Actions, nonrenewable fossil fuels would be irretrievably lost through the use of gasoline and diesel-powered equipment during the operation of the Proposed Actions and transport of materials offsite. Labor utilized during these operations would also be irretrievably lost. Although Proposed Actions would require irretrievable use of some resources, it is unlikely that their limited use would adversely affect the overall future availability of these resources.

Appendix A – Aerial Figures for 12 TVA Properties

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Allen Fossil Plant

Source: World Imagery and World Transportation, ESRI

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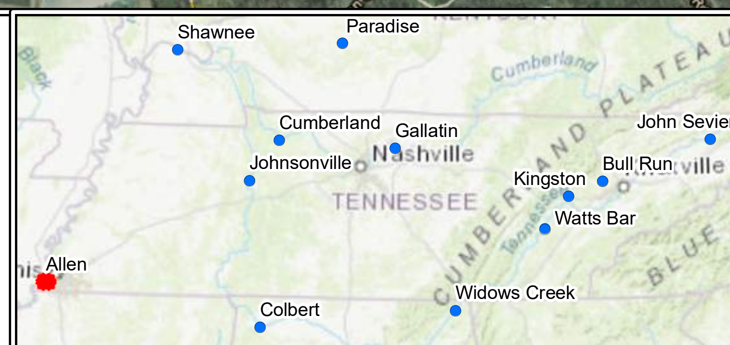

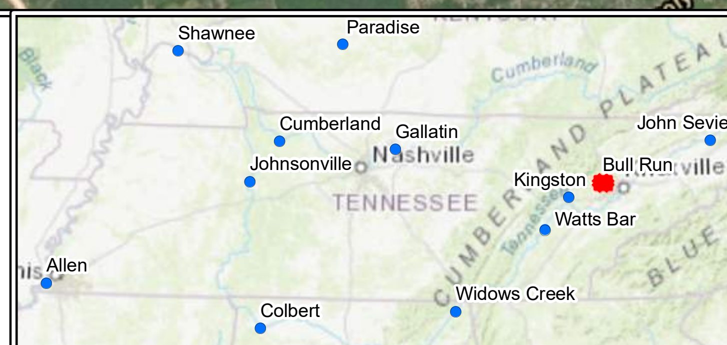

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Bull Run Fossil Plant

Source: World Imagery and World Transportation, ESRI

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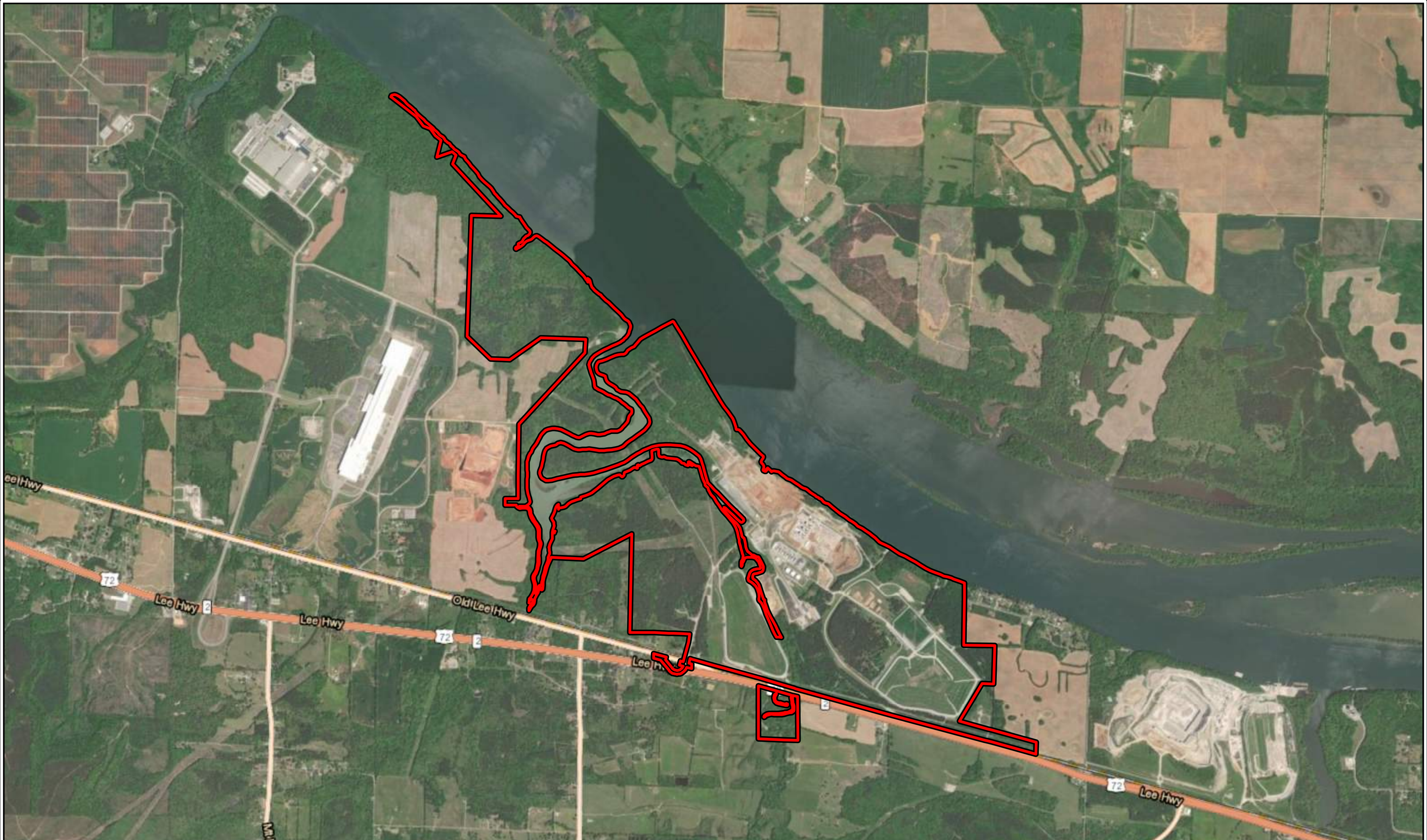

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Colbert Fossil Plant

Source: World Imagery and World Transportation, ESRI

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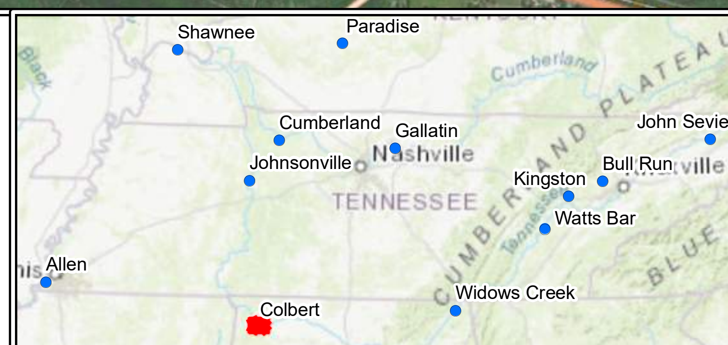

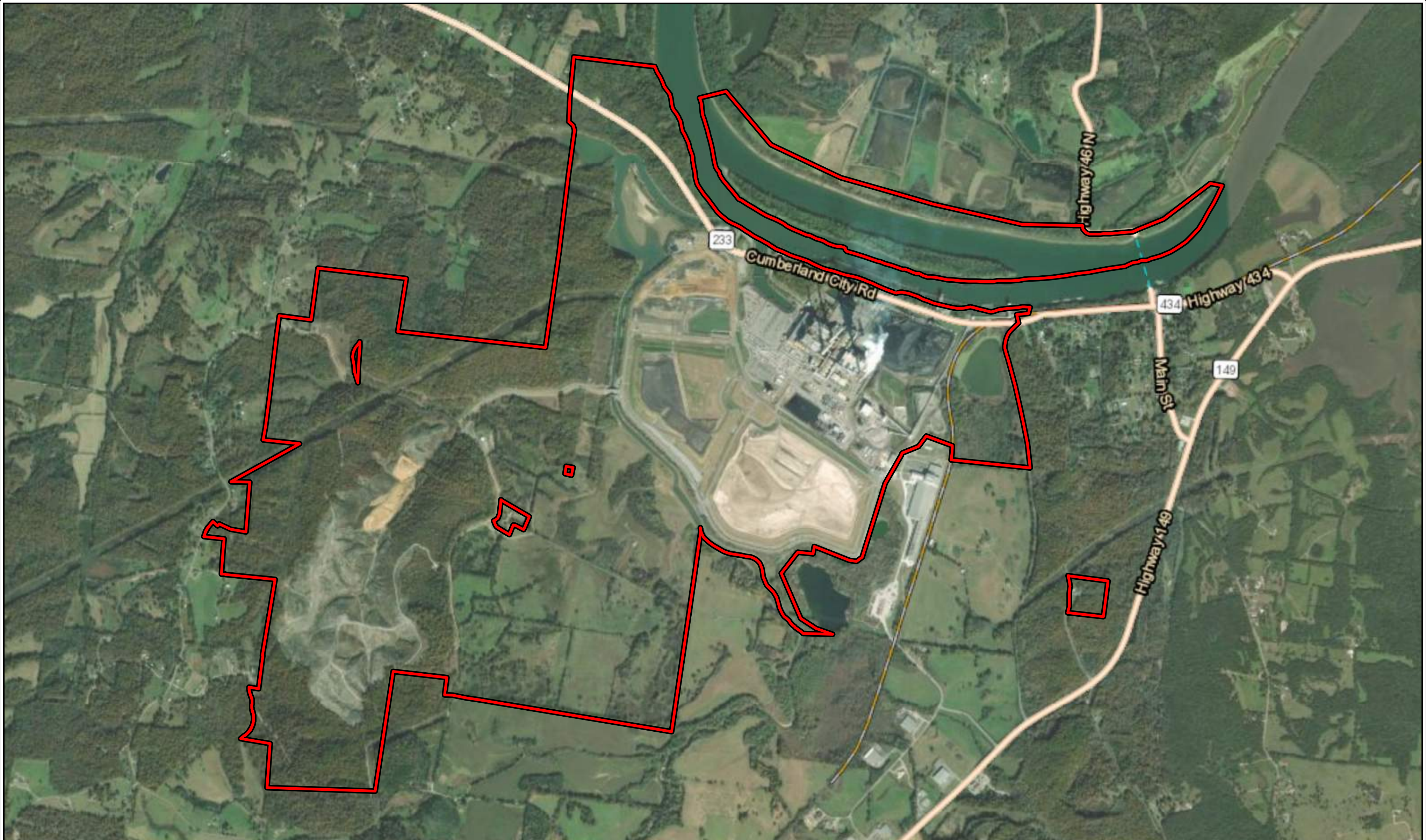

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Cumberland Fossil Plant

Source: World Imagery and World Transportation, ESRI

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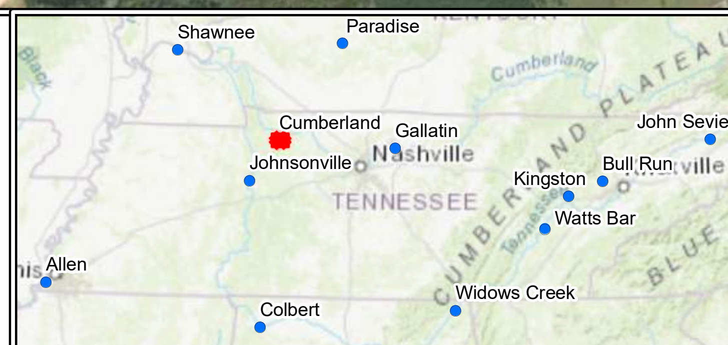

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Gallatin Fossil Plant

Source: World Imagery and World Transportation, ESRI

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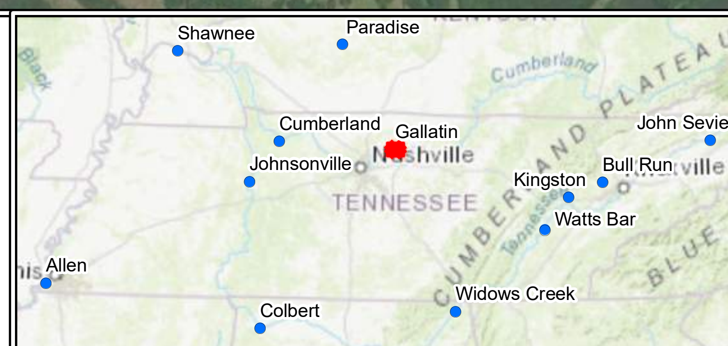

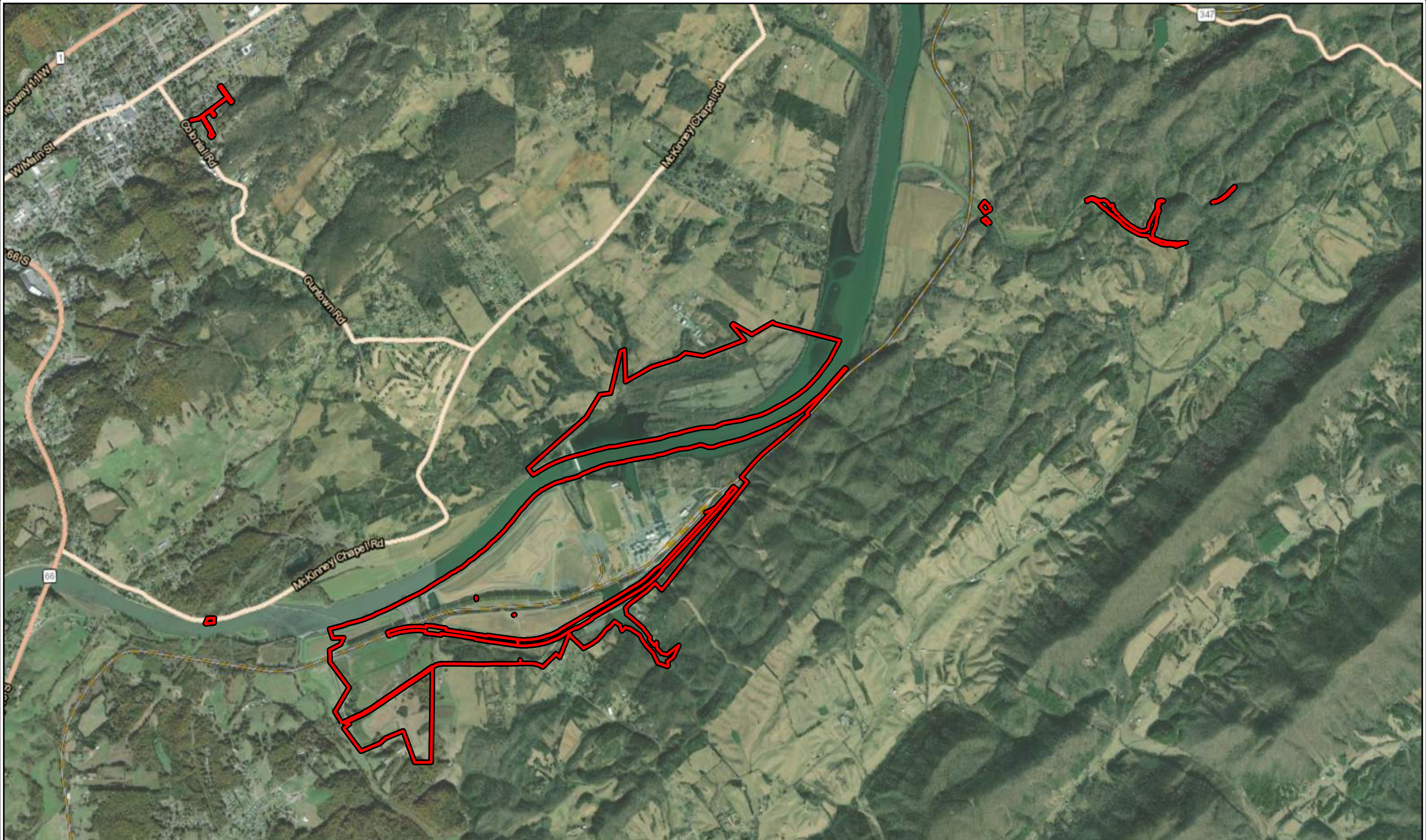

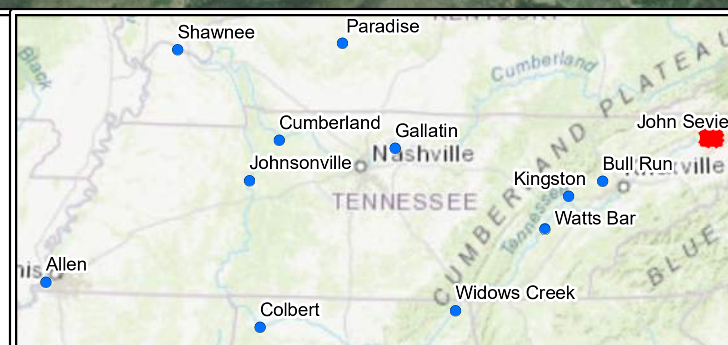

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John Sevier Fossil Plant

Source: World Imagery and World Transportation, ESRI

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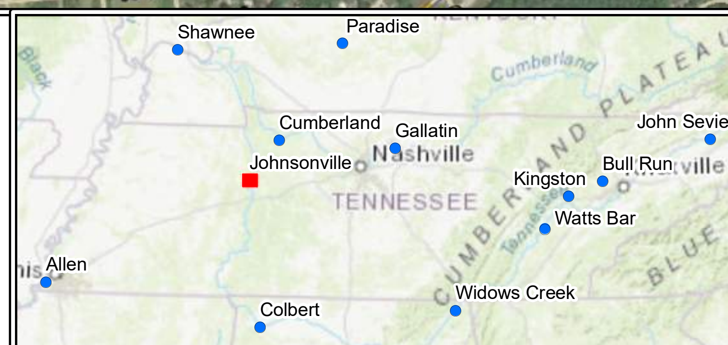
Johnsonville Fossil Plant

Source: World Imagery and World Transportation, ESRI

0 750 1,500 Feet



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Kingston Fossil Plant

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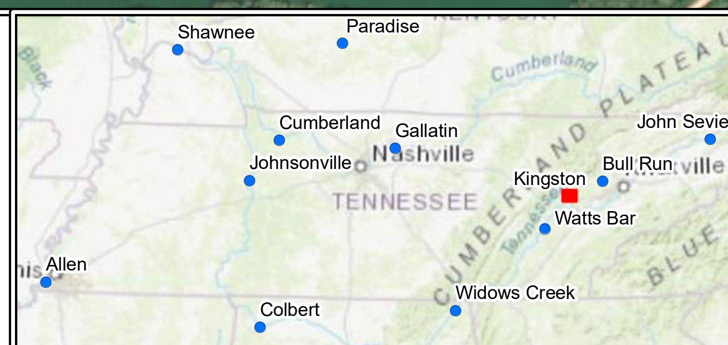

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Paradise Fossil Plant

Source: World Imagery and World Transportation, ESRI

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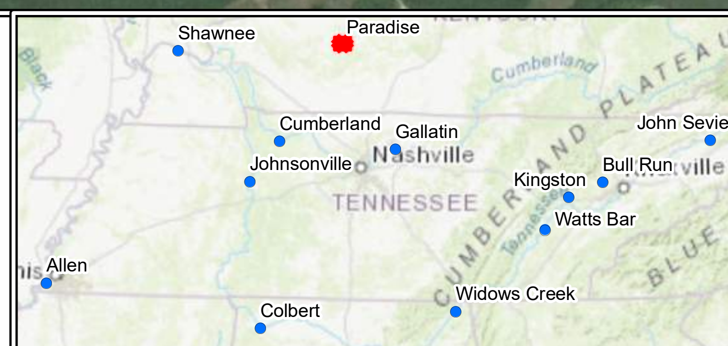

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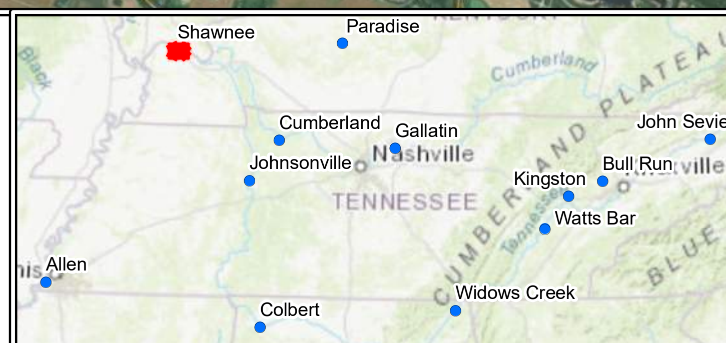
Shawnee Fossil Plant



Source: World Imagery and World Transportation, ESRI

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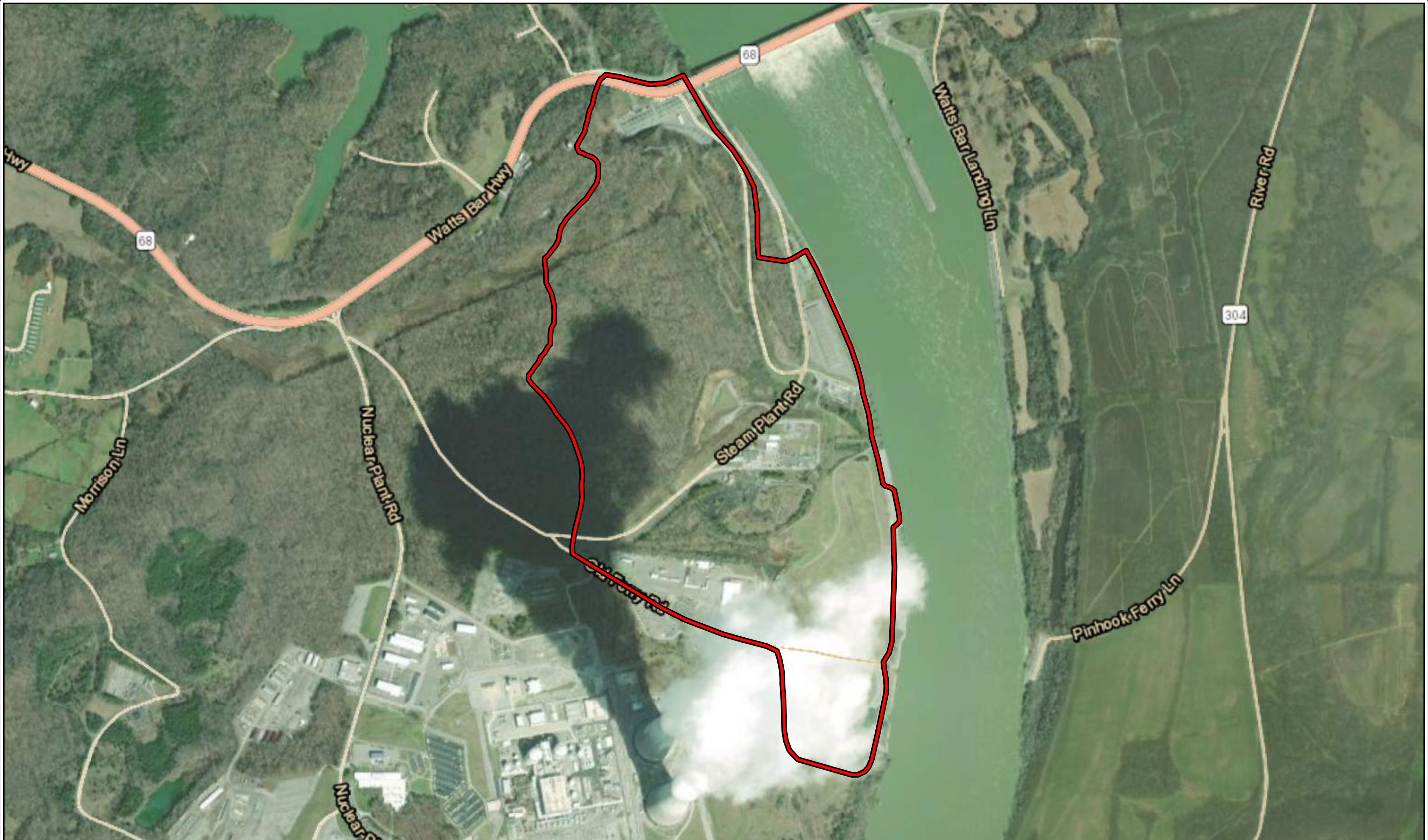

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Watts Bar Fossil Plant

Source: World Imagery and World Transportation, ESRI

0 625 1,250
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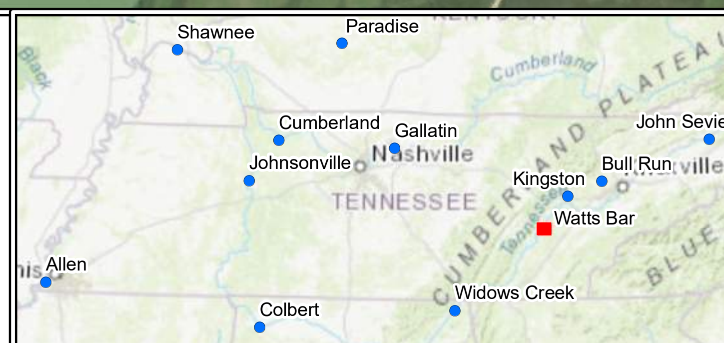

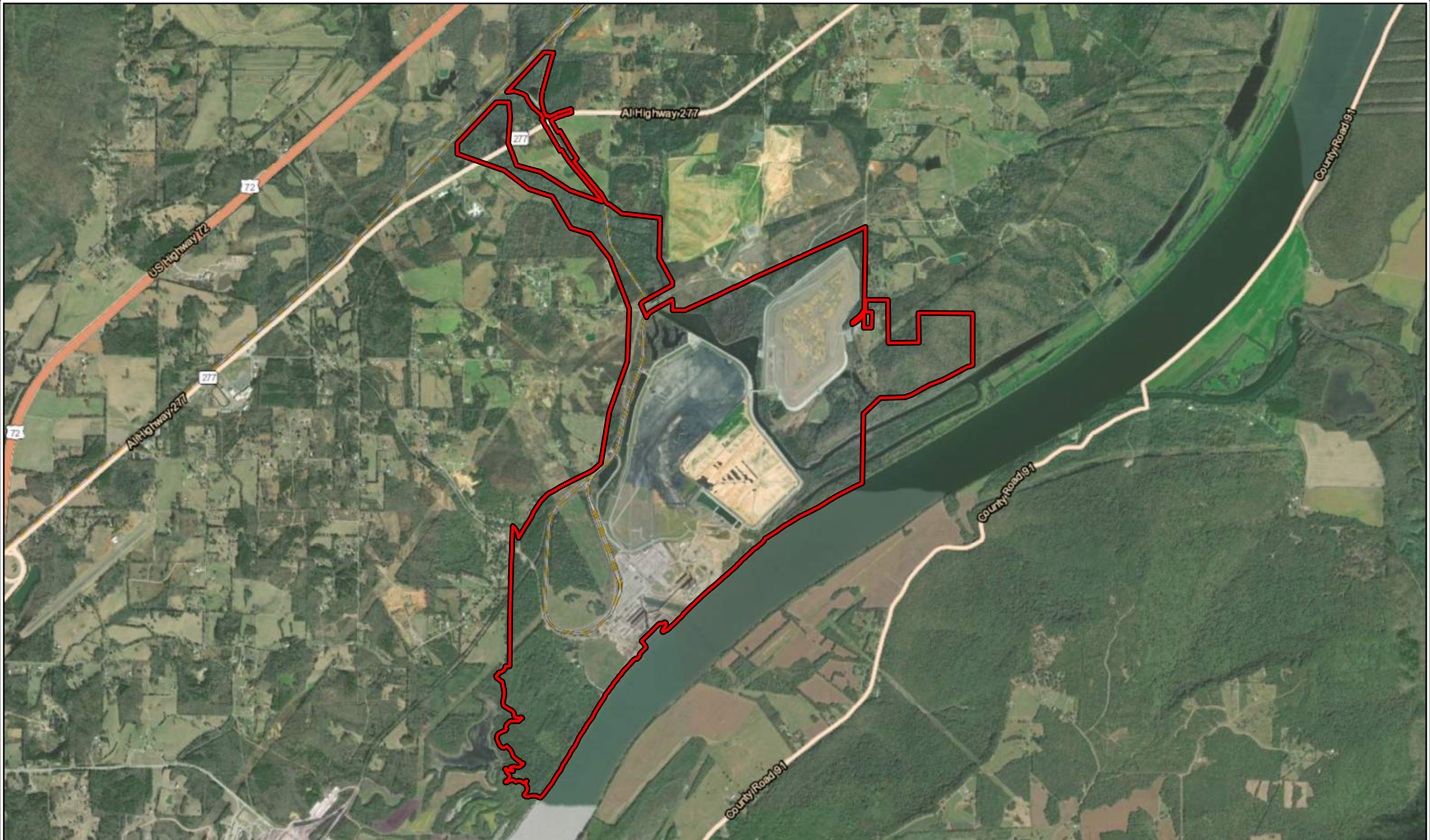

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Widows Creek Fossil Plant

Source: World Imagery and World Transportation, ESRI

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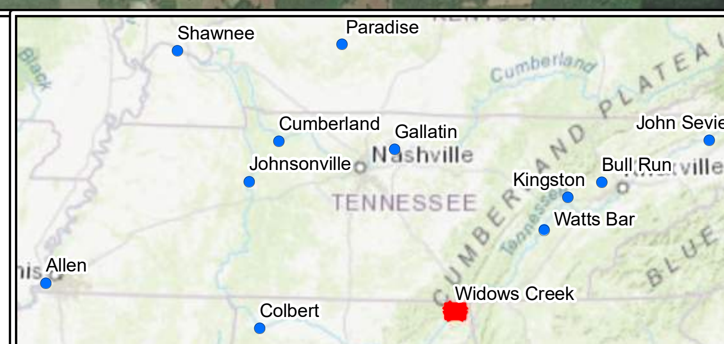

Appendix B – Environmental Screening Checklist

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Environmental Screening Checklist

The goal of this program is to meet groundwater regulatory standards at TVA properties through programmatically evaluating groundwater corrective actions. This Environmental Screening Checklist is used to collect project information to determine that proposed actions fall within the bounding parameters identified in Table 2-1 in the TVA Groundwater Corrective Action Programmatic Environmental Assessment (PEA).

A TVA NEPA Specialist/Environmental Program Manager will complete this environmental checklist well before construction activities are scheduled to begin in accordance with TVA's legal and policy requirements associated with this program. The NEPA Specialist and Environmental Program Manager will ensure that TVA Subject Matter Experts (SMEs) document input in ENTRAC for their respective resource categories for final environmental review and site approval.

TVA NEPA Specialist (name): ____

TVA Environmental Program Manager (name): ____

Proposed TVA Property Site Name/Address (or lat/long): ____

If the answer to any question below is *YES*, further review of environmental impacts by TVA may be required.

If TVA determines that the proposed project impacts sensitive resources beyond the bounded values assessed in the PEA associated with this checklist, the proposed project would be subject to a site-specific environmental review consistent with TVA NEPA procedures.

Corrective Action Attributes	
Which alternative has been selected? (Choose all that apply. If alternative E, please select which alternatives will be combined.)	☐ Alternative B ☐ Alternative C ☐ Alternative D ☐ Alternative E Please describe actions briefly:
Number of wells	Wells: Observation wells:
Maximum disturbance area (including laydown)	Project area acreage:
Volume of borrow material needed (CY)	
Radius of Influence (ft) (Not applicable for MNA)	

Construction-Phase Attributes	
☐ Yes ☐ No	Will the duration of construction exceed 12 months?
☐ Yes ☐ No	Will the number of truck trips exceed the bounding parameter?
☐ Yes ☐ No	Will removal of trees with a trunk diameter greater than 3 inches at breast height be necessary? If so, how many trees or acres of trees will be cleared? ________ trees/acres
☐ Yes ☐ No	Will development of the site require filling in, or alterations to, wetlands or streams, or streamside management zones?
☐ Yes ☐ No	Will development of the site result in impacts to caves or sinkholes?
☐ Yes ☐ No	Would there be greater than 1,500 CY of spoils generated?
☐ Yes ☐ No	Would solid waste generated during construction be greater than 3 CY total?
☐ Yes ☐ No	Would noise from heavy equipment exceed 85 decibels and/or reach sensitive receptors?
☐ Yes ☐ No	Would any wells or laydown areas be constructed within 100-year floodplains as delineated on Federal Emergency Management Agency (FEMA) flood insurance rate maps and/or on contour maps showing known 100-year flood elevations?
Operational Characteristics	
☐ Yes ☐ No	Would solid waste generated be greater than 3 CY biweekly?
Reasonably Foreseeable Future Actions	
☐ Yes ☐ No	Are other actions underway or proposed that, when combined with potential effects of construction and operation of the proposed project, could have a notable collective effect on human health or the environment? If yes, please describe:
Bounding Parameters	
☐ Yes ☐ No	Do any values exceed the bounding parameters outlined in Table 2-1 in the PEA for each applicable alternative selected? If yes, please describe:

TVA subject matter experts reviewed the material presented in this checklist. Documentation of the review is attached.

In accordance with the National Environmental Policy Act (NEPA), TVA must evaluate and document whether the proposed action described within this document is already covered under an existing NEPA review. The following questions record the evaluation of four criteria for making this determination.

Determination of NEPA Adequacy	
☐ Yes ☐ No	Is the site-specific proposed action bounded by the proposed action as analyzed in the TVA Groundwater Corrective Action PEA? If no, please describe:
☐ Yes ☐ No	Are there significant circumstances or information relevant to site-specific environmental concerns that would substantially change the analysis in the TVA Groundwater Corrective Action PEA? If yes, describe:
☐ Yes ☐ No	Are there effects that would result from the site-specific proposed action that were not addressed in the TVA Groundwater Corrective Action PEA? If yes, describe:
☐ Yes ☐ No	Is additional site-specific NEPA necessary? If yes, explain:

Based on the evaluation documented herein, I conclude that the TVA Groundwater Corrective Action PEA and Finding of No Significant Impact (FONSI) fully covers the proposed site-specific action and constitutes TVA's compliance with the requirements of NEPA. The site-specific project does not present significant changes to the proposed action or significant new circumstances or information relevant to environmental concerns that would require supplemental analysis. Impacts associated with the proposed action would be minor to moderate and are bounded by the conclusions of the Final PEA and FONSI. This form documents TVA's compliance with the National Environmental Policy Act for this site-specific action.

____ ____________

NAME | Date Signed
Manager, NEPA Program
Project Support
Tennessee Valley Authority

Appendix C – Additional Alternative Information

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Additional Information on Alternatives

Alternative B

EIST aims to remediate groundwater contamination directly within the subsurface, minimizing disruption to the surrounding environment. These methods typically involve introducing reactive media, chemical reagents, or biological agents into the groundwater to immobilize or degrade COIs. Technologies offer targeted treatment strategies that adapt to site-specific hydrogeologic conditions. EIST is often preferred for its ability to address contamination at the source while reducing the need for extensive excavation and above-ground treatment infrastructure.

Evaluation of EIST approaches for COIs is typically dependent upon a detailed hydrogeologic detailed hydrogeologic conceptual site model (CSM), a groundwater flow model, and a geochemical model. The CSM serves as the basis for developing a numerical groundwater flow model and a geochemical model that are calibrated and verified against actual site conditions. The flow field from the groundwater model serves as an input to the geochemical model along with site-specific geochemical data. The geochemical model is then used to evaluate potential COI attenuation rates and long-term stability for the EIST approach. Bench-scale testing can be used to evaluate potential reagents to be used in situ.

EIST may be an applicable remedial alternative based on site-specific conditions, such as:

- Localized area of impacts: COIs have been detected above GWPS within a limited number of wells. This indicates that in situ treatment would need to be deployed over a limited region. Additional investigations would be conducted to define the targeted treatment area.

- Metals treatment technologies: Removal of COIs with multiple treatment technologies have been demonstrated in industrial wastewater applications. Potential treatment alternatives include advanced filtration, co-precipitation, redox manipulation, adsorption, and ion exchange. The most effective alternative(s) would be selected based on the geochemistry of the groundwater and potential bench-scale treatability testing. Bench-scale testing can help determine the preferred treatment media, groundwater/treatment media contact time, and effectiveness of an EIST system in achieving GWPS.

A groundwater monitoring program is typically an integral part of any EIST system. The monitoring program tracks changes in COI concentrations providing feedback on the effectiveness of the EIST system.

Several critical site-specific conditions need to be considered when evaluating the applicability of an EIST system, including:

- Site Access: EIST systems require access for heavy equipment and a working platform to excavate trenches. Uneven or wooded terrain would complicate site preparation activities and may make installation infeasible.

- Dike Stability: The installation of an EIST could require the use of trenches. The location of the trenches in relationship to Site dikes requires careful evaluation to make sure that stability of the dike structures is maintained.

- Depth: Installation of EIST systems can be limited by the design depth and soil types present. Depending on depth and soil characteristics, specialized installation techniques may be required. For example, single-pass trenching machines can install EIST systems in sandy materials without obstructions but are limited to a maximum depth of approximately 50 feet below ground surface. Slurry trenching techniques can be used to reach deeper impacts, but additional site infrastructure is required to support the installation.

- Geochemistry: The valence state of COIs, pH and redox potential of groundwater, and chemical makeup of the subsurface must be evaluated to determine the applicability of an EIST system

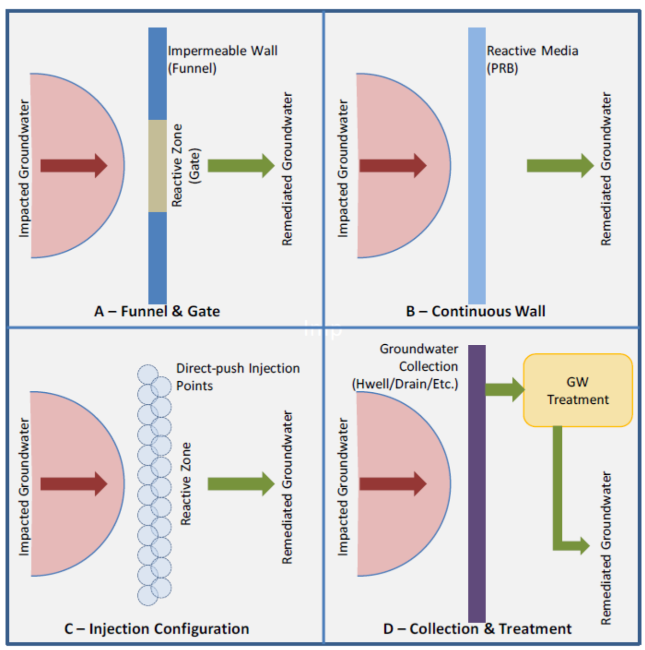
PRB

Conceptual Approach

- Continuous Trencher
  Dewind MT 4500 – 24-foot-wide track-mounted rig
  Cutting chain attached to a trench box (boot)
  Trench box loaded with reactive media
  Front hoppers and rear loading conveyors to deliver media
- Continuous trench installed along the unit perimeter
- Reactive media placed to target transmissive zone
- Backfilled above the reactive media with bentonite slurry in CCR material and native soil above to reduce spoils
- Typically install trenches 1.5 to 3 feet wide and up to 60 feet deep

Typical Treatment Barrier Configurations

- Permeable Reactive Barrier
  Reactive media is placed in the saturated zone
  Typically emplaced via trenching or soil mixing
  GW passes through reactive zone and immobilizes or chemically transforms constituents
- Injection or Extraction Barrier



Advantages related to the use of PRBs include:

- Eliminates open trench and shoring/benching,
- Targets specific depth intervals/transmissive zones to minimize reactive media,
- Even distribution of reactive media prevents preferential pathways, and
- Moderate soil and waste management.

Challenges related to the use of PRBs include:

- Space limitations - minimum of 30 feet required on dikes for a continuous trencher and support operations,
- Potential penetration of the CCR material,
- Potential to reduce hydraulic conductivity along trench walls,
- Generally limited to a target depth of 60 feet,
- Replacement of reactive media may be required over design life, and
- Identification of a single reagent is challenging depending on the specific COIs that exceed GWPS values.

Vertical Injection

Conceptual Approach

- Reagent delivered using vertical injection wells and a dedicated mix/delivery system
- Injection well installed with hollow stem auger or sonic drilling methods
- Reagent delivered under low pressure – gravity feed up to 30 psi
- Low pressure pushes reagent solution into pore spaces of surrounding formation
- Typically installed in 1-2 rows with ROIs of 10 to 20 feet

Horizontal Injection

Conceptual Approach

- Horizontal direction drilling to install 4–8-inch horizontal injection well along treatment perimeter
- Advanced in solid steel casing beneath dikes for support
- Larger boreholes require 200,000-pound rig – 10-feet wide by 50-feet long with drill cab and excavator for support
- Small diameter piping with packers to create multiple injection intervals
- Reagent delivered using a dedicated mix/delivery system similar to vertical injection
- Reagent delivered under low pressure to push reagent solution into pore spaces of surrounding formation
- Lower local ROIs than vertical injection (5-10 feet), but increased downgradient ROI due to dispersion

Funnel and Gate

Conceptual Approach

- Funnels consist of low permeability walls installed via continuous trench
- Gates consist of vertical injection of aqueous reagent solution
- Vertical injection wells installed via hollow stem or sonic drilling
- Dedicated mix and delivery system (tankage, chemical metering and injection pumps, manifold, conveyance)
- Low pressure (up to 30 pounds per square inch) continuous injection
- Typically installed in 1-2 rows with ROIs of 10 to 20 feet

Alternative C

Alternatives C addresses groundwater exhibiting statistically significant concentrations above the GWPS by providing hydraulic control to control the flow of groundwater.

Typical groundwater extraction deployment approaches for hydraulic control are:

- Vertical Wells: The use of vertical wells is a proven technology that can be used in unconsolidated soils and bedrock. The number of wells, spacing between wells and well depths are a function of aquifer characteristics and the targeted control zone.

- Horizontal Wells: The use of horizontal wells potentially allows for the installation of more well screen along a zone of COI impacts in comparison with vertical wells, thus improving the overall efficiency of the extraction system. The use of horizontal wells is not recommended for aquifers where there is large differential between high and low groundwater elevations as it may be difficult to pinpoint the COI recovery zone. Deep horizontal wells may not be as practical as vertical wells depending on site-specific conditions.

The basis of design for a hydraulic control system is typically focused on developing a detailed hydrogeologic CSM and a groundwater flow model. The CSM serves as the basis for developing a numerical groundwater flow model that is calibrated and verified against actual site conditions. The calibrated groundwater flow model is then used to evaluate a variety of approaches (e.g., vertical wells, horizontal wells, trenches) and configurations, and to estimate the groundwater extraction rates necessary to hydraulically control the target zone. Understanding extraction rate requirements is important for developing an effective means of treating extracted groundwater (if treatment is needed). These models allow for an evaluation of approaches and extraction rates to develop an effective means of treating extracted impacted groundwater. Extracted groundwater often requires treatment to remove or reduce the concentrations of COIs prior to discharge to a receiving water body, publicly owned treatment works, land application, or re-injection through a well system. Bench-scale testing is often performed to assist in selecting the preferred water treatment technology.

Treatment of the extracted groundwater may be completed onsite or offsite using treatment methodologies such as:

- pH Adjustment: In cases where low pH is the primary COI, the groundwater can be treated by simple pH adjustment. Increasing the pH of groundwater is accomplished by the addition of caustic solution (e.g., sodium hydroxide) at a rate that can be determined through bench-scale testing. Similarly, high pH groundwater can be treated through the addition of an acidic solution at a rate that can be determined through bench-scale testing. Other treatment methods discussed below may also require some pH adjustment to facilitate treatment.

- Chemical Precipitation: COIs can be removed from groundwater by raising the pH, using sodium hydroxide, calcium carbonate, or sulfides to convert the soluble COI to an insoluble form that precipitates out from the water stream. Bench-scale testing can be used to determine the addition rates of chemical precipitates and the percent COI removal that can be achieved through this process.

- Adsorption: COIs can be removed from groundwater by passing groundwater through an adsorption media such as bentonite, activated alumina, granular activated carbon, or iron- impregnated silica sands. COIs are adsorbed onto the surface of the media and removed from the groundwater. The adsorption material has a finite service life due to the amount of available treatment surfaces on the media. This adsorption material must be periodically replaced when the available surfaces are consumed with COI. Bench-scale testing can be used to define the groundwater/media contact time for COI removal and estimate the active life of the adsorption media before it requires replacement.

- Ion Exchange: In this process, an ion on the surface of the treatment media is exchanged with the ion that is removed from the impacted groundwater. Ion exchange is a proven technology with different media performing better for different COIs. Advances in the beneficial reuse of high calcium content biomaterials has made the use of this technology attractive for some COIs. Bench-scale testing may be completed to determine if ion exchange is a viable technology for consideration. Bench- scale testing can also determine the necessary contact time between the impacted groundwater and ion exchange media, and the service life of the ion exchange media.

Groundwater Extraction: Vertical Extraction Wells

Conceptual Approach

- Vertical extraction wells are oriented in a line perpendicular to groundwater flow to provide hydraulic control and located along the downgradient portion of the Site that is targeted for hydraulic control
- Vertical extraction wells are spaced at an interval that is appropriate for the site conditions to meet performance objectives
- Vertical extraction wells are screened using stainless steel screen within the aquifer that is targeted for hydraulic control
- Extracted groundwater is pumped through a trenched conveyance pipeline and treated (if needed) prior to discharge under applicable permit(s)

Groundwater Extraction: Horizontal Extraction Wells

Conceptual Approach

- Horizontal direction drilling to install 4-8-inch horizontal injection well along extraction perimeter
- Advanced in solid steel/high density polyethylene casing beneath dikes for support
- Larger boreholes require 200,000-pound rig – 10-feet wide by 50-feet long with drill cab and excavator for support
- Small diameter piping with packers to create multiple injection intervals
- Multiple horizontal extraction wells can be spaced at an interval that is appropriate for the site conditions to meet performance objectives
- Horizontal extraction wells are screened using stainless steel or high density polyethylene screen within the aquifer that is targeted for hydraulic control
- Extracted groundwater is pumped through a trenched conveyance pipeline and treated (if needed) prior to discharge under applicable permit(s)

Alternative D

Conceptual Approach

- Groundwater monitoring plans are developed to monitor the physical, chemical, or biological processes that occur naturally at the areas targeted for MNA

- Additional groundwater monitoring wells may be installed if existing groundwater monitoring wells do not meet the objectives of the groundwater monitoring plan

The CSM serves as the basis for developing a numerical groundwater flow model and a geochemical model that are calibrated and verified against actual site conditions. The flow field from the groundwater model serves as an input to the geochemical model along with site-specific geochemical data. The geochemical model is then used to evaluate potential COI attenuation rates and stability of the attenuated COI mass.

Appendix D – Regulatory Framework

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Regulatory Framework

Geology, Soils, and Prime Farmland

The Farmland Protection Policy Act of 1981 (7 United States Code [U.S.C.] 4201 et seq.) recognizes the importance of prime farmland and directs federal agencies to minimize the extent to which federal programs convert farmland to nonagricultural uses. The Farmland Protection Policy Act of 1981 specifically protects prime and unique farmland, which are characterized by the Natural Resources Conservation Service (NRCS). Soils that have the best combination of physical and chemical characteristics from which the highest yields of food, feed, forage, fiber, and oilseed crops can be produced with minimal expenditure of energy and economic resources are considered prime farmland. Soils that do not meet prime farmland criteria only due to excessive moisture but could qualify as prime farmland if properly drained are categorized as prime farmland if drained. Prime farmland is designated independently of land use and is based on soil properties; therefore, areas of water or developed land cannot be considered prime farmland. Prime farmland along with land that would be considered prime farmland if drained of excess moisture is present to varying degrees within the boundaries of the TVA properties proposed for groundwater corrective action (NRCS 2025).

Groundwater

The Safe Drinking Water Act of 1974 established the Wellhead Protection Program, a pollution prevention and management program implemented by each state, used to protect underground sources of drinking water. The Safe Drinking Water Act also created 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 Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the Federal Insecticide, Fungicide, and Rodenticide Act.

On April 17, 2015, the U.S. Environmental Protection Agency (USEPA) published the Disposal of Coal Combustion Residuals (CCR) from Electric Utilities final rule (CCR Rule) in the Federal Register to provide a comprehensive set of national criteria for the management of CCR produced by electric utilities. The CCR Rule requires groundwater monitoring and addresses the potential risks of coal ash constituents migrating into groundwater when groundwater protection standards are statistically exceeded. On May 8, 2024, USEPA finalized changes to the CCR regulations for inactive surface impoundments at inactive electric utilities, referred to as "legacy CCR surface impoundments." Within tailored compliance deadlines, owners and operators of legacy CCR surface impoundments must comply with all existing requirements applicable to inactive CCR surface impoundments at active facilities, except for the location restrictions and liner design criteria.

Floodplains

As a federal agency, TVA adheres to the requirements of Executive Order (EO) 11988 (Floodplain Management). The objective of the EO 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". The EO is not intended to prohibit floodplain development in all cases, but rather to create a consistent government policy against such development under most circumstances (U.S. Water Resources Council 1978). The EO requires that agencies avoid the 100-year floodplain unless there is no practicable alternative.

Wetlands

The U.S. Army Corps of Engineers (USACE) regulates the discharge of fill material into waters of the United States including wetlands, pursuant to Section 404 of the Clean Water Act (CWA; 33 U.S.C. 1344). Additionally, EO 11990 (Protection of Wetlands) requires federal agencies to avoid, to the extent possible, adverse impacts to wetlands and to preserve and enhance their natural and beneficial values.

In Tennessee, the Tennessee Department of Environment and Conservation (TDEC) certifies CWA Section 404 permits and impacts to intrastate wetland resources through a general or individual aquatic resources alteration permit. This permit is required for any alteration to the physical, chemical, or biological properties of any waters of the state, including wetlands, pursuant to the Tennessee Water Quality Control Act (§69-3-108, 0400-40-07). TDEC's permit process ensures compliance with Tennessee's anti-degradation policy as well (§ 693-108, 0400-40-04).

In Alabama, the Alabama Department of Environmental Management (ADEM) Coastal Monitoring Program is responsible for monitoring and assessing wetlands as well as certifying CWA Section 401 permits. The application for Section 401 Water Quality Certification from ADEM is submitted jointly with a Section 404 application to the USACE for potential alterations to waters of the State (NAWM 2015).

In Kentucky, the Kentucky DEP, Division of Water regulates impacts to jurisdictional surface water resources in accordance with USACE jurisdictional determinations. Their Water Quality Certification program has not adopted mitigation provisions for wetlands beyond what is required under CWA Section 404, does not require state-level jurisdictional determinations, nor has it developed wetland-specific water quality standards. However, general water quality standards applicable to all surface waters may also be applicable to wetlands, as wetlands are included in the definition of surface waters (Kentucky DOW 2020).

Habitat, Wildlife, and Threatened and Endangered Species

Special status species are those species for which state or federal agencies provide an additional level of protection by law, regulation, or policy. The Endangered Species Act (ESA; 16 U.S.C. §§ 1531-1543) was passed to conserve the ecosystems upon which endangered and threatened 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 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 listed species, also can be designated under the ESA. The ESA establishes programs to conserve and recover endangered and threatened 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 action on endangered and threatened species and critical habitats. If the proposed action has the potential to affect these resources, the federal agency is required to consult with the U. S. Fish and Wildlife Service (USFWS) and take measures to avoid or mitigate adverse effects.

In addition to the federal classifications, all states in the TVA Power Service Area have enacted their own laws protecting special status species under a variety of their own, state-specific classification systems. In some states, only species listed under the federal ESA receive legal protection under these laws. In other states, the legal protections also apply to the additional species designated by the state. As a federal agency, TVA is not subject to these state laws, but it considers them in its environmental reviews as appropriate.

EO 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds) directs federal agencies to take certain actions to conserve migratory birds and implement the Migratory Bird Treaty Act (MBTA). The MBTA prohibits the “take” of migratory birds. The regulatory definition of “take” as defined by 50 Code of Federal Regulations (CFR) § 10.12, “means to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue hunt, shoot, wound, kill, trap, capture, or collect.” The following prohibitions apply to migratory bird nests: “possession, sale, purchase, barter, transport, import and export, take, and collect.” The MBTA is executed and enforced by USFWS. In addition to protection under the MBTA, bald and golden eagles are also protected under the Bald and Golden Eagle Protection Act, which states that to kill, harass, and possess (without a permit), or sell bald and golden eagles and their parts is illegal.

Invasive species are non-native species whose introduction causes or is likely to cause economic or environmental harm or harm to human health (NISC 2016). EO 13112 (Invasive Species) directs federal agencies to prevent the introduction of invasive species, control their populations, restore invaded ecosystems, and take other related actions to minimize impacts from invasive species (USDA 1999). Additionally, EO 13751 (Safeguarding the Nation from the Impacts of Invasive Species) amends EO 13112 (Invasive Species) and directs actions to continue coordinated federal prevention and control efforts to address invasive species (USDA 2016).

Cultural and Historic Resources

Section 106 of the National Historic Preservation Act (NHPA), as amended (54 U.S.C. § 300101 et seq.), is specifically designed to address the effects of federal and federally funded or permitted projects on tangible cultural resources—that is, physically concrete properties—of historic value. The NHPA provided for a national program to support both public and private efforts to identify, evaluate, and protect the nation’s important cultural resources. Once identified, these resources are evaluated for inclusion in the National Register of Historic Places (NRHP) maintained by the National Park Service. Tangible cultural resources may qualify for inclusion in the NRHP if they are 50 years of age or older (with some exceptions) and if found to embody one or more of four different values, or criteria, in accordance with 36 CFR § 60.4, as listed below:

Criterion A: association with events that have made a significant contribution to the broad patterns of our history. Such events may include a specific occurrence or pattern of occurrences, cultural traditions, or historic trends important at a local, regional, or national level. To be considered in association with a cultural resource, events must be important within the particular context being assessed.

Criterion B: association with the lives of persons significant in our past. People considered may be important locally, regionally, or nationally, and the cultural resources considered are limited to properties illustrating a person’s achievements rather than commemorating them.

Criterion C: embodiment of the distinctive characteristics of a type, period, or method of construction; representative of the work of a master; possessing high artistic values; or representative of a significant and distinguishable entity whose components may lack individual distinction. Cultural resources considered generally include architectural resources such as buildings, objects, districts, and designed landscapes.

Criterion D: cultural resources that have yielded, or may be likely to yield, information important in prehistory or history. Considered cultural resources typically include archaeological sites but may also include buildings, structures, and objects if they are the principal source of important information not contained elsewhere.

Cultural resources that are listed or considered eligible for listing in the NRHP are called “historic properties.” Federal agencies are required by the NHPA to consider the possible effects of their undertakings on historic properties and take measures to avoid, minimize, or mitigate any adverse effects. The National Environmental Policy Act (NEPA) requires federal agencies to consider how their undertakings may affect the quality of the human environment, including both cultural resources and those defined as historic properties, so that the nation may “preserve important historic, cultural, and natural aspects of our national heritage.” “Undertaking” includes any project, activity, or program that has the potential to have an effect on a historic property and that is under the direct or indirect jurisdiction of a federal agency or is licensed or assisted by a federal agency. The consultation process for compliance with Section 106 of NHPA will be followed for site-specific reviews, if deemed necessary.

A project may have effects on a historic property that are not adverse. However, if the agency determines that the undertaking’s effect on a historic property within the area of potential effect would diminish any of the qualities that make the property eligible for the NRHP (based on the criteria for evaluation at 36 CFR Part 60.4), the effect is said to be adverse. Examples of adverse effects would be ground-disturbing activity in a historically significant archaeological site or erecting tall buildings or structures within the viewshed of a historic building in such a way as to diminish the structure’s integrity of feeling or setting.

Adverse effects must be resolved in consultation with others, such as the State Historic Preservation Office and federally recognized Indian tribes. Resolution may consist of avoidance (such as redesigning a project to avoid impacts or choosing a project alternative that does not result in adverse effects), minimization (such as redesigning a project to lessen the effects such as installing visual screenings), or mitigation. Mitigation can take various forms but adverse effects to archaeological sites are often mitigated by means of archaeological excavation to recover the important scientific information contained within the site. Mitigation of adverse effects to historic buildings and structures can involve thorough documentation of the resource by compiling historic records, studies, and photographs.

Agencies are required to consult with the appropriate State Historic Preservation Office(s), federally recognized Indian tribes that have an interest in the undertaking and who associate themselves with the project area, and any other party with a vested interest in the undertaking. Through various regulations and guidelines, federal agencies are encouraged to coordinate Section 106 and NEPA reviews to improve efficiency and allow for more informed decisions. Under NEPA, impacts to cultural resources that are part of the affected human environment but not necessarily eligible for the NRHP must also be considered by federal agencies. Generally, these considerations, as well as those of NRHP-eligible traditional cultural resources (also called traditional cultural properties), are accomplished through consultation with parties having a vested interest in the undertaking.

Noise

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978, U.S.C. 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 that results in a public nuisance. Because of the subjective nature of such ordinances, they are often difficult to enforce.

To quantify community cumulative noise exposure over a 24-hour period, the day-night sound level (L_{dn}), expressed in A-weighted decibels (dBA), is often used. L_{dn} is the 24-hour average noise level with 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 noises that occur at night. Typical background day-night noise levels for rural areas are anticipated to range between an L_{dn} of 35 and 50 decibels (dB), whereas higher-density residential and urban areas background noise levels range from 43 dB to 72 dB (USEPA 1974). The EPA noise guideline recommends an L_{dn} 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” (USEPA 1974). The U.S. Department of Housing and Urban Development considers an L_{dn} of 65 dBA or less to be compatible with residential areas (HUD 1985).

Air Quality

The Clean Air Act (CAA; 42 U.S.C. § 7401 *et seq.*) 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 USEPA 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 (USEPA 2024c). The CAA also requires USEPA to set standards for emissions of hazardous air pollutants (HAPs).

<u>Criteria Air Pollutants</u>

NAAQS have been established to protect the public health and welfare with respect to six criteria air pollutants: carbon monoxide, nitrogen dioxide, ozone, particulate matter, sulfur dioxide, and lead. Primary standards protect public health, while secondary standards protect public welfare (e.g., visibility, crops, forests, soils, and materials) (USEPA 2024d). The CAA also identifies 188 pollutants as HAPs (USEPA 2024e). Most HAPs are emitted by human activities, including mobile sources (motor vehicles), stationary sources (factories, refineries, and power plants), and indoor sources (building materials and activities such as dry cleaning).

USEPA has numerous ambient air quality monitoring programs related to the NAAQS. The most basic is the Ambient Air Monitoring Program, which collects national air quality data on criteria pollutants and volatile organic compounds. The program is carried out by USEPA and State and local air pollution agencies with oversight and guidance provided by USEPA. USEPA has several other programs involving local, tribal, State, regional, and national air quality data (USEPA 2024f).

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 achieves the NAAQS.
- Nonattainment – any area with air quality worse than the NAAQS.
- Maintenance – an area that was formerly in nonattainment but has monitored attainment and is currently under a maintenance plan.
- Unclassified – not enough data to determine attainment status. However, the unclassifiable or attainment/unclassifiable status areas are treated as in attainment with NAAQS, for the purposes of CAA planning and permitting requirements.

Hazardous Materials and Solid Waste

Hazardous materials are defined by USEPA as substances that, due to their quantity, concentration, or physical or chemical characteristics, may pose a substantial hazard to human health or the environment when improperly managed. These materials include hazardous substances, hazardous wastes, and other regulated chemicals used or generated at industrial facilities, including electric utility operations (USEPA 2025g), which are regulated under a suite of federal laws including Occupational Safety and Health Administration (OSHA), RCRA, the Emergency Planning and Community Right-to-Know Act, the Toxic Substances Control Act, and the CERCLA (USEPA 2025g).The most recent list of regulated hazardous substances is found in 40 CFR Part 302, which identifies quantities of these substances that, when released to the environment, require notification to a federal government agency (USEPA 2025h). Petroleum products are specifically exempted from 40 CFR Part 302, but some are generally considered hazardous substances due to their physical characteristics (especially fuel products), and their ability to impair natural resources.

RCRA provides the principal framework for hazardous and solid waste management in the United States and is widely known for managing hazardous waste from “cradle-to-grave,” including its generation, transportation, treatment, storage, and disposal. RCRA implementing regulations at 40 CFR Part 261 define hazardous waste as meeting one or more of four characteristics: ignitability, corrosivity, reactivity, or toxicity (USEPA 2024g). RCRA also includes separate regulations for certain potentially hazardous wastes, such as petroleum products. Used oil, including gear oils, greases, mineral oils, and assorted other petroleum-based oils, for example, is regulated as hazardous waste if it is disposed of, but is regulated differently if it is recycled. Universal wastes are a subset of hazardous wastes that are widely generated. Universal wastes include batteries, pesticides, mercury-containing equipment, lamps, and aerosol cans, and may be managed in accordance with RCRA requirements or by separate provisions. The majority of TVA’s used oil is recycled annually, and in 2022, approximately 58.7 tons of universal waste was recycled by TVA (TVA 2024).

Public Health and Safety

Workplace health and safety regulations are designed to eliminate personal injuries and illnesses from occurring in the workplace. These laws may comprise both federal and state statutes. U.S. Department of Labor, OSHA is the main statute protecting the health and safety of workers in the workplaces. OSHA regulations are presented in Title 29 CFR Part 1910 (29 CFR 1919), OSHA Standards. A related statute, 29 CFR 1926, contains health and safety regulations specific to the construction industry. The Tennessee Department of Labor and Workforce Development has adopted federal OSHA standards contained in 29 CFR Parts 1910 and 1926 pursuant to Tennessee Code Annotated Section 50-3-201. Additionally, the federal regulations govern workplace health and safety requirements in private sector workplaces in Alabama since no state law governs workplace safety for public sector employers. The Kentucky Occupational Safety and Health Program, under the statutory authority of Kentucky

Revised Statutes Chapter 338 has a state plan approved by the OSHA to protect the health and safety of workers in the workplaces.

Appendix E – Literature Cited

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Appendix F – List of Preparers

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List of Preparers

NEPA Management

Brittany Kunkle (TVA)
Position: Project Manager, NEPA Specialist
Education: B.S., Environmental and Soil Science
Experience: 6 years in NEPA Compliance
Involvement: NEPA Compliance and Project Management

Carol Butler Freeman (TVA)
Position: Project Manager, NEPA Specialist
Education: M.S., Geological Sciences and Space Studies; B.S., Geology
Experience: 17 years in NEPA Compliance
Involvement: NEPA Compliance and Project Management

Bill Roddy (TVA)
Position: Environmental Program Manager
Education: B.S., Environmental Science
Experience: 17 years environmental compliance; 6 years NEPA document preparation
Involvement: Environmental Planning and Project Management

Roy Quinn (TVA)
Position: Senior Manager
Education: B.S., Engineering
Experience: 26+ years civil and environmental engineering
Involvement: Program alignment and technical contribution

Amy Vargas (AECOM)
Position: Project Manager
Education: M.S., Biology; B.S., Botany
Experience: 19 years of experience in environmental consulting and 17 years in NEPA compliance
Involvement: NEPA Compliance

Other Contributors

Sophia Jamaldin (TVA)
Position: Archaeologist
Education: M.A., Anthropology; B.A., Anthropology
Experience: 12 years of experience in cultural resource management and archaeological research
Involvement: Cultural Resources

Carrie Williamson, P.E. (TN), CFM (TVA)
Position: Program Manager, Flood Risk
Education: M.S., Civil Engineering; B.S., Civil Engineering
Experience: 12 years in Floodplains and Flood Risk; 3 years in River Forecasting; 11 years in Compliance Monitoring
Involvement: Floodplains and Flood Risk

Anneliesa Barta (AECOM)
Position: Environmental Planner
Education: M.B.A., Finance; B.S., Psychology
Experience: 13 years of experience in environmental and sustainability planning, 5 years of experience in NEPA compliance
Involvement: Socioeconomics

Rebecca Cooper (AECOM)
Position: Ecologist II
Education: B.A., Biology
Experience: 3 Years in Environmental Science
Involvement: Wetlands, Terrestrial Ecology, Aquatic Ecology, Botany

Laary Cushman (AECOM)
Position: Senior Project Manager
Education: A.B.D. (Ph.D.) Biology; M.S., Plant and Environmental Sciences
Experience: 27 years of experience in environmental planning and NEPA compliance
Involvement: Technical Reviewer

Doug Gray (AECOM)
Position: Chemical Engineer
Education: B.S., Chemical Engineering
Experience: 33 years in evaluation, design, and implementations of innovative remedial technologies for impacted soil and groundwater
Role: Technical Reviewer

Regina Greer (AECOM)
Position: Project Administrator
Education: B.S., Computer Science
Experience: 30 years in project administration and 20 years of experience in NEPA document preparation
Role: Technical Editor and Document Preparation

Natalie Kisak (AECOM)
Position: Environmental Planner
Education: M.A., Environmental Resource Policy; B.A., Environmental Studies and Public Policy
Experience: 6 years of experience in environmental planning and NEPA compliance
Involvement: Socioeconomics

Kate Melanson (AECOM)
Position: Ecologist
Education: Ph.D., Ecology and Evolutionary Biology; M.A., Ecology and Evolutionary Biology; B.A., Biology
Experience: 9 years in research, 3 years in government, and 1 year in NEPA compliance
Role: Aquatic Ecology, Soil Erosion, Surface Water, Navigation, Land Use, Prime Farmland, Noise, Public Health and Safety, Transportation, Visual

Molly Notestine (AECOM)
Position: Ecologist
Education: M.S., Plant Soil & Insect Science; B.S., Resource Ecology and Management
Experience: 20 years in environmental consulting and NEPA compliance
Involvement: Land Use; Geology, Soils and Prime Farmland; Hazardous Materials and Solid Waste; Technical Reviewer.

Elizabeth Perry, PG (AECOM)
Position: Hydrogeologist
Education: B.S., Engineering Geology; B.A., Mathematics
Experience: 40 years in environmental consulting; Professional Geologist in TN.
Role: Technical Reviewer

Nicole Spangler (AECOM)
Position: Chemical Engineer
Education: B.S., Chemical Engineering
Experience: 20 years in environmental services and 17 years in NEPA compliance
Role: Air Quality, Greenhouse Gas, Climate Change, Noise

Kelley Samuels (AECOM)
Position: Senior Ecologist
Education: B.A., Environmental Sciences
Experience: 30 years in environmental services
Role: Technical Reviewer

Charlene Wu (AECOM)
Position: Senior Environmental Planner
Education: B.S., Environmental Science and Policy; M.S., Environmental Management
Experience: 12 years in environmental services
Role: Technical Reviewer

Cameron Wyse (AECOM)
Position: Biologist
Education: B.S., Biology
Experience: 3 years in environmental services
Role: Terrestrial Zoology, Wetlands

Fang Yang (AECOM)
Position: Air Quality Scientist
Education: M.S., Atmospheric Science; B.S., Physics
Experience: Over 35 years of experience in air quality and noise studies and 29 years in NEPA compliance
Role: Air Quality, Greenhouse Gas and Climate Change Reviewer