Corrective Action/Risk Assessment Plan – DRAFT

Kingston Fossil Plant

Harriman, Tennessee

Tennessee Valley Authority

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Executive Summary

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to Tennessee Valley Authority (TVA) to establish a process for investigating, assessing, and remediating unacceptable risks from management of coal combustion residuals (CCR) at TVA coal-fired plants in the state of Tennessee. There are three CCR units at the Kingston Fossil Plant (KIF Plant) that were used for the management of CCR material included in the TDEC Order: the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench (herein collectively called the 'TDEC Order CCR units').

This Corrective Action / Risk Assessment (CARA) Plan has been prepared pursuant to the TDEC Order and specifies the basis and actions TVA plans to take at the KIF Plant TDEC Order CCR units, including actions related to closure of the CCR units and groundwater corrective action. The TDEC Order provides that the actions to be taken may include "(1) soil, surface water, and groundwater remediation, (2) risk assessment and institutional controls, or (3) no further corrective action."

The CARA Plan builds upon information gained during TVA's prior and ongoing environmental investigation and monitoring programs overseen by TDEC and USEPA, as well as a comprehensive environmental investigation overseen by TDEC that included characterizing the KIF Plant site hydrogeology and the TDEC Order CCR units. Together, these investigations and monitoring programs collected more than 20,000 samples of CCR material, groundwater, background soils, surface stream water, sediment, air, and ecological communities (e.g., fish); and conducted a water use survey of offsite wells. Using these data, a risk assessment based on United States Environmental Protection Agency guidance was performed to evaluate potential risks to human and ecological receptors (e.g., fish) from potential exposures to CCR constituents related to the TDEC Order CCR units. Additionally, the investigation results were used to conduct site-specific assessments of CCR unit closure methods and groundwater corrective measure technologies to form the basis for TVA's planned closure approach and groundwater corrective actions identified in this CARA Plan.

TVA's mission is to supply affordable and reliable power to the people of the Tennessee Valley while protecting the natural resources of this region and supporting the communities we serve. TVA's goal within this CARA Plan is to make the best, most appropriate choices for closure and corrective action to ensure that the TDEC Order CCR units at the KIF Plant are safe, secure, and protective of human health and the environment, consistent with TVA's mission.

TVA evaluated two options in this CARA Plan for closure of the TDEC Order CCR units, Closure-in-Place (CIP) and Closure-by-Removal (CBR). CIP is performed by installing a cover system to isolate the underlying CCR material from exposure to surface runoff and infiltration, human and animal contact, and wind. CBR involves excavating and relocating the CCR material from the landfill or former impoundment to an approved onsite or offsite disposal facility. TVA also evaluated several alternatives to address groundwater quality at the TDEC Order CCR units.

Based on the comprehensive investigations and conclusions of the site-specific evaluations, TVA plans continued CIP of the TDEC Order CCR units at the KIF Plant, with targeted groundwater corrective actions. TVA believes that CIP of the TDEC Order CCR units, along with targeted groundwater corrective actions, is the best way to safely and securely close the CCR units, achieve its mission, and comply with the TDEC Order and State regulations. TVA's plans, along with an implementation schedule, are shown in Exhibit ES-1 at the end of this summary.

Because each of the KIF Plant TDEC Order CCR units was previously closed, TVA has identified a collective set of additional closure actions including the installation of engineered geosynthetic cover systems and drainage modifications to enhance the existing closures to achieve long-term conditions sooner. At the Interim Ash Staging Area, TVA will implement additional closure actions including the installation of an engineered geosynthetic cover system and drainage modifications in adjacent and upgradient areas. Based on the demonstrated effectiveness of the existing geosynthetic cover systems at the Sluice Trench and Area East of Sluice Trench and Stilling Pond, TVA is not planning additional closure actions for these TDEC Order CCR units. Also, as a separate project prior to CARA implementation, TVA is constructing an East Dike seismic stability mitigation project at the Sluice Trench and Area East of Sluice Trench.

In addition to these closure actions, TVA will implement corrective actions to improve groundwater quality and meet groundwater protection standards (GWPS) at the TDEC Order CCR units. The human health and ecological risk assessment evaluation concluded that there are no unacceptable risks to onsite or offsite human or ecological receptors from the TDEC Order CCR units at the KIF Plant; therefore, corrective action is only required for groundwater to attain GWPS consistent with regulatory requirements. Based on the evaluations conducted as part of this CARA Plan, *in situ* treatment will be conducted at the 'Sluice Trench/Interim Ash Area' (which includes both the Interim Ash Staging Area and Sluice Trench and Area East of Sluice Trench CCR units) and at the Stilling Pond.

The wide-ranging, site-specific evaluations presented in this CARA Plan provide a clear basis for TVA's planned continuation of CIP with targeted groundwater corrective actions for the KIF Plant TDEC Order CCR units. CIP and the planned corrective actions are consistent with TVA's mission, protect the people and resources of the Tennessee Valley, are compliant with State regulations, and are the most appropriate actions when considering and balancing all relevant factors.

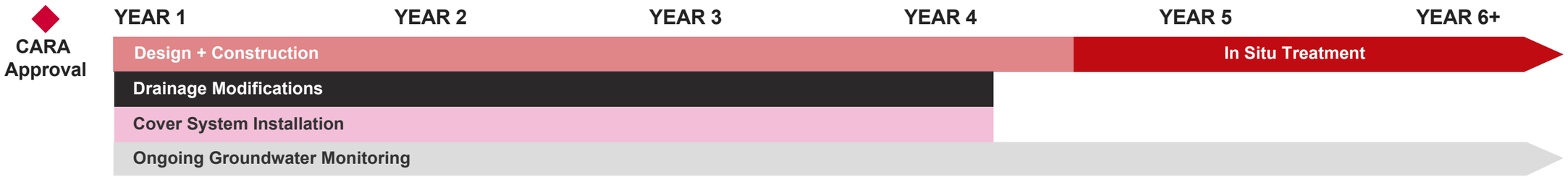
The reasons why TVA is planning these closure and corrective actions (i.e., the basis for closure and corrective action) are provided below:

- **CIP is environmentally more beneficial than CBR,** particularly for the KIF Plant TDEC Order CCR units where over 4 million cubic yards of CCR material would have to be removed and transported to alternate landfills and require over 3 million cubic yards of borrow soils that would have to be obtained from offsite sources.
- **Compared to CIP, CBR results in substantially greater adverse impacts** related to transportation and construction, particularly climate change and greenhouse gas emissions, worker and transportation safety, and potential impacts to surrounding communities with environmental concerns.
- **Once closure begins, CBR would take 19 to 22 years to complete compared to the three to four years for CIP** of all TDEC Order CCR units due to the volume of CCR material.
- **CBR with complete removal of the CCR material from the three TDEC Order CCR units may be infeasible and unsafe** due to structural stability concerns at the adjacent KRP Ash Landfill.
- **CIP provides source control faster than CBR** due to the extended CBR construction activities.
- **Geosynthetic cover systems are effective** in controlling, minimizing or eliminating infiltration through the cover system.
- **Once the East Dike stability berm and foundation soil ground improvements are constructed, the TDEC Order CCR units will meet the established slope stability factors of safety** during closure, the post-closure period, and beyond.
- ***In situ* treatment is an established technology** that is expected to attain GWPS within a few years after implementation and would maintain this condition until effects of source control make it unnecessary.
- **CIP meets or exceeds the closure performance standards** required by TDEC regulations.
- **There are no onsite or downgradient offsite uses of groundwater as a drinking water source.**
- **There are currently no unacceptable risks to onsite or offsite human or ecological receptors, and this will continue during harvesting, closure, and the time required to attain and maintain GWPS.**

With no unacceptable risks related to Closure-in-Place, Closure-by-Removal is not necessary or justified with its much longer timeline to complete closure, greater overall environmental impacts, and substantially higher cost.

Closure-in-Place, along with targeted groundwater corrective actions, is the best solution to protect the people and resources of the communities near the KIF Plant consistent with TVA's mission.

CARA Plan Implementation Timeline



Legend

- Groundwater Monitoring Well
- Drainage Modifications
- In Situ Treatment (Horizontal Well Injection)
- Approximate East Dike Seismic Stability Mitigation Project Limits (Separate TVA Project)
- Existing Geosynthetic Cover System
- Existing Geosynthetic Liner System
- Planned Geosynthetic Cover System Modification or Extension

NOTE: Closure actions and groundwater corrective actions are based on design drawings in Appendix F.1.

Exhibit No.
ES-1

DRAFT

Title

Planned KIF Plant CCR Unit Closure and Corrective Actions Implementation Schedule

Client/Project

Tennessee Valley Authority
Kingston Fossil (KIF)Plant TDEC Order

Project Location

Roane County, Tennessee

175668043
Prepared by KB on 2025-08-21

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Abbreviations

AMSL	Above Mean Sea Level
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
CARA	Corrective Action/Risk Assessment
CBR	Closure-by-Removal
CCR	Coal Combustion Residuals
CCR Rule	USEPA Final Rule on Disposal of Coal Combustion Residuals from Electric Utilities
CERCLA	Comprehensive Environment Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIP	Closure-in-Place
CSM	Conceptual Site Model
DSWM	TDEC Division of Solid Waste Management
EAR	Environmental Assessment Report
EI	Environmental Investigation
EIP	Environmental Investigation Plan
EPRI	Electric Power Research Institute
GHG	Greenhouse Gas
GWPS	Groundwater Protection Standard(s)
HHERA	Human Health and Ecological Risk Assessment
KIF Plant	Kingston Fossil Plant
KRP	Kingston Recovery Project
LLDPE	Linear Low-Density Polyethylene
LOE	Lines of Evidence
LTM	Long-term Monitoring
MCL	Maximum Contaminant Level
MW	Megawatt
MNA	Monitored Natural Attenuation
MNR	Monitored Natural Recovery
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
PCS	Perimeter Containment System
PWS	Perimeter Wall Stabilization
PEIS	Programmatic Environmental Impact Statement
%	Percent
Stantec	Stantec Consulting Services Inc.
TDEC	Tennessee Department of Environment and Conservation
TDEC Order	Commissioner’s Order OGC15-0177
TMSP	Tennessee Storm Water Multi-Sector General Permit
TRV	Toxicity Reference Value
TVA	Tennessee Valley Authority
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

Chapter 1 Introduction

The Tennessee Valley Authority (TVA) and Stantec Consulting Services Inc. (Stantec), on behalf of TVA, prepared this Corrective Action / Risk Assessment (CARA) Plan to specify the basis and actions TVA plans to take related to closure and groundwater corrective action for the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench coal combustion residuals (CCR) units at the Kingston Fossil Plant (KIF Plant) in Harriman, Tennessee. The KIF Plant is a TVA coal-fired power plant in Roane County, located in the east portion of Tennessee (see below and Exhibit 1-1).

KIF Plant Location

1.1 TVA Mission

TVA's mission is just as relevant today as it was nine decades ago when Congress created TVA: harness the potential of the rich resources in the Tennessee Valley region to make life better for the people who call it home. We are inspired daily to pursue new ideas and innovative solutions to improve our service to the people of the Tennessee Valley. The 10,000 employees of TVA form an experienced, talented team committed—every day—to improve the quality of life for the approximately 10 million people we serve.

Energy:

- TVA generates safe, clean, reliable and affordable power for the region's homes and businesses, working with local power companies to keep service steady and reliable.
- We deliver power at the lowest feasible cost for all our customers while keeping TVA power safe and reliable.

- Our mission is unchanged from its 1933 roots—we serve the people of the Tennessee Valley to help the region thrive and grow.

Environment:

- TVA's mission of service includes being stewards of the region's natural resources, including its waterways and surrounding lands.
- We manage the thriving Tennessee River system to provide multiple benefits to the people we serve—including flood control, recreation and power production—and ensure that our region will be a safe, healthy and beautiful place to live and play for years to come.

Economic Development:

- From the beginning, TVA was charged with giving the people of the Tennessee Valley region a better opportunity to prosper.
- Today, we work with partners across the region to help bring new investments and good jobs to the region and keep them here.
- Our reliable, low-cost, safe, and clean electricity helps the region recruit industry and keeps power bills lower for our homes, businesses and industries.

These core principles guide decision making for all facets of TVA, including management of CCR material, while providing affordable and reliable power to the people of the Tennessee Valley.

1.2 Background, Scope, and Objectives

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to TVA (TDEC 2015, in Appendix A.1). There are three CCR units at the KIF Plant that were used for the management of CCR material included in the TDEC Order: the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench, referenced collectively herein as "TDEC Order CCR units." Per the June 14, 2016 Environmental Investigation Plan request letter from TDEC (Appendix A.2), the Kingston Recovery Project (KRP) Ash Landfill and Peninsula Disposal Area CCR units were not included in the TDEC Order due to prior considerations and work at those areas conducted pursuant to the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and other associated authorities aligned with the TDEC Order. Pursuant to the Administrative Order and Agreement on Consent, entered into between TVA and the United States Environmental Protection Agency (USEPA), and consistent with Title 40, Code of Federal Regulations (CFR). Part 257.101(g), the KRP Ash Landfill was deemed protectively closed on September 15, 2015 (USEPA 2015c). In accordance with the TDEC Order, TVA prepared an Environmental Investigation Plan (EIP) for the KIF Plant (TVA 2018) to obtain and provide information requested by TDEC. As specified in the TDEC Order, the objective of the EIP was to "identify the extent of soil, surface water, and ground water contamination by CCR" from onsite management of CCR material in the TDEC Order CCR units. In addition, per TDEC's information requests, the EIP included assessment of CCR unit structural stability and integrity. Between 2018 and 2024, TVA and Stantec implemented environmental investigation (EI) activities in accordance with the approved EIP. The EI included characterization of the site hydrogeology and investigations of CCR material, groundwater, background soils, and seeps, as well as a water use survey. Investigations associated with surface

streams, sediments, and ecology have been addressed as part of the KRP (described in Chapter 1.3.4), and the findings from those investigations and monitoring programs are incorporated into the EI.

The KIF Plant Environmental Assessment Report (EAR) (Kingston Environmental Assessment Report [tva.com]) presents the results of those investigations, describes the extent of surface stream water, sediment, and groundwater impacts, if any, from the KIF Plant TDEC Order CCR units, and provides the information, data, and evaluations used to make those assessments. The EAR identifies geotechnical analysis findings, and environmental sampling results above TDEC-approved screening levels in specific media, that require further evaluation in the CARA Plan to determine whether unacceptable risks exist that require corrective action. Most TDEC-approved EAR screening levels are not regulatory standards and are conservatively based on published health studies (Stantec 2021). Following completion of the EI, TVA conducted supplemental investigations and assessments to support the information presented herein. As such, information in this CARA Plan is based on EI data, TDEC Order groundwater investigations, results from other ongoing environmental programs, and additional data from supplemental investigations through May 2023.

This CARA Plan has been prepared pursuant to the TDEC Order and specifies the basis for and actions TVA plans to take at the KIF Plant TDEC Order CCR units, including actions related to unit closure, improving groundwater quality where needed, and mitigating unacceptable risks to human health and the environment, if present. Improving groundwater quality and mitigating unacceptable risks are accomplished by implementing a corrective action. More simply, a 'corrective action' is how TVA proposes to improve soil, surface water, or groundwater quality to address unacceptable risks, or to comply with groundwater regulatory requirements.

The actions recommended in this CARA Plan have been developed and evaluated based on regulatory requirements that govern CCR unit closure activities and groundwater protection, herein respectively called 'performance standards' and groundwater protection standards (GWPS). The GWPS established for the CARA Plan are based on regulatory standards (see Chapter 6) and are presented in Table 1-1. The regulatory framework applicable to the CARA Plan is described in Chapter 1.3 below. To determine the need for corrective action in sediment and surface water, the CARA Plan also includes an evaluation of potential risks to human health and ecological receptors at and near the KIF Plant. The KIF Plant Human Health and Ecological Risk Assessment (HHERA) (Stantec 2024) was prepared based on guidance published by the USEPA and is included as Appendix B.

Finally, as specified in the TDEC Order, the CARA Plan is subject to a public review and comment process and will not be finalized for TDEC approval until consideration of public comments is complete.

1.3 Regulatory Framework

The onsite management of CCR material and closure of the CCR units at the KIF Plant are subject to the following regulatory standards and requirements. Specific requirements in applicable regulations and orders governing the TDEC Order CCR unit closure and corrective actions are presented in Chapters 5 and 6, respectively.

1.3.1 TDEC Order

The TDEC Order was issued under the authority of the Tennessee Solid Waste Disposal Act to establish a process for investigating, assessing, and remediating unacceptable risks from management of CCR material at TVA coal-fired plants in the state of Tennessee. TDEC Order requirements for unit closure and remediation of unacceptable risks are applied to the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench CCR units at the KIF Plant in this CARA Plan. The TDEC Order states:

"The CARA Plan shall specify all actions TVA plans to take at the site and the basis of those actions. Corrective measures may include (1) soil, surface water, and ground water remediation, (2) risk assessment and institutional controls, or (3) no further corrective action. As appropriate for the site, the final approved CARA Plan shall include:

i. The method(s) TVA will employ to remove and/or close in place CCR material at the site;

ii. The method(s) TVA will employ to remediate CCR contaminated soil, surface water, and ground water at the site;

iii. The method(s) TVA proposes to restore any natural resources damaged as a result of the CCR waste water treatment and on-site CCR disposal;

iv. A plan for monitoring the air and water in the area during the cleanup process;

v. A plan to ensure that public and private water supplies are protected from CCR contamination and that alternative water supplies are provided to local citizens if CCR contamination above ground water protection standards is detected in ground water drinking wells; and,

vi. A plan addressing both the short-term and long-term management of CCR at the site, including remediation and stabilization of the CCR surface impoundment(s) and/or landfill and/or non-registered disposal site(s), to include design drawings and appropriate supporting engineering calculations."

Also, the TDEC Order requires that the CARA Plan include a schedule of activities to be completed, and that there is a public input process on the draft CARA Plan before it is approved by TDEC.

1.3.2 CCR Rule

The CCR Rule sets forth national criteria for the management of CCR material, was published by the USEPA on April 17, 2015, and can be found in Title 40, CFR Part 257, Subpart D (CCR Rule, USEPA 2015a). The rule includes criteria for monitoring groundwater and assessing corrective measures if constituents listed in Appendix IV of the CCR Rule are detected in samples collected from downgradient groundwater monitoring wells at statistically significant levels greater than established GWPS. Groundwater monitoring results and assessment of corrective measures are reported as required by the CCR Rule. TVA's CCR Rule Compliance Data and Information website is available for the public to view CCR Rule-required documents, including groundwater monitoring reports for the KIF Plant CCR units that are regulated by the CCR Rule, at the following location: Kingston Coal Combustion Residuals (tva.com).

The CCR Rule also sets forth criteria for CCR unit stability, closure and post-closure plans, designs, location demonstrations, and operating criteria demonstrations which are certified by a qualified professional engineer. In the CCR Rule, USEPA determined that either Closure-in-Place (CIP) or Closure-by-Removal (CBR) can be equally protective provided they are conducted properly.

Two of three TDEC Order CCR units at the KIF Plant are also subject to the CCR Rule: (1) the Stilling Pond and (2) the Sluice Trench and Area East of Sluice Trench. As specified by the CCR Rule, TVA has prepared separate closure and post-closure plans in accordance with those federal regulations and reporting requirements.

On May 8, 2024, USEPA published a rule amending the CCR Rule and setting national criteria for two additional categories of CCR units: legacy CCR surface impoundments and CCR management units (CCR Legacy Rule, USEPA 2024). This new rule is effective on November 8, 2024. TVA is in the beginning stages of determining its compliance

obligations under the CCR Legacy Rule. Any requirements in the CCR Legacy Rule that apply to the CCR units at the KIF Plant will be executed in accordance with the rule.

CCR Rule and CCR Legacy Rule closure and groundwater protection requirements are not specifically addressed in this CARA Plan, which is governed by the TDEC Order and State law. The closure performance standards and groundwater requirements addressed by the TDEC Order and State law are generally consistent with, and similar to, those in the CCR Rule and CCR Legacy Rule. Both sets of regulations are focused on protecting human health and the environment, ensuring that groundwater protection standards are met, and safely closing CCR units.

1.3.3 State Programs

In addition to the TDEC Order, TDEC has issued permits to TVA for ongoing CCR material management and wastewater discharges from the KIF Plant CCR units. Current permits include:

- TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM) - Class II Landfill Permit No. IDL 73-0094 for the KRP Ash Landfill.
- TDEC Rule 0400-11-01-.04 – DSWM Class II Landfill Permit No. IDL 73-000-0211 for the Peninsula Disposal Area.
- National Pollutant Discharge Elimination System (NPDES) Permit No. TN0005452. Permitted wastewater discharges are to the Clinch River Mile 2.9 via Outfalls 001 and 002.
- Tennessee Multi Sector Permit (TMSP) Tracking No. TNR051787. Notice of Coverage under the General NPDES Permit for storm water discharges associated with industrial activity. Storm water discharges are to the Clinch and Emory Rivers via multiple outfalls (which includes storm water discharges from the KIF Plant CCR units).

The Class II Landfill Permits for the KRP Ash Landfill and Peninsula Disposal Area, issued by TDEC after completion of all actions associated with compliance to the Administrative Order for the KRP, govern CCR material management, CCR unit closure, and groundwater protection by incorporating TDEC DSWM regulatory requirements. Records are maintained for groundwater monitoring well sample results and groundwater elevations throughout the life of the landfill, including the post-closure care period. Groundwater monitoring results are currently reported to TDEC at the intervals specified in the permit, and CCR unit closure and post-closure requirements are specified in the regulations. Specific closure and groundwater protection requirements of the TDEC DSWM regulations are described further in Chapters 5 and 6 below.

Under NPDES Permit No. TN0005452, outfall monitoring results are recorded and submitted monthly to TDEC's Division of Water Resources. NPDES permit discharge requirements are considered in this CARA Plan when additional discharge to surface water bodies is considered as part of a TDEC Order CCR unit corrective action.

1.3.3.1 Harvesting for Beneficial Use

The USEPA encourages the beneficial use of CCR material because the practice can result in environmental, economic, and product benefits. CCR material use replaces the need for virgin materials removed from the earth, thereby conserving natural resources and lowering greenhouse gas (GHG) emissions. CCR material can also improve the strength and durability of materials and reduce economic costs for CCR material disposal (USEPA 2023). Companies purchase and use CCR material as a replacement for Portland cement in concrete and to manufacture products like wallboard and roofing shingles that are used in construction projects across the United States. CCR material is also used for the

construction of buildings, roads, driveways, airport runways, bridges, and dams. Notable national monuments and infrastructure built with construction materials that included CCR material are the Oakland Bay Bridge, Hoover Dam, One World Trade Center, and the Washington DC Metro.

Beneficial use of CCR material in Tennessee is regulated by TDEC. Companies located in the Tennessee Valley that currently purchase TVA CCR material to incorporate into their products include Smyrna Ready Mix and Georgia-Pacific. These companies have strategically located their manufacturing plants near TVA plants resulting in jobs and other economic benefits to the Tennessee Valley. CCR material produced by TVA has been used in the construction materials for multiple projects in the Tennessee Valley including the concrete for the Riverwalk parking garage in Knoxville and the University of Tennessee Student Union building.

At the KIF Plant, TVA is currently implementing beneficial use by the harvesting of gypsum from the Peninsula Disposal Area under a TDEC-approved plan and is evaluating future harvesting of fly ash at the TDEC Order CCR units. High-quality gypsum generated by plant operations and harvested from the Peninsula Disposal Area is sold for the manufacture of wallboard, cement, and for agricultural applications.

Fly ash produced by the KIF Plant is certified for use in concrete road construction in multiple states and is supplied to over 200 concrete plants in the region. Every year, approximately 100,000 tons or 91% of the fly ash produced is beneficially used.

1.3.4 Kingston Recovery Project

On December 22, 2008, CCR material was released into the adjacent Swan Pond Embayment and subsequently into the Emory, Clinch, and Tennessee River systems as a result of a structural failure initiated in the northwestern corner of Ash Disposal Area Dredge Cell No. 2 (refer to Exhibit 1-2). TVA undertook immediate response actions beginning on the day of the failure in close coordination with the USEPA, TDEC, and other agencies. TVA and the USEPA signed an Administrative Order and Agreement on Consent that provided the regulatory framework for response and recovery actions under CERCLA. TDEC also issued Commissioner's Order No. OGC09-0001 to TVA requiring the comprehensive assessment, cleanup and restoration of areas impacted by the release. The recovery and restoration actions discussed herein are collectively referenced as the Kingston Recovery Project, or KRP. TVA's compliance with the USEPA Administrative Order and Agreement on Consent is documented in the Kingston Ash Recovery Project Completion Report (TVA 2015).

Following the immediate response actions, time-critical actions began following issuance of the Administrative Order and Agreement on Consent. These actions included the dredging and excavation of CCR material from the Emory River and Swan Pond Embayment, dewatering and processing of the recovered CCR material (including water management), loading of the dewatered CCR material into railcars, and transport of the CCR material to the Arrowhead Landfill in Perry County, Alabama per the Action Memorandum approved by USEPA (TVA 2009a). Time-critical dredging was not conducted below Emory River Mile 1.8 due to the presence of non-KIF Plant and non-CCR related legacy constituents (cesium-137) in the sediment.

Subsequent non-time-critical actions approved by USEPA (TVA 2012) included the removal of additional CCR material from the Swan Pond Embayment. CCR material removed as part of the non-time-critical actions was dewatered and placed in the KRP Ash Landfill. The KRP Ash Landfill was constructed with a perimeter containment system to withstand design earthquake loads and closed with the construction of a flexible membrane liner and soil cover system. The perimeter containment system (PCS) was designed to prevent offsite release of CCR material from the closed ash landfill,

for both long-term static conditions and during seismic loading. The PCS included a perimeter wall stabilization (PWS) component consisting of a grid of buried cement-bentonite walls constructed within a designated footprint around the KRP Ash Landfill perimeter (Exhibit 1-2). For purposes of the PWS design and construction, the perimeter was divided into eight segments. For each segment, one of three approved PWS configurations was constructed, depending upon the design requirements. These configurations include: two perimeter walls (inboard and outboard) that are connected by shear walls across the stabilized footprint; an inboard perimeter wall with shear walls extending the full width of the stabilized footprint; and shear walls (without perimeter walls) extending the full width of the stabilized footprint. The design requirements for each segment determined the width of the stabilized footprint, spacing between inboard and outboard walls (where applicable), spacing between shear walls, and depth of bedrock embedment.

Upon completion of the removal actions, an estimated 532,000 cubic yards of CCR material remained in the river system (TVA 2015). The Action Memorandum for the River System (TVA 2012) provided the justification for leaving that material in place to avoid impairing the ecological habitat or increasing short-term risks to human health or the environment associated with the presence of non-KIF Plant and non-CCR related legacy constituents (cesium-137) in the sediment. Monitored natural recovery (MNR) was the recommended action approved by the USEPA to address the residual CCR material in the river system. Long-term monitoring programs were developed to assess the effectiveness of MNR and confirm that risks associated with the CCR material release remain low. Long-term monitoring results are reported to TDEC and USEPA every two years. Every five years, the long-term monitoring activities are reviewed and adjusted as appropriate. This monitoring will continue for up to 30 years. The long-term monitoring results so far show that the MNR remedy is working as expected and that all remedial targets were achieved (Arcadis 2020).

1.4 Supplemental Investigations and Assessments

Supplemental investigations, approved by TDEC, were conducted after completion of EI activities to provide additional data or information to support the CARA Plan; additional investigations under separate regulatory programs also provided useful data for the CARA Plan. Additional assessments, including potential technology evaluations and groundwater flow and geochemical modeling, were performed to identify closure actions and corrective measure technologies that would meet or exceed regulatory performance standards and attain GWPS (Table 1-1).

Closure Method Assessment: The objective of this assessment was to provide a relative impact analysis of CIP and CBR to support the closure plans provided for each TDEC Order CCR unit in this CARA Plan. The assessment qualitatively evaluated 22 resource areas (e.g., air quality, surface water, transportation) as well as cumulative impacts and cost, and summarized the conclusions for each TDEC Order CCR unit. TVA's 2016 Programmatic Environmental Impact Statement (PEIS) identified these 22 resource areas as potentially being impacted by the closure alternatives considered. The evaluations of the potential impacts to each resource area are high-level qualitative analyses of existing environmental information from reports referenced in this CARA Plan and, where available, demographic, socioeconomic, environmental justice, and transportation information.

Corrective Measures Assessment: The overall objective of the corrective measures assessment was to identify corrective measure(s) to address unacceptable risks or regulatory compliance requirements within environmental media affected by KIF Plant TDEC Order CCR units. The corrective measures assessment used information obtained from the EI and other ongoing programs, including information gained though the supplemental investigations described below, to evaluate corrective measure technologies that can potentially meet applicable regulatory standards (i.e., attainment of GWPS as discussed in Chapter 6.1). Retained technologies were developed into corrective measure alternatives. Generally, to select a corrective measure alternative, the alternatives were evaluated based on a range of factors such as

effectiveness, certainty of success, implementability, and community concerns. Any planned corrective measure must also satisfy regulatory standards.

Groundwater Flow Modeling: The overall objective of the modeling activities was to create a quantitative tool capable of predicting groundwater flow under varying conditions to evaluate groundwater management scenarios and corrective measure strategies for the KIF Plant. Specific objectives included developing and calibrating a numerical groundwater flow model, simulating baseline groundwater flow conditions to reflect the hydrogeologic conceptual site model (CSM) and providing a framework for predictive modeling simulations to support the CARA Plan.

Geochemical Modeling: The purpose of the geochemical modeling activities was to evaluate potential source control measures and inform potential groundwater corrective measures using site-specific geochemical data from the KIF Plant. To support the geochemical modeling, an investigation was conducted to collect additional site-specific data to supplement the dataset collected during the EI. The scope of work included collection of soil, groundwater, and pore water samples for analysis of geochemical constituents and parameters, evaluation of analytical data for use in the geochemical model, and evaluation of geochemical model outputs for groundwater corrective measure options.

***In Situ* Treatment Evaluation:** Treatability testing was performed to evaluate the viability of using *in situ* treatment as a corrective measure technology to address cobalt in groundwater at concentrations above GWPS. The testing evaluated various reagents and processes to promote cobalt attenuation in a laboratory setting prior to a field application. Additionally, *in situ* delivery methods were evaluated for the reagents based on reagent disposition, permeable reactive treatment configurations, site conditions, and operational constraints. As part of this evaluation, supplemental *in situ* groundwater treatment investigations were conducted to augment the dataset collected during the EI. The scope of work included drilling and sampling of soil and the collection of bulk groundwater samples for use in treatability testing.

Groundwater Extraction Evaluation: The objective of the groundwater extraction evaluation was to assess available groundwater extraction technologies that can hydraulically control groundwater in the uppermost aquifer in areas with CCR constituents at statistically significant concentrations above the GWPS. The evaluation included the rationale and design of the groundwater extraction systems being considered.

Pore Water Extraction Evaluation: The purpose of the pore water extraction evaluation was to assess pore water removal (extraction) technologies that may lower the phreatic surface (as defined in Chapter 2.2.4) within the KIF Plant TDEC Order CCR units. The evaluation included a summary of the design considerations used to identify suitable active pore water extraction systems, and a review and comparison of the technologies considered to be suitable for the long-term pore water extraction at the TDEC Order CCR units. Based on site-specific conditions at each TDEC Order CCR unit, specific active pore water extraction technologies were identified where applicable. Pore water extraction pilot testing activities have been conducted to determine if full-scale implementation of this technology will be feasible and effective at the Sluice Trench and Area East of Sluice Trench and potentially other CCR units governed by the TDEC Order. Results of the pilot test are included in Appendix K.2 – Pore Water Extraction Pilot Test Evaluation.

Post-Closure Groundwater Quality Evaluation: The objective of the post-closure groundwater quality evaluation was to conduct a statistical evaluation of groundwater data following closure of the Stilling Pond and Sluice Trench and Area East of Sluice Trench to identify if there have been statistically significant changes in groundwater quality following completion of closure. Statistically significant changes in groundwater quality were identified by comparing groundwater quality constituent concentrations prior to completion of the geosynthetic cover systems to constituent concentrations following completion of the cover systems.

1.5 Key Milestones

A chronology of key milestones and events related to the TDEC Order CARA Plan that occurred following approval of the EIP is provided below.

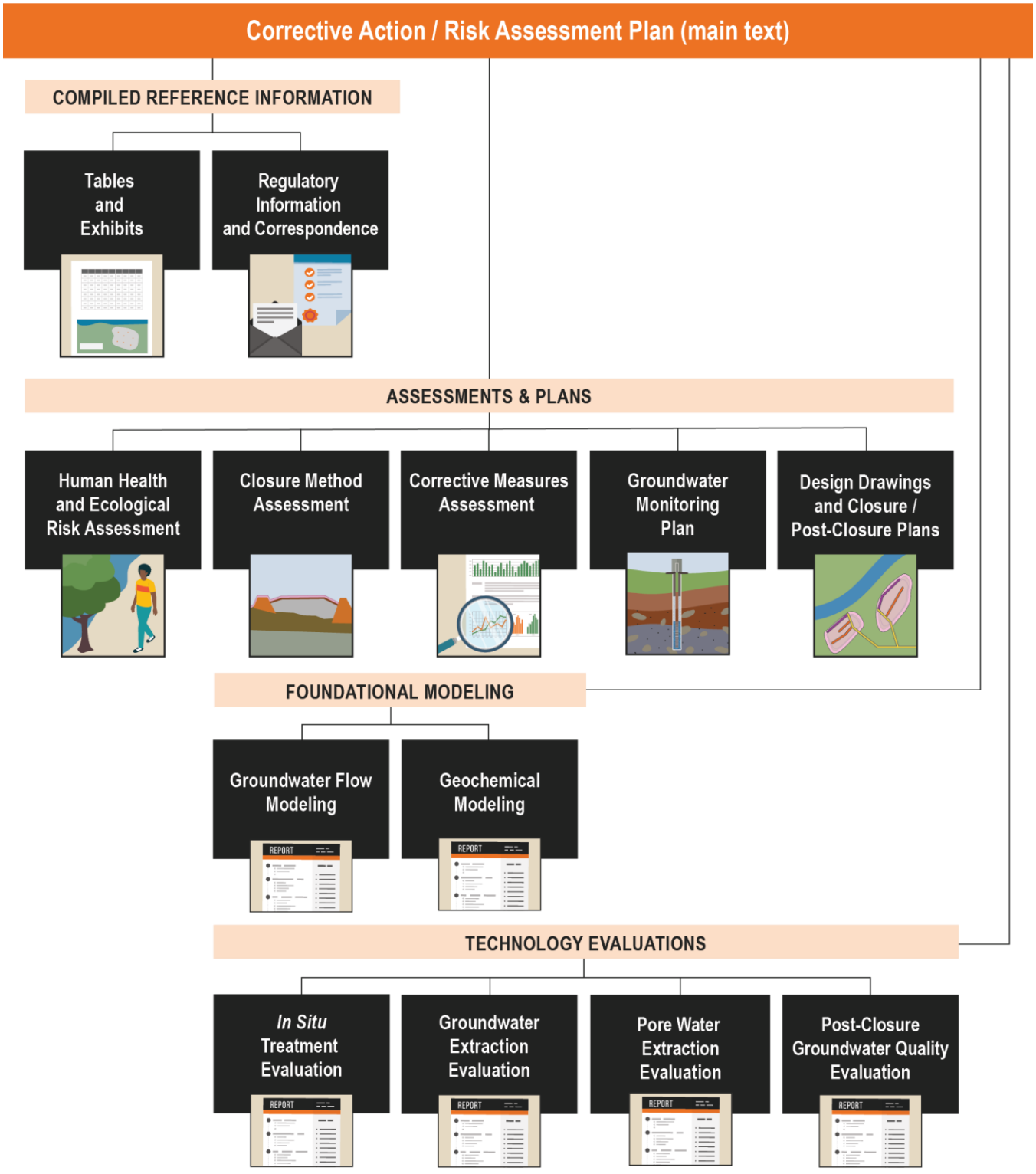
Date	Event
October 1, 2018	Phase 1 EI field activities commence to support CCR Rule
November 16, 2018	TDEC approval of KIF Plant EIP Revision 4
December 17, 2018	Kickoff meeting held with TVA and TDEC to discuss implementation of EIP
December 6, 2019	Phase 1 EI field activities substantially complete (excluding Phase 2 Sampling and Water Use Survey)
June 17, 2020	Initial Sampling and Analysis Report submitted to TDEC
January 25, 2021	Phase 2 field activities commence
February 26, 2021	Phase 2 field activities complete
March 28, 2023	Last Sampling and Analysis Report accepted by TDEC
May 30, 2023	Submittal of KIF Plant EAR Revision 0 to TDEC
August 16, 2023	TDEC comments on KIF Plant EAR Revision 0
November 14, 2023	Submittal of KIF Plant EAR Revision 1 to TDEC
January 12, 2024	TDEC acceptance of KIF Plant EAR Revision 1 and Initiation of Water Use Survey
January 18, 2024	TDEC acceptance of Pore Water Extraction Pilot Test Work Plan
March 12, 2024	Submittal of KIF Plant EAR Revision 2 to TDEC
April 22, 2024	TDEC acceptance of KIF Plant EAR Revision 2
June 10, 2024	TDEC approval of CARA Revision 0 deadline extension
July 30 – September 13, 2024	Pore Water Pilot Test 1
July 31, 2024	Submittal of Draft KIF Plant HHERA Revision 0 to TDEC
September 13 – October 28, 2024	Pore Water Pilot Test 1 Recovery Monitoring Period
September 20, 2024	Submittal of Draft KIF Plant CARA Plan Revision 0 to TDEC
November 11, 2024 – January 6, 2025	Pore Water Pilot Test 2
January 6 – February 20, 2025	Pore Water Pilot Test 2 Recovery Monitoring Period
April 17, 2025	TDEC approval of CARA Revision 1 deadline extension
July 18, 2025	TDEC approval of CARA Revision 1 deadline extension
September 19, 2025	Submittal of Draft KIF Plant CARA Plan Revision 1

1.6 Report Organization

This CARA Plan is based on EI data, TDEC Order groundwater investigations, and results from other ongoing environmental programs obtained for the KIF Plant CCR units through December 2022 and additional data from supplemental investigations through May 2023. This CARA Plan presents the basis for and planned methods of CCR unit closure, and corrective action of contaminated media.

This main document of the CARA Plan provides a summary of KIF Plant site background information, EI sampling results, and risk assessment findings. Following these summary materials, it presents the applicable State requirements that govern CCR unit closure and corrective action, and the evaluation processes used to identify the closure method and corrective action(s) (if warranted) for each of the KIF Plant TDEC Order CCR units. As required by the TDEC Order, information regarding natural resource restoration, air and water management, water supply protection, and long- and short-term management of CCR material is also provided. Appendices to this CARA Plan provide modeling and supplemental investigation information used to support TVA's planned closure method and corrective actions for the KIF Plant TDEC Order CCR units to address TDEC Order and TDEC DSWM requirements.

The structure of the overall document is provided in the diagram below:



This CARA Plan is organized as follows:

- **Executive Summary**: Describes the principal elements of the closure and corrective actions presented in the CARA Plan and the basis for these actions.
- **Chapter 1 – Introduction:** Describes the background of the TDEC Order and purpose of the CARA Plan, regulatory framework, public and agency involvement, an overview of the supplemental investigations and assessments completed to support the CARA Plan, and document organization.
- **Chapter 2 – Site Background:** Presents the historical and current operational activities, regional and plant-specific geology, surface water hydrology, and hydrogeology of the KIF Plant.
- **Chapter 3 – TDEC Order Investigation Summary and Conceptual Site Models:** Summarizes the TDEC Order investigation findings and CSMs for the TDEC Order CCR units based on the EI and associated historical and ongoing program results.
- **Chapter 4 – Human Health and Ecological Risk Assessment Summary:** Summarizes the components that form the basis and the results of the HHERA. The results of the risk assessment are used in the CARA Plan to evaluate whether corrective action(s) are needed, and if so, provide information for the schedule for implementation. Based on the results of the HHERA, this chapter provides a summary of the environmental media, locations, and CCR constituents requiring further evaluation for corrective action in this CARA Plan.
- **Chapter 5 – Basis and Methods of CCR Unit Closure:** Provides an overview of CIP and CBR methods, the applicable State requirements that govern CCR unit closure, and programmatic National Environmental Policy Act (NEPA) findings and site-specific evaluations regarding both closure methods for the KIF Plant TDEC Order CCR units. Based on these evaluations, the planned closure method and applicable additional closure actions for each of the three TDEC Order CCR units at the KIF Plant are presented.
- **Chapter 6 – Basis and Methods of CCR Unit Corrective Action:** Describes the applicable State requirements that govern CCR unit corrective action, the process used to evaluate corrective measures considered for corrective action(s), and the planned corrective action(s) as applicable for the TDEC Order CCR units at the KIF Plant.
- **Chapter 7 – Supporting Plans:** Describes the scope of the supporting plans to meet the requirements presented in the TDEC Order related to natural resources restoration, air and water monitoring during implementation of corrective actions, a site-wide groundwater monitoring plan, water supply protection, and short-term and long-term management of CCR material, as appropriate for the KIF Plant.
- **Chapter 8 – Summary and Next Steps:** Presents a summary of TVA's basis for the planned CCR unit closure and groundwater corrective action at the KIF Plant for the TDEC Order CCR units. Next steps, including TVA's public involvement approach to finalize this plan, and the implementation schedule for the CARA Plan are also discussed.
- **Chapter 9 – References**: List of documents referenced in the CARA Plan main text.
- **Tables and Exhibits:** Tables and Exhibits are presented following the main text of this report and are numbered according to the chapter in which they are first presented.

- **Appendices:** The Appendices include regulatory information and correspondence, the HHERA Report, and technical memoranda which inform the evaluation of additional closure activities and potential corrective measures. Also included as an appendix are design drawings for the closure and corrective actions identified in this CARA Plan, and a groundwater monitoring plan that would be implemented following approval of the CARA Plan. Below is the list of appendices:
    - Appendix A – Regulatory Information and Correspondence
    - Appendix B – Human Health and Ecological Risk Assessment
    - Appendix C – Closure Method Assessment
    - Appendix D – Corrective Measures Assessment
    - Appendix E – Groundwater Monitoring Plan
    - Appendix F – Design Drawings and Closure/Post-Closure Plans
    - Appendix G – Groundwater Flow Modeling
    - Appendix H – Geochemical Modeling
    - Appendix I – *In situ* Treatment Evaluation
    - Appendix J – Groundwater Extraction Evaluation
    - Appendix K – Pore Water Extraction Evaluation
    - Appendix L – Post-Closure Groundwater Quality Evaluation

Chapter 2 Site Background

This chapter describes KIF Plant CCR unit background information, including historical and current operational activities, regional and plant-specific geology, surface water hydrology, and hydrogeology.

2.1 Site Operations, CCR Units, and Land Use

TVA constructed the KIF Plant between 1951 and 1954, commencing power generation in 1954. TVA operates the nine-unit KIF Plant that annually generates approximately 10 billion kilowatt-hours of electricity (i.e., enough to supply 700,000 homes). Daily, the KIF Plant uses an average of 14,000 tons of coal and produces about 122,000 tons of CCR material annually in the forms of fly ash, bottom ash, and gypsum (TVA 2022a). Both fly ash and gypsum generated from the KIF Plant operations are beneficially used as raw manufacturing materials (TVA 2022b). Of the approximately 122,000 tons of CCR material produced each year, approximately 101,000 tons are beneficially used. On average, approximately 91 percent (%) of the fly ash generated at the KIF Plant is sold as a product to the concrete industry where it is used in roads, bridges, buildings, airport runways, dams, precast concrete products, and driveways. Concrete with fly ash is stronger, more durable, lower cost, and environmentally friendly because every ton of fly ash that replaces Portland cement reduces carbon emissions by one ton (TVA 2019c). The KIF Plant supplies fly ash to over 75 concrete plants in five different states (TVA 2022b). Approximately 84% of the gypsum generated annually at the KIF Plant is sold as a product to Georgia-Pacific Gypsum LLC for use in the wallboard industry and CEMEX Knoxville to manufacture ready mix concrete. This type of gypsum conserves natural resources by replacing mined natural gypsum (TVA 2022b).

The KIF Plant has a total of five CCR units, as shown on Exhibit 2-1: the Stilling Pond, Interim Ash Staging Area, Sluice Trench and Area East of Sluice Trench, which are surface impoundments, and the Peninsula Disposal Area and KRP Ash Landfill, which are landfills. Three of these CCR units are included in the TDEC Order, as shown on Exhibit 2-1: the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench. The total area of all five CCR units is approximately 395 acres. The total area of the three TDEC Order CCR units is approximately 100 acres. TVA currently manages CCR material at the KIF Plant in the Peninsula Disposal Area landfill. Fly ash that is not beneficially used is transported by truck to the Peninsula Disposal Area. Dewatered gypsum is temporarily stockpiled in the Peninsula Disposal Area for later beneficial use. Reject gypsum (gypsum fines) are disposed within the Peninsula Disposal Area. Bottom ash is sluiced to the Bottom Ash Dewatering Facility where it is dewatered and then transported by truck to the Peninsula Disposal Area for disposal.

TVA implements a comprehensive set of environmental protection measures as part of the operational activities at the Peninsula Disposal Area, as well as at the inactive KRP Ash Landfill, Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench CCR units. These best management practices include erosion protection and sediment control measures, spill prevention, stormwater management, and dust mitigation measures. These protection measures are in place to control release of CCR material into ambient air, and surrounding soil, surface water, or groundwater.

TVA issued a record of decision, after completion of a NEPA Environmental Impact Statement that evaluated a reasonable range of options, to retire the KIF Plant and construct a single natural gas-fired combined cycle plant, dual-fuel aeroderivative combustion turbine plant, new switchyard, three to four megawatt (MW) solar site, 100 MW lithium-ion battery energy storage system, and new transmission line infrastructure, paired with a 122-mile natural gas pipeline that will be owned and operated by others (TVA 2024a and 2024b). Construction of this infrastructure will advance TVA’s

Strategic Intent and Guiding Principles to execute a plan to 70% carbon reduction by 2030, develop a path to 80% reduction by 2035, and aspire to achieve net-zero carbon reduction by 2050. Additional information about this decision is provided here: TVA to Retire Kingston, Build State-of-the-Art Energy Complex.

Land use surrounding the KIF Plant is primarily developed, and includes residential, commercial, and some forest areas, with the nearest residence located approximately 0.4 miles south of the KIF Plant in Harriman. Additionally, four municipal water departments withdraw water from the Emory River, Little Emory River, and Watts Bar Lake for municipal purposes in the vicinity of the KIF Plant, as follows (TVA 2022c).

- The Roane Central Water District supplies public water to areas west and southwest of the KIF Plant with water sourced from the Rockwood Water Utility approximately five miles southwest and downstream of the plant. The Rockwood Water Utility obtains water from Watts Bar Reservoir near the Postoak Creek inlet.
- The Harriman Utility Board supplies public water to areas north and northwest of the KIF Plant with water sourced from the Emory River approximately 2.5 miles northwest and upstream of the plant.
- The Kingston Water Department supplies public water to areas south and southeast, including the KIF Plant, with water sourced from Watts Bar Reservoir approximately two miles south and downstream of the plant, but slightly upstream of the confluence of the Emory and Clinch Rivers.
- The Cumberland Water Utility supplies public water to areas east and northeast of the KIF Plant with water sourced from the Little Emory River approximately four miles northeast and upstream of the KIF Plant.

2.1.1 CCR Unit Summary

A description of each KIF Plant TDEC Order CCR unit, including current operational information, is provided below.

2.1.1.1 Stilling Pond

The Stilling Pond is a closed surface impoundment that covers about 40 acres and is bounded by dikes. CCR material present in the Stilling Pond is sluiced ash. The estimated total volume of CCR material is about 800,000 cubic yards (TVA 2024c). Stormwater flows discharge to the Emory River through Outfall F22 in accordance with the TMSP.

The Stilling Pond ceased receiving CCR material in 2015 and was closed in 2018 (Stantec 2018). The closure included the removal of free water, partial excavation of Dike C for borrow material, and the construction of a geosynthetic soil cover system (Stantec 2017a, 2017b, 2018). The cover system contains (from bottom to top) a geotextile cushion, a 40-mil Linear Low-Density Polyethylene (LLDPE) geomembrane, a geocomposite drainage layer, an 18-inch cover soil layer, and a six-inch vegetative cover (Stantec 2017a, 2017b, and 2018).

TVA completes post-closure care activities in accordance with the closure and post-closure plans submitted to TDEC and prepared per CCR Rule requirements (Stantec 2017 and 2017b). Post-closure care activities include vegetative cover monitoring and maintenance, maintaining the approved final contours, drainage and groundwater monitoring system maintenance, groundwater sampling, analysis, and reporting, and post-closure inspections.

2.1.1.2 Interim Ash Staging Area

The Interim Ash Staging Area is a closed CCR unit that covers about 40 acres. CCR material present in the Interim Ash Staging Area is stacked ash over sluiced ash. The estimated total volume of CCR material is about 3 million cubic yards. Stormwater runoff from the Interim Ash Staging Area discharges to the Emory River through Outfall F21 in accordance with the TMSP.

The Interim Ash Staging Area ceased receiving CCR material in 1965 when it reached capacity. It served as a temporary staging area for CCR material during river dredging operations and construction of the KRP Ash Landfill following the Dredge Cell failure in 2008. Activities to prepare the area for temporary CCR material staging included the installation of prefabricated vertical wick drains to expedite the consolidation of the underlying ash and alluvium, for the purpose of improving foundation strength/stability (TVA 2009b). TVA constructed the Bottom Ash Dewatering Facility in 2015 to support the transition from wet to dry CCR material handling. The Bottom Ash Dewatering Facility is currently active. The Interim Ash Staging Area was closed in 2016. The closure included the removal of staged CCR material and construction of an engineered soil cover system over most of the CCR unit (AECOM 2016). A final cover system has not been constructed at the Bottom Ash Dewatering Facility.

Post-closure care activities include vegetative cover monitoring and maintenance, maintaining the approved final contours, drainage systems maintenance, and post-closure inspections. Routine groundwater sampling and analysis for this CCR unit is conducted in association with the Sluice Trench and Area East of Sluice Trench.

2.1.1.3 Sluice Trench and Area East of Sluice Trench

The Sluice Trench and Area East of Sluice Trench is a closed surface impoundment that covers about 20 acres and is bounded by a dike. CCR material present in the Sluice Trench and Area of East of Sluice Trench is stacked ash over sluiced ash. The estimated total volume of CCR material is about 900,000 cubic yards. Stormwater runoff from the Sluice Trench and Area East of Sluice Trench discharges to the Emory River through Outfall F24 in accordance with the TMSP.

The Sluice Trench and Area East of Sluice Trench ceased receiving CCR material in 2015. TVA completed the construction of a seepage collection system and reverse graded filter at the Sluice Trench and Area East of Sluice Trench in 2017. The seepage collection system discharges seep water to the Polishing Pond for treatment prior to discharging to NPDES-permitted Outfall 001. The Water Quality Channel and Polishing Pond (Exhibit 2-1) were constructed in the Sluice Trench and Area East of Sluice Trench in 2015 to support the transition from wet to dry CCR material handling. The Sluice Trench and Area East of Sluice Trench was closed in 2018 (AECOM 2019). The Water Quality Channel and Polishing Pond areas of the Sluice Trench and Area East of Sluice Trench were closed using a geosynthetic liner system (AECOM 2018, Trans-Ash 2015). The area between the Water Quality Channel and the Bottom Ash Dewatering Facility was closed with an engineered soil cover system. The remaining area was closed using a geosynthetic soil cover system (AECOM 2018). The geosynthetic soil cover system contains (from bottom to top) a 40-mil geomembrane, a geocomposite drainage layer, and a 24-inch layer of cover soil, of which the top six inches can support vegetation (AECOM 2018).

TVA completes post-closure care activities in accordance with the closure and post-closure plans prepared per CCR Rule requirements (AECOM 2018). Post-closure care activities include vegetative cover monitoring and maintenance, maintaining the approved final contours, drainage and groundwater monitoring system maintenance, groundwater sampling, analysis, and reporting, and post-closure inspections.

2.2 Geology, Surface Water Hydrology, and Hydrogeology

The KIF Plant is located in the Valley and Ridge province in the Appalachian Mountains. Regionally, the Valley and Ridge province consists of a belt of northeast-southwest trending ridges and valleys formed by differential erosion of a thick sequence of folded and faulted Paleozoic rocks (United States Geological Survey [USGS] 1995). Much of the valleys are made up of limestones and shales which are more susceptible to erosion, while the more resistant sandstones and conglomerates form the ridges (USGS 1978). The folded strata are the result of the thrust faulting and the various deformation events that produced the Appalachian Mountains (USGS 1979). The folding is less intense in the Tennessee portion of the province, but major faults are common and vertical to overturned beds appear in many places, particularly on the northwestern sides of anticlines (USGS 1997).

2.2.1 Geology

Locally, structural geology at the KIF Plant is typical of the Valley and Ridge province and consists of northeast striking and southeast-dipping strata (TVA 1991). Bedding planes dip to the southeast and have been primarily controlled by the Chattanooga Thrust Fault and the Kingston Thrust Fault, which trend in a northeasterly direction and can be traced from northwest Georgia to Central Virginia (TVA 2018). Local geologic mapping indicates the plant is underlain by Cambrian and Ordovician age bedrock of the Rome Formation, Conasauga Group, and the Knox Group, as shown on Exhibit 2-2. The bedrock primarily consists of shale with interbedded siltstone, limestone, and conglomerate, and is locally of low groundwater-producing capacity. Cores collected from the KRP Ash Landfill had bedding contact angles of 10 to 30 degrees from horizontal (AECOM 2009). Borehole geophysics conducted at boring AD-2-D (located east of the Sluice Trench) indicated a statistical mean bedding plane dip of 41 degrees toward the southeast in the Conasauga Formation. The band of Rome Formation on the northwest side of the KIF Plant, along with the overlying Conasauga and Knox Formations, represent a thrust fault block which has been forced over the Knox Group outcrop to the northwest. The two major faults associated with this thrust block constitute the two closest faults to the KIF Plant (TVA 2004). Unconsolidated deposits overlay the bedrock and can be divided into two categories: (1) alluvial clays, silts, sands, and gravels deposited by the Clinch River and its tributaries, and (2) residuum derived from the decomposition of the parent bedrocks (TVA 2004).

2.2.2 Surface Water Hydrology

The KIF Plant is located at the confluence of the Emory River and Clinch River (Exhibit 2-1). The Emory River flows in a northwest to southeast direction and the Clinch River flows in a northeast to southwest direction. Both the Emory River and Clinch River are impounded by Watts Bar Dam. In accordance with the TVA Watts Bar Operating Guide (TVA 2022d), normal summer pool for Watts Bar Reservoir is maintained between 740 and 741 feet above mean sea level (amsl); normal winter pool is maintained between 735 and 737 feet amsl. Prior to the construction of Watts Bar Dam, Swan Pond Creek followed a meandering course through the KIF Plant footprint and discharged to the Emory River (Exhibit 2-3); however, the construction of Watts Bar Dam circa 1942 created a backwater area that impounded Swan Pond Creek along with the Emory and Clinch Rivers. No springs were identified in the Water Use Survey Area.

The complex surface water hydrology at the KIF Plant is influenced by structures constructed to divert cold water to the Plant Intake Channel as well as conditions in Watts Bar Reservoir. These structures include an underwater dam located on the Clinch River that diverts cold water upstream along the bottom of the Emory River to the Plant Intake Channel and a skimmer wall that restricts warmer water from flowing into the Plant Intake Channel (Exhibit 2-1). Wave action in Watts Bar Reservoir temporarily induces reverse flows in the vicinity of the KIF Plant. Cold water discharges from Melton Hill

Dam, located approximately 19 miles upstream of the KIF Plant on the Clinch River, also influence thermal stratification near the KIF Plant.

2.2.3 Regional Hydrogeology

The Valley and Ridge province is underlain by carbonate bedrock aquifers of Cambrian, Ordovician, and Mississippian age (USGS 1995). On a regional level, these aquifers underlie more than half of the province and are typically present in valleys and rarely present on the broad, dissected ridges.

Groundwater in the Valley and Ridge aquifers primarily is stored in and moves through fractures, bedding planes, and solution openings in the rocks. Groundwater movement in the province in eastern Tennessee is localized in part by the repeating lithology created by thrust faulting and in part by streams. Major streams are parallel to the northeast-trending valleys and ridges, and tributary streams are perpendicular to the valleys and ridges. Older rocks have been displaced over younger rocks along thrust faults forming a repeating sequence of permeable and less permeable hydrogeologic units. The repeating sequence, coupled with the stream network, divides the area into a series of adjacent, isolated, shallow groundwater flow systems. Within these local flow systems, most of the groundwater movement takes place within 300 feet of land surface. The water moves from the ridges toward the adjacent streams that flow parallel to the long axes of the valleys. The majority of the groundwater is discharged directly to local springs or streams, but some of it flows along permeable fractures, bedding planes, and solution zones to finally discharge at more distant springs or streams.

2.2.4 Plant Hydrogeology

This subchapter describes the hydrogeology of the KIF Plant. Prior to discussing the plant hydrogeology, the following provides definitions and illustrations of hydrogeological terms.

2.2.4.1 Hydrogeological Terms

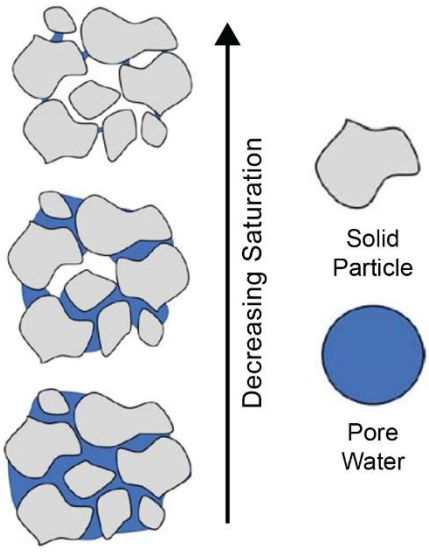
For purposes of this document, the following hydrogeological terms as they are defined below are used throughout this document.

- Pore water - subsurface water that occurs in pore spaces in CCR material.
- Groundwater - subsurface water that occurs in pore spaces in unconsolidated or geologic materials (e.g., soil, bedrock).
- Aquifer - a geologic formation capable of yielding useable quantities of groundwater.
- Unconfined aquifer - an aquifer in which the water table forms the upper boundary.
- Saturated - unconsolidated or geologic materials (e.g., soil, bedrock) or CCR material where all of the pore space is filled with water. The use of the term “saturated” in references to the moisture content of CCR material does not imply that the pore water is readily separable from the CCR material.
- Moisture content - the measure of the amount of water contained within unconsolidated or geologic materials (e.g., soil, bedrock) or CCR material. Moisture content of saturated material can be variable because the characteristics of the material determine the amount of pore space available for water to fill.

- Phreatic surface - the surface of pore water at which pressure is atmospheric and below which CCR material may be saturated with pore water. Pore water levels are measured at locations where temporary wells or piezometers were installed within CCR material. The measured pore water levels are used to infer pore water levels between the wells and piezometers to develop the phreatic surface.
- Uppermost aquifer - the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within a facility's property boundary.
- Water table - the surface of groundwater at which pressure is atmospheric and below which geologic materials (e.g., soil or bedrock) may be saturated with groundwater. The measured groundwater levels are used to infer groundwater levels between the wells and piezometers to develop the water table surface. Groundwater levels are measured at locations where wells or piezometers were installed at depths near the water table surface.

Groundwater level measurements from wells or piezometers installed around the CCR units and at multiple depths below the water table provide information about the direction of groundwater movement.

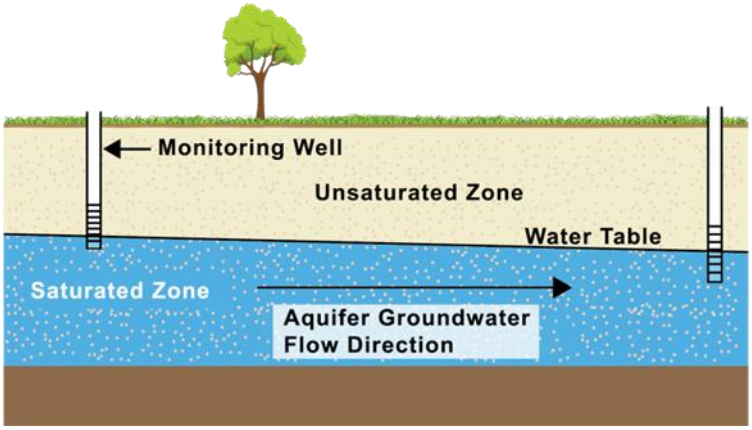
Pore Water



Benson, C., *Water Flow in Coal Combustion Products and Drainage of Free Water*, Report No. 3002021963, Electric Power Research Institute, Palo Alto, CA.

This figure depicts how subsurface water occurs in the pore spaces in CCR material (referred to as "pore water" in this CARA Plan), and how saturation varies within the CCR material. The phreatic surface is the surface of pore water at which pressure is atmospheric and below which CCR material may be saturated with pore water.

Unconfined Aquifer



Groundwater is subsurface water that occurs in pore spaces in soil or bedrock. Groundwater level measurements taken in a well screened near the water table in an unconfined aquifer represent the water level in the aquifer. Groundwater level measurements are used to estimate directions of groundwater movement. Groundwater generally flows much more slowly than water in a surface stream or river.

2.2.4.2 KIF Plant Hydrogeology

Groundwater flows by gravity from areas of higher groundwater elevations to areas of lower elevations along flow paths that are generally perpendicular to groundwater elevation contours. Physiographic and hydrogeological features affect how groundwater flows. Hydrogeological barriers (i.e., rivers and surface streams) and divides (i.e., ridges that form watershed boundaries) bound the extent of groundwater flow. Groundwater flows toward, but not across, hydrogeological barriers and away from hydrogeological divides.

Hydrostratigraphic units are geological formations that are defined to characterize the hydrogeology of the KIF Plant to understand where and how groundwater is flowing. In saturated geological formations that have higher permeability than adjacent formations, groundwater flows in a mostly horizontal direction. In saturated geological formations that have lower permeability than adjacent formations, groundwater flows in a more vertical direction. The more permeable geological formations capable of yielding useable quantities of groundwater are called aquifers. Aquifers are targeted for development as water sources by property owners. The hydraulic characteristics of hydrostratigraphic units are used to classify aquifers. If an aquifer's upper boundary forms the water table, then it is called an unconfined aquifer.

The following figures show three-dimensional representations of the various geological deposits and CCR material at the KIF Plant. In the first figure, the CCR material is colored gray with striping, and the fine-grained unconsolidated materials are colored orange. The second figure shows the unconsolidated materials with the CCR material removed. In the third and fourth figures, the coarse-grained unconsolidated materials are colored light yellow, and the bedrock surface is colored gray. The fill dikes surrounding the CCR units are colored brown.

KIF Plant CCR and Unconsolidated Materials

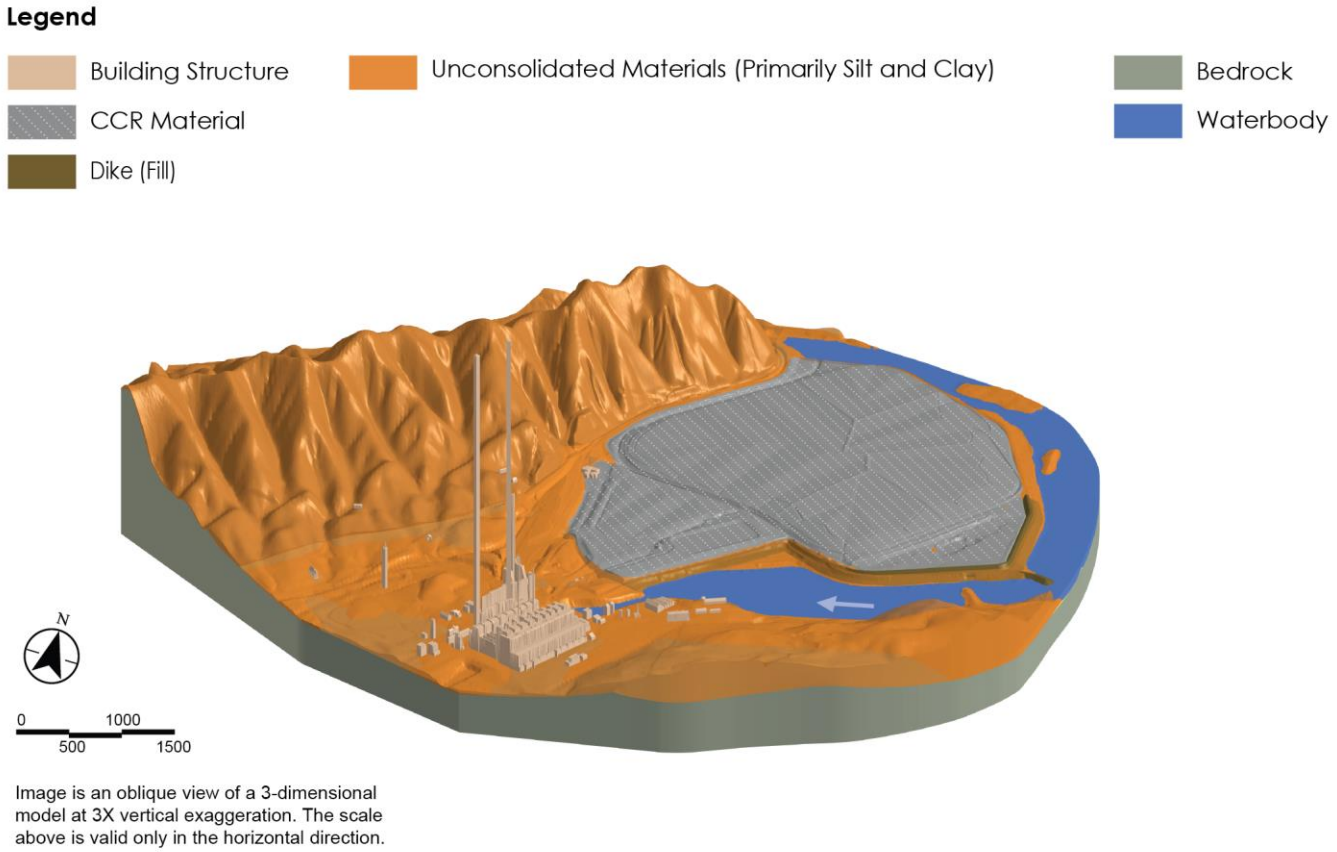


Image is an oblique view of a 3-dimensional model at 3X vertical exaggeration. The scale above is valid only in the horizontal direction.

KIF Plant Fine-Grained Unconsolidated Materials (Primarily Silt and Clay)

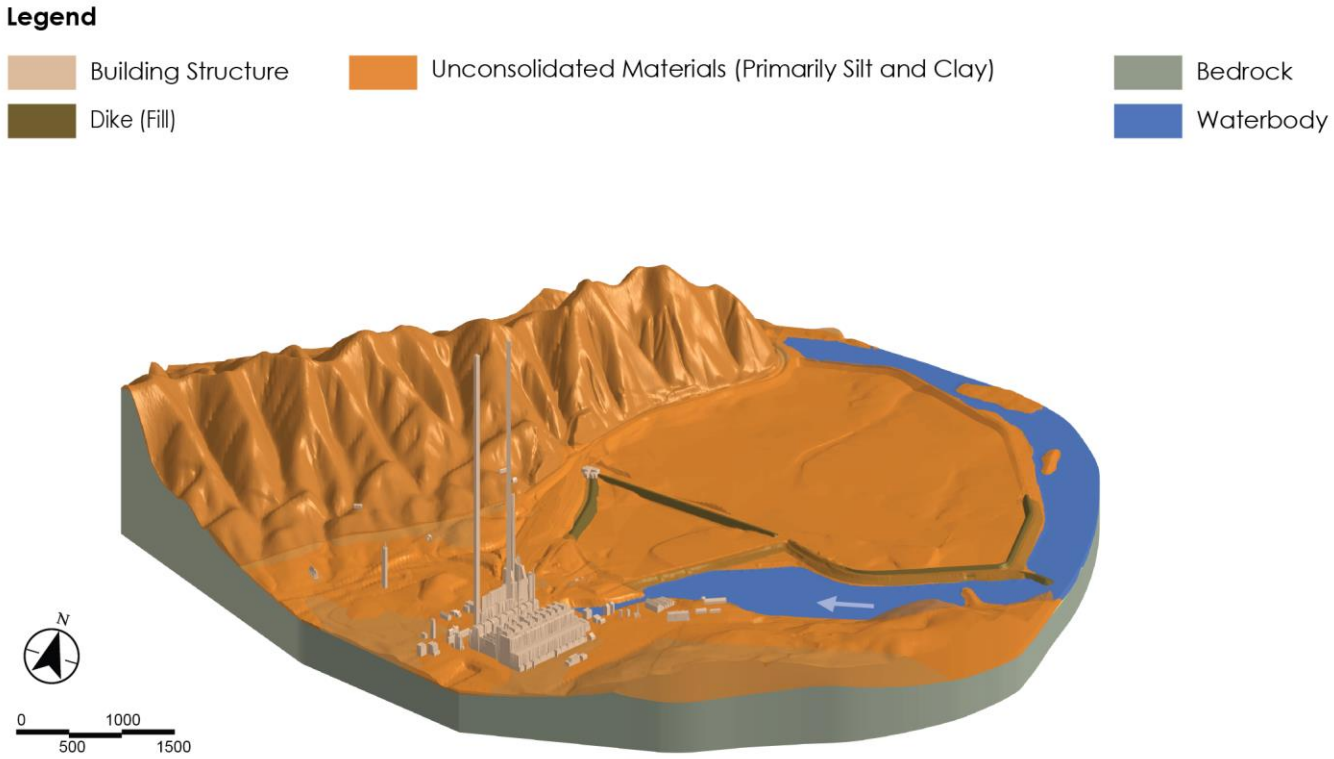


Image is an oblique view of a 3-dimensional model at 3X vertical exaggeration. The scale above is valid only in the horizontal direction.

KIF Plant Coarse-Grained Unconsolidated Materials (Primarily Sand and Silty Sand)

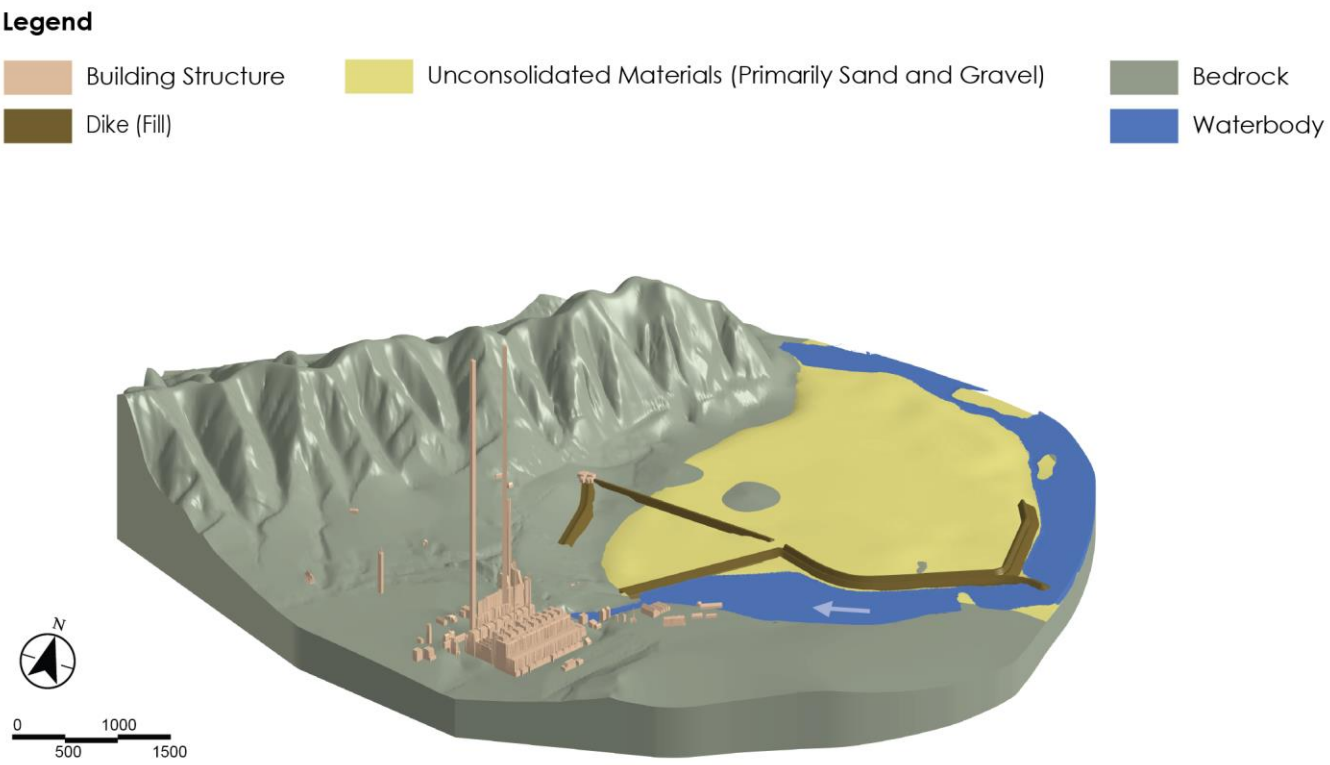


Image is an oblique view of a 3-dimensional model at 3X vertical exaggeration. The scale above is valid only in the horizontal direction.

KIF Plant Bedrock Surface

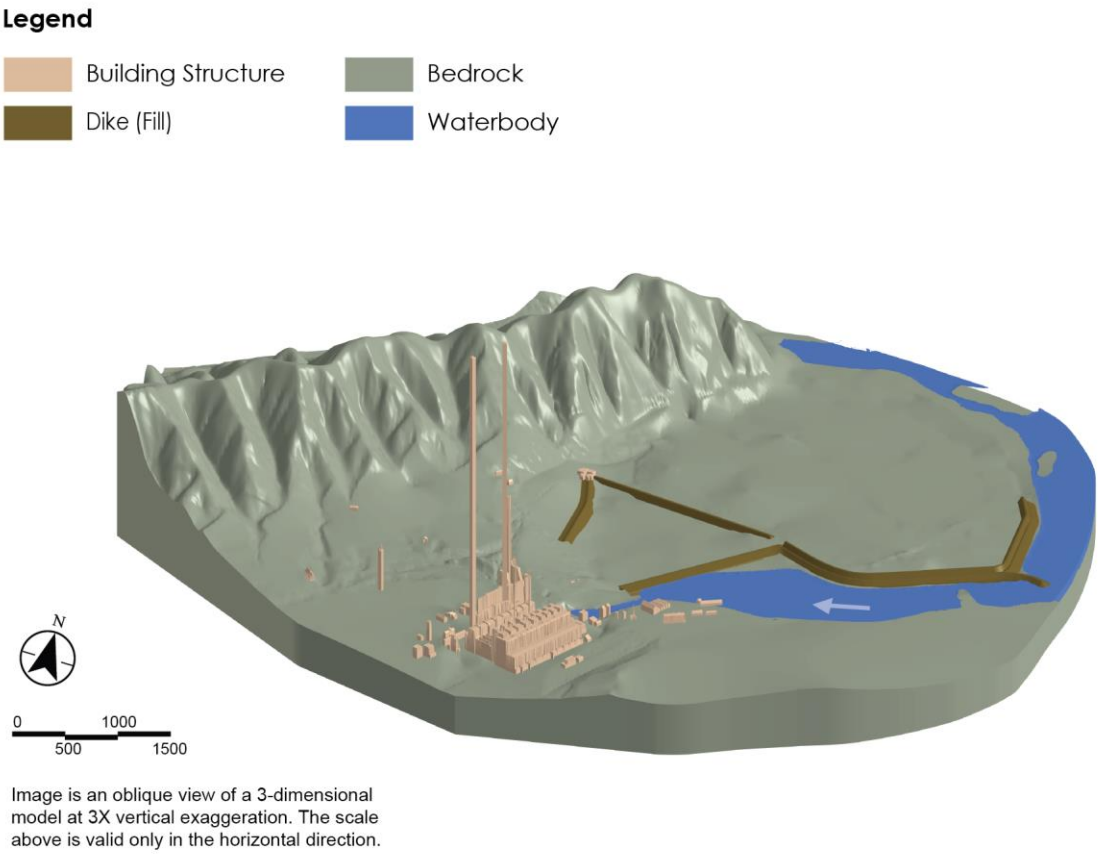


Image is an oblique view of a 3-dimensional model at 3X vertical exaggeration. The scale above is valid only in the horizontal direction.

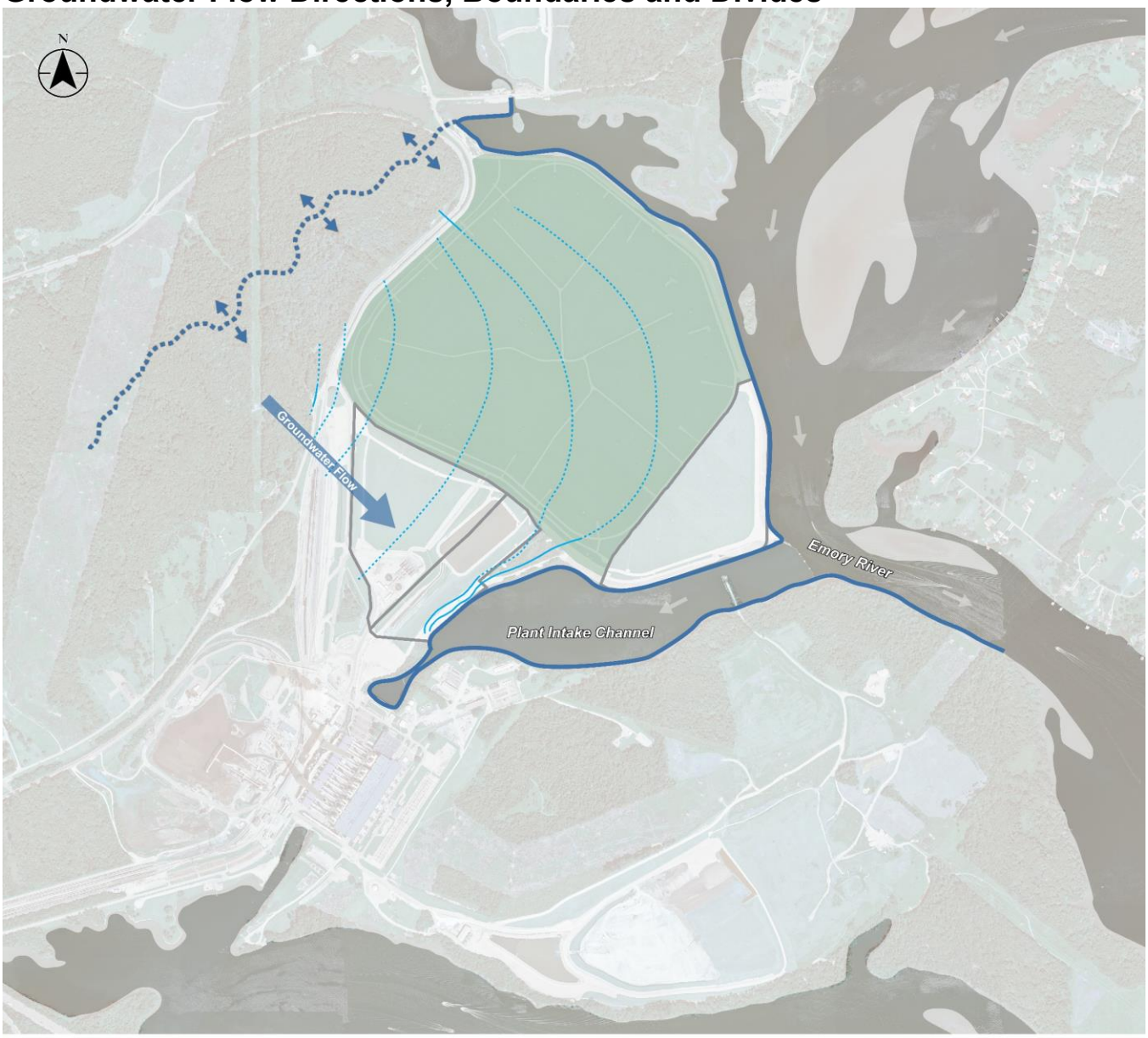
2.2.5 Uppermost Aquifer and Groundwater Flow

The unconsolidated materials are defined as the uppermost aquifer and are under unconfined conditions. During the EI, groundwater levels were measured within the uppermost aquifer prior to each of the six groundwater sampling events to evaluate the direction and rate of groundwater flow in the uppermost aquifer. Surface water elevations were measured at the Emory River because the elevations of surface streams affect groundwater flow.

The available data indicated that groundwater generally flows to the east-southeast toward the Emory River or Plant Intake Channel. Calculated groundwater flow rates ranged from approximately one foot/year to 16 feet/year, which is generally much slower than water flow in surface streams or rivers. Flow rates in surface streams or rivers generally are measured in feet per second (USGS 1999). Exhibit 2-4 is a representative groundwater contour map.

Physiographic features that affect groundwater flow in the vicinity of the KIF Plant include the steep topography of Pine Ridge to the northwest and the Emory River and the Plant Intake Channel to the east-southeast and downgradient of the CCR units. To the west and upgradient of the plant is Pine Ridge, which serves as a topographic divide to groundwater flow. In the vicinity of the CCR units, groundwater flow is bounded to the east and southeast by the Emory River and Plant Intake Channel. Groundwater flow directions, boundaries, and the topographic divide are shown in the following figure.

Groundwater Flow Directions, Boundaries and Divides



Legend

- Interpolated Groundwater Contour
- Groundwater Contour (5 foot interval)
- Surface stream that bounds groundwater flow
- Hydrogeological Divide
- Generalized groundwater flow direction
- Surface stream flow direction
- CCR Unit Area (Approximate)

Note: Groundwater contours included to illustrate general groundwater flow directions. See Exhibit 2-4, Groundwater Elevation Contour Map Event #3 (August 19, 2019), for actual groundwater elevations and groundwater contours.

Groundwater Monitoring Systems

Groundwater monitoring wells have been installed at the KIF Plant for various programs including CCR Rule, TDEC permitted landfill program, and the TDEC Order. The current groundwater monitoring system associated with each TDEC Order CCR unit is shown on Exhibit 2-4.

There are two groundwater monitoring systems at the KIF Plant TDEC Order CCR units under the CCR Rule: the Sluice Trench and Area East of Sluice Trench, and the Stilling Pond. The wells comprising the Sluice Trench and Area East of Sluice Trench groundwater monitoring system include five downgradient wells (KIF-105, KIF-106, KIF-109, AD-2, and AD-3) and one background well (AD-1). The wells comprising the Stilling Pond groundwater monitoring system include three downgradient wells (KIF-103, KIF-104, and 6AR) and one background well (AD-1).

There is also one groundwater monitoring system for the Interim Ash Staging Area that is monitored in accordance with the TDEC permitted landfill program requirements including two downgradient wells (AD-2 and AD-3) and one background well (AD-1).

Chapter 3 TDEC Order Investigation Summary and Conceptual Site Models

This chapter summarizes the TDEC Order investigation findings and CSMs for the TDEC Order CCR units based on the EI and associated historical and ongoing program results. CSMs describe sources of CCR constituents, pathways by which they can move, and environmental media potentially affected if they are released.

For the EAR, analytical results were compared to TDEC-approved screening levels to identify areas that required further evaluation in this CARA Plan. Most screening levels are more protective than regulatory standards and are based on published scientific studies. Concentrations above the screening level do not necessarily mean that an adverse health effect is occurring, but rather, that further evaluation is required in this CARA Plan to determine if an unacceptable risk exists and if corrective action is required. Potential slope stability impacts were defined as those areas having analysis results (i.e., factors of safety) that do not meet TDEC-approved criteria for one or more load cases.

For the CARA Plan, groundwater data are compared to GWPS (Table 1-1).

CSMs for each TDEC Order CCR unit are presented as Exhibits 3-1 and 3-2. These exhibits depict findings discussed in the EAR on a representative cross-section of subsurface conditions for each TDEC CCR unit. Results of the EI are presented for the overall investigation area on Exhibit 3-3 and near the TDEC Order CCR units on Exhibit 3-4. A summary of assessment findings is also presented below.

3.1 Conceptual Site Model

KIF Plant Hydrogeological CSM

The unconsolidated materials have been defined as the uppermost aquifer, which is considered to be under unconfined conditions and is monitored downgradient of the TDEC Order CCR units. The horizontal groundwater flow direction within the uppermost aquifer is generally to the east-southeast toward the Emory River or Plant Intake Channel. Groundwater flow in the vicinity of the CCR units is bounded to the east and southeast by the Emory River and the Plant Intake Channel. Pine Ridge to the west and upgradient of the plant, serves as a topographic divide to groundwater flow.

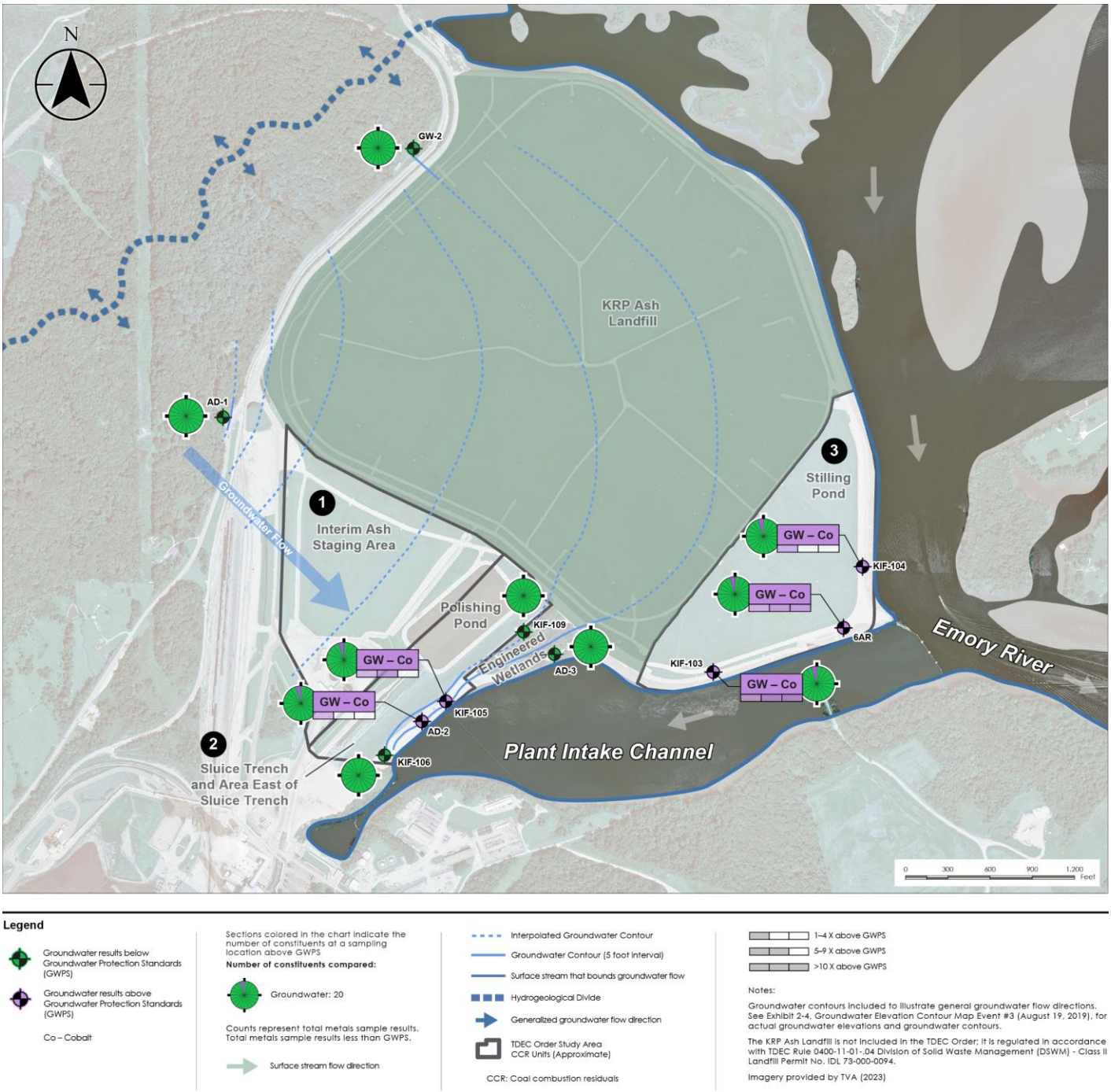
The low permeability of the perimeter dikes limits lateral flow into or out of the TDEC Order CCR units. Pore water within the CCR material has specific chemical characteristics that are different from the characteristics of groundwater downgradient of the CCR units. Certain CCR constituents that have been detected in pore water are affected by geochemical processes during transport by groundwater through geological materials. The effect of these geochemical processes, which can result in reducing dissolved CCR constituent groundwater concentrations, can explain the observed differences between the characteristics of pore water and groundwater quality. The geochemical processes can also result in the mobilization of constituents (e.g., cobalt) from the natural geological materials. Hydrogeologic modeling of groundwater flow conditions and geochemical processes are further evaluated within this CARA Plan to support groundwater corrective measure evaluations at the TDEC Order CCR units.

3.2 Overall Environmental Investigation Findings

The EAR presented the results of the EI investigations, described the extent of surface stream water, sediment, and groundwater impacts, if any, from the KIF Plant TDEC Order CCR units, and provided the information, data, and evaluations used to make those assessments. Geotechnical analysis findings, and environmental sampling results above TDEC-approved screening levels in specific media, are further evaluated in this CARA Plan to determine whether unacceptable risks existed that require corrective action. Reported groundwater analytical results were compared to the screening levels by conducting a statistical evaluation of sample results reported over time following USEPA guidance (see Appendix E.3 of the EAR). The evaluation was not based on comparing individual reported groundwater sample results to the screening levels.

The graphic below shows a summary of findings presented in the EAR near the KIF Plant TDEC Order CCR units. On this graphic, groundwater sampling locations are at the identified wells, and sampling results are depicted adjacent to the sampling locations.

Overall Findings Near KIF Plant CCR Units



As presented in the EAR, more than 96% of the environmental sample results from over 300 samples were below screening levels. The KRP data included for evaluation of surface stream water, sediment and ecology were collected under a similar quality assurance program as the EI data and are considered to be of comparable data quality for use in the EAR and this CARA Plan. The EI and supplemental data indicated groundwater concentrations above GWPS are

limited to onsite groundwater areas, and extensive investigations conducted for the KRP indicated that there are no adverse impacts to ecological communities in the Clinch, Emory, and Tennessee Rivers. The following are the overall assessment findings from the EI presented in the EAR:

- Evaluation of the previous and ongoing extensive investigations conducted for the KRP indicate that surface stream water, sediment and biota tissue concentrations are below remedial objectives and declining, and there are no adverse impacts to benthic macroinvertebrate communities or fish health in the Clinch, Emory, and Tennessee Rivers, or to aerial-feeding insectivorous birds. TVA is continuing long-term monitoring activities to document these findings, as required by the USEPA and TDEC under the terms of the CERCLA remedy.

- The TDEC Order CCR units have adequate structural stability, and slopes are stable under current static and seismic loading conditions, except at the Sluice Trench and Area East of Sluice Trench for the pseudostatic global and post-earthquake, global load cases. TVA is implementing seismic stability mitigation measures as a separate project prior to CARA Plan implementation as described in Chapter 5. The TDEC Order CCR units also have adequate structural integrity, and there is no evidence of voids/cavities in bedrock that could lead to loss of structural support and potential release of overlying CCR material.

- There are no known active seeps onsite (See Appendix I of the EAR for more information).

- Most CCR constituent concentrations in onsite groundwater were below GWPS, and statistically significant groundwater results above GWPS are limited to onsite areas downgradient along the perimeter of the TDEC Order CCR units. However, further evaluation was recommended and is included in this CARA Plan to evaluate methods and design for targeted corrective action for onsite groundwater at well locations where statistically significant concentrations of CCR constituents above GWPS existed.

- The inferred groundwater and pore water elevations in the vicinity of the TDEC Order CCR units were similar. The elevations of pore water levels within and groundwater levels in the vicinity of the Stilling Pond were generally within five feet of the Emory River stage. Pore water level fluctuations at most locations within the TDEC Order CCR units showed a similar, but subdued, correlation with the fluctuation pattern of the Emory River stage. Pore water level fluctuations were more subdued in comparison to groundwater level fluctuations, suggesting that foundation soils are impeding the flow of pore water.

- Groundwater flow in the unconsolidated materials is bounded to the east and southeast by the Emory River and the Plant Intake Channel. Pine Ridge to the west and upgradient of the plant serves as a topographic divide to groundwater flow.

- Based on the overall results of the water use survey, current and historical CCR management associated with the KIF Plant have not affected water supply wells or springs located in the vicinity of the KIF Plant and are not anticipated to do so in the future (See Appendix H.9 of the EAR for more information).

The following summary provides the specific findings of the EI that required further evaluation in this CARA Plan.

Summary of Findings Requiring Further Evaluation in the CARA Plan			
TDEC Order CCR Unit	**Stability**	**Groundwater**	**Surface Stream, Sediment, Ecology**
Interim Ash Staging Area	None	Cobalt (Wells AD-2 and KIF-105)	None
Sluice Trench and Area East of Sluice Trench	None (seismic mitigation will commence in parallel with the CARA Plan phase)	Cobalt (Wells AD-2 and KIF-105)	
Stilling Pond	None	Cobalt (Wells 6AR, KIF-103, and KIF-104)	

The groundwater corrective measure evaluations and identified corrective actions in this CARA Plan are based on the conclusions of a statistical evaluation of groundwater data available as of December 2022. Groundwater data continues to be collected at the TDEC Order CCR units in accordance with existing monitoring plans, and the extent, type, or need for groundwater corrective actions will be reevaluated in response to changing groundwater conditions. If concentrations of the target constituent were to fall below GWPS during approval and final design of the groundwater corrective actions such that groundwater corrective action is no longer required, then the corrective measures identified in the CARA Plan would not be implemented. The groundwater corrective actions to be implemented will be driven by the statistical evaluation of groundwater data and trends at the time of implementation. Proposed changes to the planned groundwater corrective actions would be coordinated with and approved by TDEC.

As described in this CARA Plan (see Chapter 5), TVA is constructing an East Dike seismic stability mitigation project at the Sluice Trench and Area East of Sluice Trench TDEC Order CCR unit as a separate project prior to CARA Plan implementation. TVA anticipates completing the construction phase of the project in 2025.

Chapter 4 Human Health and Ecological Risk Assessment Summary

The HHERA process was used to evaluate potential risks to human and ecological receptors from potential exposures to CCR constituents that may have been released from the three TDEC Order CCR units at the KIF Plant (Appendix B). Current land use is industrial and there are no planned changes in land use. Results of this HHERA are used in the CARA Plan to evaluate whether corrective action(s) are needed to address unacceptable risk, and if so, provide information for the schedule for corrective action implementation.

When evaluating human and ecological exposures to environmental stressors, acceptable versus unacceptable risk is frequently defined by regulation and public policy. The HHERA methodology is based on guidance published by the USEPA, who makes clear that determining “acceptable/unacceptable” risk should go beyond solely calculating numerical risk estimates. As such, the objective of the HHERA is to provide quantitative and qualitative statements of potential risks (i.e., “acceptable/unacceptable levels”) to human and ecological receptors, based on multiple lines of evidence (LOE). Qualitative LOE include the findings from sampling and studies conducted as part of the KRP, including environmental sampling, biological studies, human health risk assessments, and ecological risk assessments.

At a minimum, the additional planned closure and corrective actions as described in this CARA Plan are expected to improve current conditions. However, the risk estimates to human and ecological receptors from exposure to CCR constituents protectively assume that current offsite environmental conditions, as reported in the EAR, reflect post-closure conditions. As described below, assessment of onsite exposures assumes post-closure conditions, including a previously completed or planned geosynthetic cover system at each of the three TDEC Order CCR units.

4.1 Human Health Risk Assessment

A human receptor is a hypothetical person (e.g., young child, adult) who resides, visits, or works on or near the KIF Plant and is, or could potentially be, exposed to CCR constituents from the TDEC Order CCR units. General physical and behavioral characteristics specific to the receptor type (e.g., body weight and amount of soil ingested) were used to estimate the amount of chemical exposure received by the onsite worker. Hypothetical receptors with exaggerated behaviors and activity patterns were used in the HHERA. If no unacceptable human health risk is identified for these more exposed and more sensitive hypothetical people, then no adverse health effects would be expected for less exposed, less sensitive people. Risks to offsite receptors from exposure to CCR constituents were previously evaluated as part of the KRP through a baseline human health risk assessment (BHHRA) (Jacobs 2012). The HHERA relied on a qualitative interpretation of findings from the BHHRA to evaluate potential risks to offsite receptors from CCR constituents in surface stream water, seasonally exposed sediment, and sport fish filet from the Emory River associated with the TDEC Order CCR units at the KIF Plant.

The HHERA focuses on the TDEC Order CCR units, not the historical operations of the KIF Plant or the closure activities. There are no potable groundwater wells at the KIF Plant, and there are no plans to install potable groundwater wells in the future. Potential risks associated with onsite exposures to CCR material are limited to exposure scenarios where people could reasonably be expected to penetrate the geosynthetic cover system. The HHERA evaluated an onsite worker, an offsite resident, and an offsite recreational user.

4.1.1 Onsite Worker

An onsite worker is defined as an adult engaged in short-term repair work on the infrastructure of the TDEC Order CCR units during post-closure. This onsite worker could have limited, direct contact with CCR material for a short duration (20 days or less). They could be exposed to CCR constituents in CCR material via incidental ingestion and dermal contact with CCR material, inhalation of particulates released from CCR material, and external exposure to ionizing radiation from CCR material. To determine whether the human health risk for a CCR constituent should be evaluated further, maximum measured concentrations of constituents in the CCR material were compared to human health receptor-specific screening levels for CCR material that have been reviewed and accepted by TDEC (Stantec 2021). The maximum concentrations of several CCR constituents were greater than these screening levels and were analyzed in more detail in the HHERA.

Using the estimated exposures and published toxicity data, risk estimates for the onsite worker are below acceptable state thresholds for cancer and noncancer risk.

These findings support the conclusion that there are no unacceptable risks for an onsite worker potentially exposed to CCR material while making short-term repairs to the Interim Ash Staging Area, Sluice Trench and Area East of Sluice Trench, or Stilling Pond during post-closure.

4.1.2 Offsite Resident

An offsite resident is defined as an adult, adolescent, young child, or infant who uses potable water from municipal water departments that withdraw water from the Emory River in the vicinity of the KIF Plant, or who resides within a 0.5-mile radius of the KIF Plant parcel boundary and uses groundwater or springs as a potable water source. **As described in Chapter 3.2, current and historical CCR material associated with the KIF Plant has not affected water supply wells or springs near the KIF Plant; therefore, an offsite resident would not be exposed to CCR constituents via ingestion of groundwater or spring waters** (See Appendix H.9 of the EAR for more information).

Maximum detected concentrations of CCR constituents in the Emory River were lower than drinking water standards and domestic potable use criteria approved as screening levels by TDEC. In addition, the BHHRA (Jacobs 2012) concluded that results of the risk characterization indicated no unacceptable cancer risk or noncancer hazard to offsite residents due to exposure to residual ash. **These findings support the conclusion that there are no unacceptable risks for offsite residents.**

4.1.3 Offsite Recreational User

A recreational user is an adult, adolescent, or young child that is engaged in recreational activities within and along the Emory River near the KIF Plant. The recreational users were further grouped by their primary activities – swimmer, beachcombers, and consumers of locally-caught sport fish.

A swimmer may incidentally ingest or come into direct contact with surface stream water while swimming, wading or engaging in other water-related activities. Maximum detected concentrations of CCR constituents in the Emory River were lower than drinking water standards and potable use criteria approved as screening levels by TDEC. In addition, the BHHRA (Jacobs 2012) reported that risk estimates for the recreational swimmer are below acceptable state thresholds for cancer and noncancer risk. **These findings support the conclusion that there are no unacceptable risks for the recreational swimmer.**

A recreational user who is a beachcomber may incidentally ingest or have dermal contact with seasonally exposed sediment while hiking or beachcombing for driftwood, rocks, or other objects near the KIF Plant. External exposure to radiation emitted from radionuclides in sediment was also considered in the HHERA. Beachcomber receptors include people who may camp or fish from areas of exposed sediments along the shore. The risk estimates for the beachcomber, as reported in the BHHRA (Jacobs 2012), are within acceptable state thresholds for cancer and noncancer risk. These estimates were based that on exposure to seasonally exposed sediment samples that were collected within about a year following the December 2008 release from locations within the Emory River. Because the BHHRA is based on "worst case" conditions, it is reasonable to assume that the evaluation represents potential risks from residual CCR material released during the December 2008 Dredge Cell failure rather than potential impacts from the TDEC Order CCR units. Studies and data collected for the long-term monitoring (LTM) demonstrate that conditions have improved since the BHHRA was conducted, and it is reasonable to assume that potential risks would be lower in 2024 than in 2012 when the BHHRA was published.

These LOE support the conclusion that there are no unacceptable risks associated with the TDEC Order CCR Units at the KIF Plant for the recreational beachcomber.

A recreational user who is a consumer of locally caught fish may be exposed via consumption of fish taken from the Emory River near the KIF Plant. The BHHRA (Jacobs 2012) concluded that risk estimates above acceptable state thresholds for cancer and noncancer risk for consumption of fish were attributable to legacy contaminants (i.e., polychlorinated biphenyls and mercury) already present in the river system and are not associated with CCR material from the December 2008 release. This is consistent with the results of studies by Arnwine et al. (2014) and Denton (2007) that suggest mercury is a widely occurring regional contaminant. **These findings support the conclusion that there are no unacceptable risks associated with the KIF Plant TDEC Order CCR units for recreational users who consume locally caught fish.**

4.2 Ecological Risk Assessment

It was not necessary or feasible for the HHERA to individually assess each ecological receptor that could potentially inhabit, breed, or forage at or in the vicinity of the KIF Plant. Instead, the potential for adverse effects was evaluated for a subset of receptors (i.e., surrogate species) representing the various feeding guilds and ecological communities that may be exposed to CCR constituents. The ecological receptor groups evaluated in the HHERA for the Emory, Clinch, and the Tennessee Rivers were community receptors (benthic invertebrate, aquatic vegetation, fish, and aquatic/riparian feeding amphibian and reptile communities) and representative bird and mammal receptors (aquatic and riparian feeding birds, aquatic and riparian feeding mammals, and aerial feeding birds and mammals). Risks to these ecological receptors from exposure to CCR constituents were previously evaluated as part of the KRP through a baseline ecological risk assessment (BERA) (Arcadis 2012) and LTM. The results of the BERA and LTM were reviewed and evaluated to support a qualitative evaluation of risk for the ecological receptors identified above due to exposure to CCR constituents in the Emory, Clinch, and Tennessee Rivers. This HHERA is based on a qualitative review of findings and data generated during the KRP and LTM.

4.2.1 Community Receptors

Freshwater aquatic life (i.e., benthic invertebrates, aquatic plants and fish) can be exposed to CCR constituents within the environmental media that they inhabit. Adsorption and ingestion of CCR constituents from surface stream water and sediment can occur, and some CCR constituents in these media can bioaccumulate in aquatic life via food chain uptake.

Amphibians and reptiles also can be exposed to CCR constituents through ingestion and food chain uptake, as well as from dermal contact with and ingestion of sediment and surface stream water.

For these community receptors, the environmental value that is to be protected (i.e., the assessment endpoint) is the abundance and diversity of freshwater aquatic life (i.e., benthic invertebrate, aquatic plant, and fish communities) and aquatic/riparian feeding amphibians and reptiles in the Emory, Clinch, and Tennessee Rivers. Specific measures of effects were used to evaluate the abundance and diversity of each community. These included comparisons of sediment and surface stream water samples to benchmarks, comparisons of tissue sample results to critical body mass residues, and direct assessments of community abundance and diversity, as summarized below.

Measures of Effects for Community Receptors

Benthic Invertebrate Communities	Hazard estimates based on comparisons of concentrations in sediment-to-sediment benchmarks
	Hazard estimates based on comparisons of concentrations in mayfly tissue samples to critical body mass residue in mayfly tissues
	Assessment of benthic community metrics
	Laboratory toxicity tests
Aquatic Vegetation Communities	Hazard estimates based on comparisons of concentrations in sediment samples with published benchmarks
	Comparison of surface stream water and aquatic plant tissue data with aquatic plant benchmarks
Fish Communities	Hazard estimates based on comparisons of concentrations in surface stream water samples to freshwater benchmarks
	Hazard estimates based on comparisons of concentrations in fish tissue samples to critical body residue in fish tissue
	Fish reproductive studies
	Assessment of fish community health metrics
	Fish toxicity tests
Aquatic/Riparian Feeding Amphibians	Hazard estimates based on comparisons of concentrations in amphibian tissue samples to critical body residue in amphibian tissue
	Hazard estimates based on comparisons of concentrations in sediment samples to sediment benchmarks
Aquatic/Riparian Feeding Reptiles	Comparison of surface stream water data with aquatic freshwater benchmarks
	Reptile community survey data

Overall, the BERA (Arcadis 2012) concluded that risks to benthic invertebrates from exposure to CCR constituents were moderate in the Emory River and low in the Clinch River based on data collected in 2009 and 2010, and risk management was recommended for benthic invertebrate communities in Emory River. More recent monitoring data collected as part of the LTM program in 2015 and 2017 (additional community monitoring, sediment toxicity tests, tissue monitoring, and sediment sampling) provide additional evidence of no negative impacts from CCR constituents on benthic communities and no increased sediment toxicity for samples collected from potentially impacted locations compared to reference locations, indicating that sediment and tissue samples were in compliance with established LTM remedial monitoring endpoints. **These findings indicate there are no unacceptable risks to benthic invertebrate communities in the**

Emory, Clinch and Tennessee Rivers from exposures to site-related CCR constituents from the TDEC Order CCR units.

The BERA results indicated that concentrations in surface stream water and sediment above benchmarks were infrequent, concentrations of CCR constituents were either similar to or lower than those at upstream reference locations, and comparisons of plant tissue data to benchmarks do not indicate unacceptable risks. As a result, risk management recommendations for aquatic plants in the Emory, Clinch or Tennessee Rivers were not provided, and no further monitoring or studies of aquatic plant communities were conducted during the LTM program. **These findings indicate there are no unacceptable risks to aquatic vegetation communities in the Emory, Clinch, and Tennessee Rivers from exposures to site-related CCR constituents from the TDEC Order CCR units.**

Evaluations in the BERA and LTM for fish communities in the Emory, Clinch, and Tennessee Rivers included community monitoring, toxicity testing, reproduction studies, tissue sampling, health metrics studies, and surface stream water sampling. The evaluations did not indicate the likelihood of significant risks to fish communities in the Emory, Clinch and Tennessee Rivers. **These findings indicate there are no unacceptable risks to fish communities in the Emory, Clinch and Tennessee Rivers from exposures to site-related CCR constituents from the TDEC Order CCR units.**

Based on the evaluations of the BERA for amphibians and reptiles (community surveys, tissue sampling, and surface stream water and sediment sampling), there was some indication of the accumulation of increased concentrations in turtle tissues sampled from potentially impacted locations compared to reference locations. However, the ecological effects of the observed tissue concentrations are not well documented and no significant differences in direct measures of ecological effects (species richness, species abundance, and the presence of observable anomalies and diseases) were observed between reference and potentially impacted locations. In addition, the review of surface stream water and sediment results was not indicative of unacceptable risks to amphibians and reptiles. **These findings indicate there are no unacceptable risks to amphibians and reptiles in the Emory, Clinch, and Tennessee Rivers from exposures to site-related CCR constituents from the TDEC Order CCR units.**

4.2.2 Bird and Mammal Receptors

For birds and mammals, their life histories dictate the primary exposure pathways. For example, consumption of vegetation, fish, and invertebrates makes up the primary complete exposure pathways for mammalian and avian herbivores, piscivores, and insectivores, respectively.

The assessment endpoint for the birds and mammals is protection of populations of birds and mammals in the Emory, Clinch, and Tennessee Rivers. As part of the BERA, food chain modeling based on an oral dose approach was used to estimate exposures to each of the surrogate birds and mammals. Modeled exposure doses were calculated to quantify exposures (i.e., ingestion of food, surface stream water, and sediment, as applicable) for each surrogate avian and mammalian receptor using receptor-specific assumptions (e.g., body weight, ingestion rates, diet composition). The ingestion dose estimates were calculated using protective assumptions.

Surrogate Bird and Mammal Species Evaluated in the Ecological Risk Assessment

Aquatic/Riparian Feeding Birds

Wood duck (herbivorous birds)
Mallard duck (omnivorous birds)
Killdeer (insectivorous birds)
Great blue heron (piscivorous/omnivorous birds)
Osprey* (piscivorous birds)

Aquatic/Riparian Feeding Mammals

Muskrat (piscivorous mammals)
Raccoon (omnivorous mammals)
Mink (piscivorous mammals)

Aerial-Feeding Birds and Mammals

Tree swallow (aerial-feeding insectivorous birds)
Gray bat (aerial-feeding insectivorous mammals)

* Species of conservation concern

Hazards were calculated for both no effect-based and low effect-based toxicity reference values (TRVs). Hazards calculated using no effect-based TRVs that are above one indicate that there is a potential for effects to individual receptors. This is particularly relevant for species of conservation concern where effects to individuals could affect local populations. Because the low effect level is the lowest dose at which adverse effects are likely to be observed, hazards calculated using low effect-based TRVs better reflect the potential risk to receptors at the population level. For example, hazards calculated using no effect-based TRVs are used to assess the risk to the osprey.

Dietary exposure modelling conducted during the BERA indicated negligible risks for the evaluated CCR constituents for piscivorous and herbivorous birds and low risks for insectivorous and omnivorous birds while the site-specific biological monitoring data (including egg health metrics and CCR constituent concentrations in eggs for osprey) indicated no substantive evidence of impacts on the monitored bird species. However, risk management was recommended in the BERA for killdeer in the Emory and Clinch Rivers due to their consumption of benthic invertebrates, which were determined to be at low to moderate risk. Additional monitoring of tissue concentrations of dietary items for killdeer and mallard (i.e., benthic invertebrates) as part of the LTM program supported the conclusion that the low risks identified for these receptors via dietary exposure modelling are stable or decreasing over time. Dietary exposure modelling in the BERA indicated negligible risks for the evaluated site-related CCR constituents for omnivorous, piscivorous, and herbivorous mammals while the site-specific biological monitoring data indicated no substantive evidence of impacts on the monitored omnivorous mammal species (i.e., raccoon). Dietary exposure modelling conducted during the BERA indicated risks to aerial-feeding birds and mammals were low to negligible in the Emory, Clinch, and Tennessee Rivers for the evaluated CCR constituents. Additional monitoring of tissue concentrations of dietary items for tree swallow and the gray bat (i.e., benthic invertebrates) and tree swallow reproductive and tissue monitoring as part of the LTM program has supported the conclusion that the low risks identified for these receptors via dietary exposure modelling are stable or decreasing over time. **The results indicate there are no unacceptable risks at the individual or population-level to birds or mammals at the Emory, Clinch and Tennessee Rivers from exposures to site-related CCR constituents.**

4.3 Summary of Human Health and Ecological Risk Assessment Results

The HHERA process was used to evaluate potential risks to human and ecological receptors from potential exposures to CCR constituents that may have been released from the three TDEC Order CCR units at the KIF Plant. Confidence in the

conclusions of the HHERA is supported by the use of multiple LOE in a weight-of-evidence approach and by incorporation of protective assumptions about exposure factors, behaviors, and activities that overestimate exposures and risks.

The potential human receptors evaluated in the HHERA were an onsite worker, an offsite resident, and a recreational user of the Emory River. **The HHERA evaluation shows that there are no unacceptable risks to onsite or offsite human receptors related to the KIF Plant TDEC Order CCR units.**

The ecological receptor groups evaluated in the HHERA for the Emory, Clinch and Tennessee Rivers were community receptors (benthic invertebrate, aquatic vegetation, fish, and aquatic/riparian feeding amphibian and reptile communities) and bird and mammal receptors (aquatic/riparian feeding birds, aquatic/riparian feeding mammals and aerial feeding birds and mammals). **The HHERA evaluation shows that there are no unacceptable risks to ecological receptors related to the KIF Plant TDEC Order CCR units.**

The additional closure and corrective actions identified in this CARA Plan are expected to improve the current acceptable conditions, as concluded in the HHERA.

Chapter 5 Basis and Methods of CCR Unit Closure

This chapter describes the basis and methods TVA has identified for closure actions at each of the three TDEC Order CCR units at the KIF Plant, including discussion of the applicable State requirements that govern the CCR unit closure and the evaluation process used to identify closure methods for each unit. As described in Chapter 2.1, each of the CCR units was previously closed. Although previously closed, TVA has conducted both programmatic closure method evaluations and site-specific evaluations for each of the TDEC Order CCR units, and based on those evaluations is planning additional closure actions for these units under the TDEC Order, including to ensure the closures meet or exceed current State regulatory requirements as described in this chapter. While not currently planned for the KIF Plant TDEC Order CCR units, TVA continues to evaluate means to beneficially use CCR material in a manner consistent with regulatory requirements while maximizing value to the Tennessee Valley. If implemented, the schedule and volume of harvested CCR material for beneficial use will depend on a number of factors, such as the end market demand, processing requirements, and amount of material unsuitable for harvesting.

TVA is constructing an East Dike seismic stability mitigation project at the Sluice Trench and Area East of Sluice Trench TDEC Order CCR unit as a separate project prior to CARA Plan implementation. The project includes the construction of a stability berm, which will also function as a working platform, and foundation soil ground improvements by stone columns. These actions will serve as a seismic stability mitigation measure, such that the CCR unit will meet or exceed slope stability criteria for pseudostatic global and post-earthquake global stability. TDEC issued an individual Aquatic Resource Alteration Permit for the project effective February 6, 2024 (TDEC 2024) and the United States Army Corps of Engineers Nashville District issued an Individual Section 404 permit on March 5, 2024 (USACE 2024). The construction phase of the project began in 2024 and is estimated to conclude in 2025. The closure actions in this CARA Plan are in addition to this planned seismic stability mitigation measure.

The two primary closure methods considered in this plan are CIP, where the CCR material is covered and left in place, and CBR, where CCR material is removed and disposed at an approved disposal facility. It is important to note that, regardless of closure method, State regulations require corrective action to be implemented to meet GWPS, which is discussed in Chapter 6. This chapter discusses TVA's plans for CCR unit closure pursuant to the TDEC Order and State regulations.

As presented in this CARA Plan, TVA plans to implement CIP for each of the TDEC Order CCR units at the KIF Plant. CIP is consistent with TDEC regulations and supported by both programmatic and site-specific evaluations and the HHERA results described in Chapter 4. The following subchapters describe the information evaluated by TVA that forms the basis for, and the methods to implement, the planned additional closure actions at the KIF Plant CCR units:

- Chapter 5.1 provides an overview of how CIP and CBR would typically be implemented for impoundments and landfills and provides a brief description of how CCR material harvesting for beneficial use could be performed.
- Chapter 5.2 summarizes the State regulatory requirements for closure.
- Chapter 5.3 provides a summary of the programmatic 2016 PEIS evaluation findings for effectiveness and potential environmental impacts associated with each closure method (TVA 2016a and 2016b).
- Chapter 5.4 describes site-specific closure considerations for each of the TDEC Order CCR units.

- Chapter 5.5 summarizes TVA's overall basis for the planned CCR unit closure methods, describes the general approach TVA used to identify the planned actions and how they comply with State regulations, and provides CCR unit-specific descriptions of the planned actions.
- Chapter 5.6 provides a high-level summary of the basis and methods identified for CCR unit closure.

Finally, as described in Chapter 1.2, the closure methods identified in this CARA Plan will not be finalized prior to public review and input on this document. As applicable for each TDEC Order CCR unit, TVA is including draft closure and post-closure plans in this CARA Plan (Appendix F.2) for TDEC review and approval as part of the CARA Plan review process.

5.1 General Description of Closure Methods

The following provides an overview of how CIP and CBR would typically be implemented for impoundments and landfills and provides a brief description of how CCR material harvesting for beneficial use could be performed. These descriptions are general in nature and do not reflect specific actions in progress or planned at the KIF Plant TDEC Order CCR units which are discussed in Chapter 5.5.

5.1.1 Closure-In-Place

CIP is performed for a landfill by installing a cover system when the unit stops receiving waste or when CCR material harvesting activities are completed (see Chapter 5.1.3). These cover systems are utilized to isolate the underlying waste from exposure to surface runoff and infiltration, human and animal contact, and wind. For a former surface impoundment, CIP involves stabilizing the CCR material as required by field conditions prior to installing the cover system. Regrading for the purpose of recontouring and creating positive drainage may be performed prior to installation of the cover system. The three typical cover system alternatives include:

- Soil cover system: Consists of a low permeability compacted clay barrier layer and vegetative cover
- Geosynthetic soil cover system: Consists of a flexible membrane or geomembrane liner, geocomposite drainage layer, protective cover soil, and vegetative cover
- Geosynthetic-engineered turf cover system: Consists of a structured geomembrane, sand infill ballast, and engineered turf.

Cover system and post-closure requirements are specified by the TDEC DSWM (see Chapter 5.2 below). Based on the size of current surface impoundments and landfills included in the TDEC Order, TVA estimates that the time to complete CIP for surface impoundments generally would be less than five years, and for landfills, generally less than three years depending on weather conditions, and other site-specific conditions.

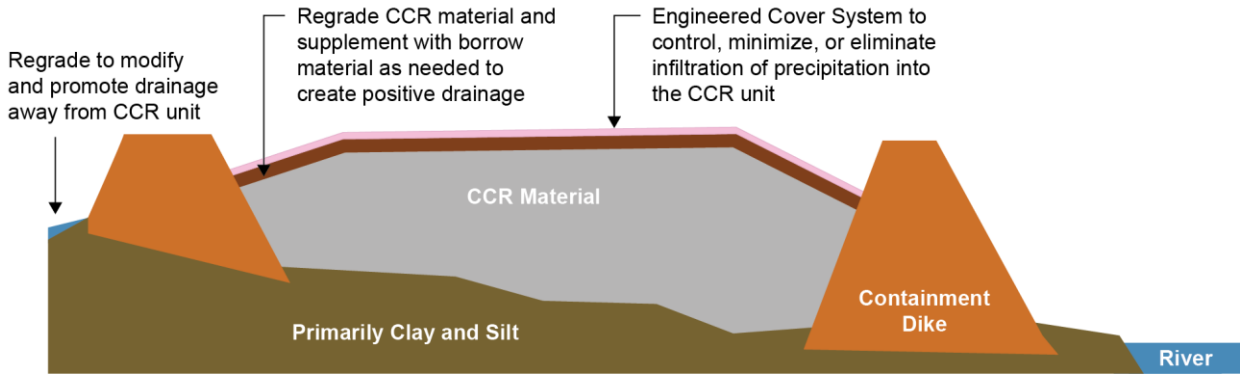
Common actions associated with CIP may include:

- Ensuring containment dike structural integrity and slope stability
- Considering harvesting of CCR material (see Chapter 5.1.3 below)

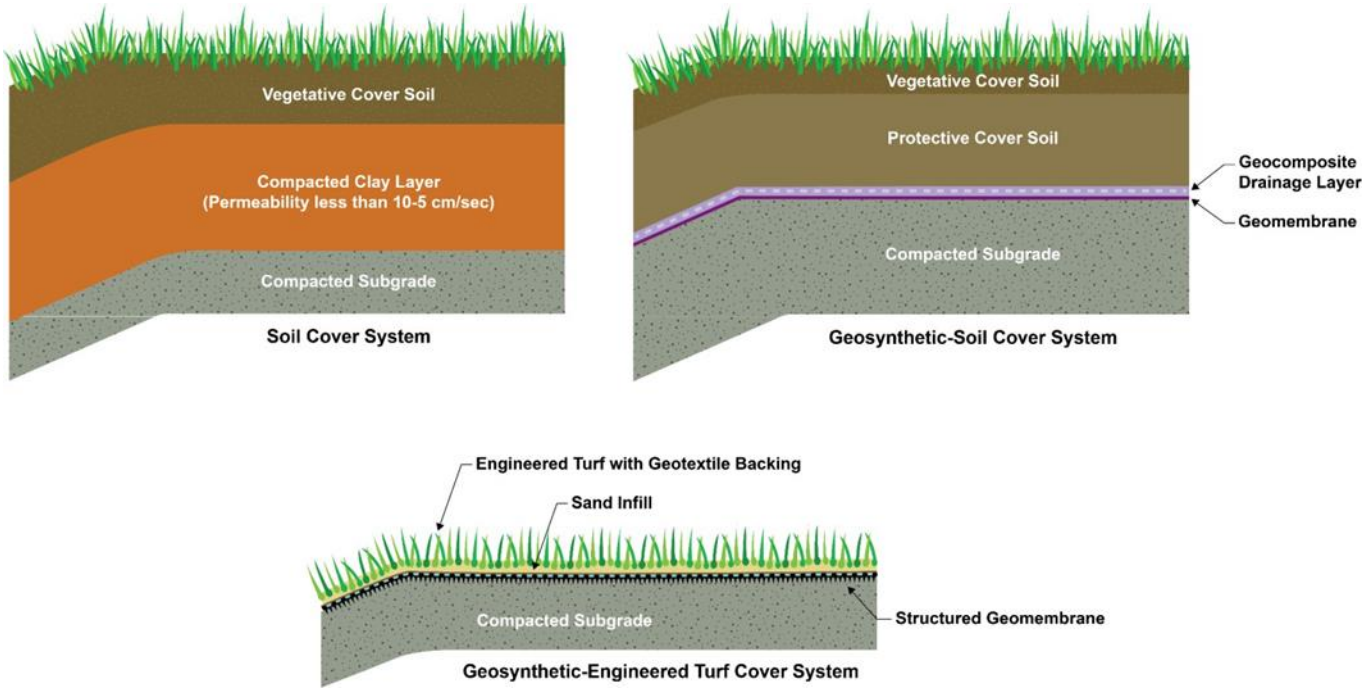
- Decanting liquids from impoundments (if present) to the extent needed to support construction of a final cover system. As applicable for site-specific conditions, additional actions such as pore water extraction may be implemented.
- Identifying laydown and cover borrow areas
- Grading to consolidate CCR material, reduce footprint, and promote site drainage. Grading could include the use of additional fill materials or re-use of existing topsoil, as needed.
- Installing cover system components (i.e., liners, drainage layers, cover soils, vegetation)
- Constructing stormwater drainage systems and other water management systems as needed
- Preparing closure documentation
- Conducting post-closure care (including performing routine inspections, monitoring, and maintenance activities) and potential use for other purposes (including potential renewable power generation).

Typical approaches for CIP, including cover systems for CCR units, are shown below:

Typical Closure-in-Place Actions



Typical Closure-in-Place Cover Systems



5.1.2 Closure-By-Removal

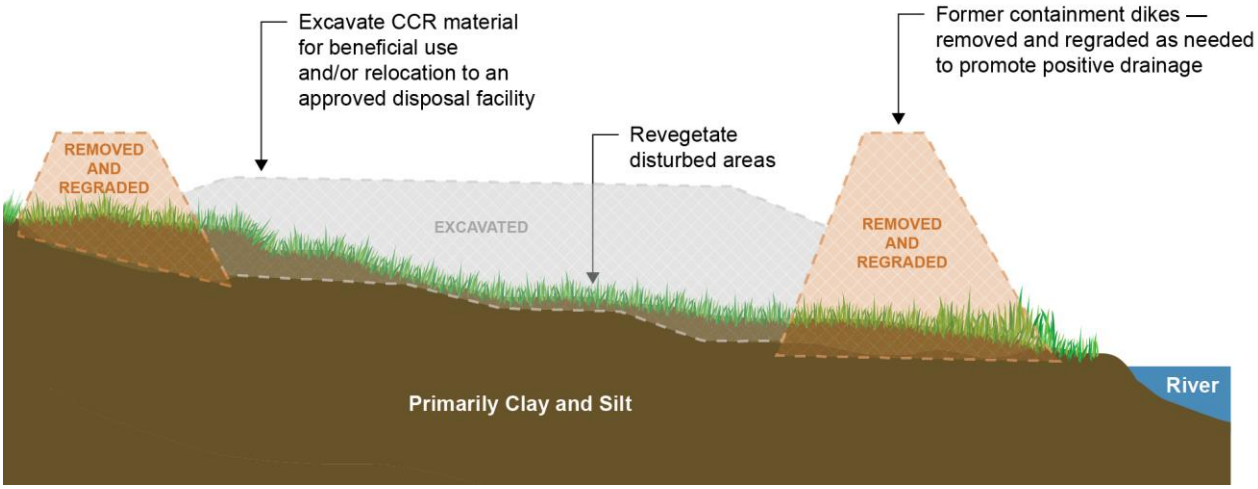
CBR involves excavating and relocating the CCR material from the landfill or former impoundment to an approved onsite or offsite disposal facility. Once final closure activities begin, the time required to complete closure depends on a number of factors including, primarily, the amount of CCR material needing to be removed from the impoundment or landfill, the location of the approved disposal facility, and the amount of borrow material required to fill in the excavation. Based on the size of the CCR unit, CBR could take years to decades to complete. Key construction actions associated with CBR may include:

- Considering harvesting of CCR material for beneficial use (see Chapter 5.1.3 below)
- Identifying onsite or offsite permitted management facilities for CCR material disposal (at most locations, this is likely to include a proposal to construct a new onsite or offsite permitted landfill, or additional disposal cells of an existing permitted landfill, which would require design, permitting and construction of the new landfill/cell and associated facilities — this process would typically take two to five years)
- Determining borrow material options
- Designing, permitting and constructing appropriate load-out facilities
- Coordinating and planning with adjacent communities both before and throughout the construction and transport activities near the closing landfill/former impoundment and the approved permitted landfill receiving the removed CCR material

- Removing CCR material and liner (if any) and transporting to the receiving landfill, including:
    - Decanting liquids from impoundments (if present) to the extent necessary to support removal construction activities. Additional actions including pore water extraction may be implemented to assist in moisture conditioning
    - Removing existing cover soil or geosynthetic cover system (as applicable)
    - Constructing a stormwater management pond, or utilizing an existing pond (if available), to handle stormwater runoff during excavation of CCR material within the unit
        - Coordinating and planning for modifications to existing, or approval of a new, discharge location for stormwater runoff
    - Excavating, temporary staging, and moisture conditioning of the CCR material onsite, including dust and stormwater management controls
    - Loading CCR material into transportation vehicles (trucks, rail cars, barges, etc.), and transporting to the receiving landfill
    - Conducting associated maintenance to transportation infrastructure (roads, load-out facilities, etc.) as needed throughout the life of the hauling
    - Unloading, placing and compacting CCR material at the receiving landfill, including dust and stormwater management controls
    - Closing the receiving landfill as required by State regulations.
- Filling, grading, and revegetating site or use for other purposes
- Preparing closure documentation.

A typical approach for CBR for CCR units is shown below:

Typical Closure-By-Removal Actions



5.1.3 CCR Material Harvesting for Beneficial Use

CCR material can be harvested for beneficial use regardless of the planned CCR unit closure method. Harvesting CCR material for beneficial use can be performed as an operational activity prior to, or following, CCR unit closure. Beneficial use involves removing the CCR material from the existing CCR unit and using those materials as a substitute for virgin, raw materials in a commercial product. The CCR material may be used in the condition it is harvested from the CCR unit or may require additional processing before being applied to its new end use. Harvesting CCR material for beneficial use can result in net positive effects including but not limited to environmental and economic benefits by reducing the mining and use of virgin materials, lowering GHG emissions, and reduced maintenance and costs for final CCR material management. Under many conditions, CCR material harvested and beneficially used in products can also provide the additional benefit of providing improved strength and durability to end materials.

Once beneficial use is included as part of the overall site strategy, the time required to complete harvesting is driven by several factors including: the amount of CCR material that needs to be harvested, the nearest facility to process the CCR material, the rate at which the facility can process the material for its ultimate end use, and the end market demand for the material.

Where harvesting for beneficial use is performed, the amount of CCR material remaining for either closure method is reduced. When harvesting is performed prior to CCR unit closure, it occurs before the final cover system is in place. As CCR material harvesting is completed in each phased area, closure activities for the CCR unit may be completed in an incremental manner. Harvesting can also be performed following installation of a final cover system and CCR unit closure. In this case, harvesting may be performed in discrete phases by opening cover system materials to expose pre-determined areas of CCR material. Turf-based cover system materials (see Chapter 5.1.1) can be designed to be modular and moveable to accommodate harvesting activities, where applicable, to expedite access and implementation of CCR material excavation. Harvesting (either before or after CCR unit closure) typically involves excavation of the CCR material, potential onsite initial processing, transport to the processing facility (either onsite or offsite), processing the CCR material, and then transporting to the end use facility. When harvested CCR material does not meet the specifications for beneficial

use, that CCR material can be replaced in the CCR unit to be handled as a part of closure activities or managed elsewhere.

Following harvesting, the closure process continues as described above for either option. The actual schedule and volume of harvested CCR material for beneficial use will depend on a number of factors, such as the end market demand, processing requirements, amount of material unsuitable for harvesting, and plant operational timelines. Therefore, the final closure configuration and closure schedule will be based on the actual grades and elevations following completion of harvesting activities.

5.2 State Regulatory Requirements

The following describes the TDEC Order requirements and TDEC DSWM regulations regarding CCR unit closure.

5.2.1 TDEC Order

The TDEC Order was issued to establish a process for investigating, assessing, and remediating unacceptable risks from management of CCR material at TVA coal-fired plants. The TDEC Order specifies that the CARA Plan must include the actions TVA plans to take for closure of the CCR units and the basis for those actions. As appropriate for the site, the final approved CARA Plan shall include "[t]he method(s) TVA will employ to remove and/or close in place CCR material at the site."

Also, the TDEC Order requires that the CARA Plan include a schedule of activities to be completed along with a public input process on the draft CARA Plan before it is finalized by TVA and approved by TDEC. The CARA Plan schedule, public notice and input process, and finalization of the CARA Plan are discussed further in Chapter 8.

5.2.2 TDEC DSWM

TDEC DSWM regulations at 0400-11-01.04(8) specify closure and post-closure requirements. The general performance standard for closure per 0400-11-01.04(8)(a) is:

(1) The operator must close the disposal facility in a manner that:

i) Minimizes the need for further maintenance; and

ii) Controls, minimizes, or eliminates, to the extent necessary to prevent threats to public health and the environment, post-closure escape of solid waste, solid waste constituents, leachate, contaminated rainfall, or waste decomposition products to the ground or surface waters or to the atmosphere.

(2) The operator must care for a disposal facility or disposal facility parcel for the period of time after closure in a manner that assures that the performance objectives of part 1 (provided above) are continuously met.

Additional CIP requirements specified in these regulations include information for the cover system design, surface grading and drainage systems, erosion prevention measures, and leachate collection systems. Additional detail regarding closure requirements specified in the TDEC DSWM regulations is provided in Table 5-1.

In accordance with TDEC regulations, the operator must initiate and complete closure activities and conduct post-closure care in accordance with the approved closure/post-closure plan if such a plan has been prepared and approved for the

disposal facility being closed. Also, for active portions of the facility, the operator must complete closure activities including grading and establishing vegetative cover in the shortest practicable time, not to exceed 180 days, after any fill areas or any portion of the fill areas have achieved final grade, unless the TDEC Commissioner allows otherwise.

5.3 PEIS Findings and Conclusions

This subchapter provides a summary of the PEIS prepared by TVA in 2016 for CCR surface impoundment closures (TVA 2016a and 2016b). Information in the PEIS and associated Electric Power Research Institute (EPRI) reports described below serves as a foundation for TVA's site-specific evaluation of closure methods for the TDEC Order CCR units at the KIF Plant presented in Chapter 5.4.

The purpose of the PEIS was to support elimination of wet CCR material storage at TVA's coal plants by closing the surface impoundments across the TVA system by either CIP or CBR. The PEIS was divided into two parts: Part I was a TVA-wide analysis and Part II was a site-specific analysis for ten selected surface impoundments that incorporated the analysis methodology presented in three EPRI reports (EPRI 2016a, 2016b, and 2016c). The EPRI reports present a science-based relative impact framework that comprehensively considers the possible human health and environmental impacts of the two closure options: CIP and CBR.

Part I of the PEIS provided a programmatic evaluation of closure of a hypothetical surface impoundment and identified the screening and evaluation factors that would be applicable for TVA's evaluation of future closure of other CCR surface impoundments at its coal-fired power plants. Part II of the PEIS applied the screening and evaluation factors identified in the programmatic evaluation to site-specific CCR units, including the Stilling Pond and Sluice Trench and Area East of Sluice Trench at the KIF Plant. In Part II, the PEIS relied on EPRI's 2016 qualitative application of relative impact framework to ten TVA surface impoundments located at TVA facilities (TVA 2016a and EPRI 2016c). The report qualitatively compares these impoundments to a hypothetical site that was previously quantitatively modeled by EPRI. Based on the programmatic and site-specific analyses, TVA identified CIP as its preferred alternative for the ten facilities evaluated. A summary of the Part II PEIS findings for the KIF Plant Stilling Pond and Sluice Trench and Area East of Sluice Trench is provided in Chapter 5.4 below.

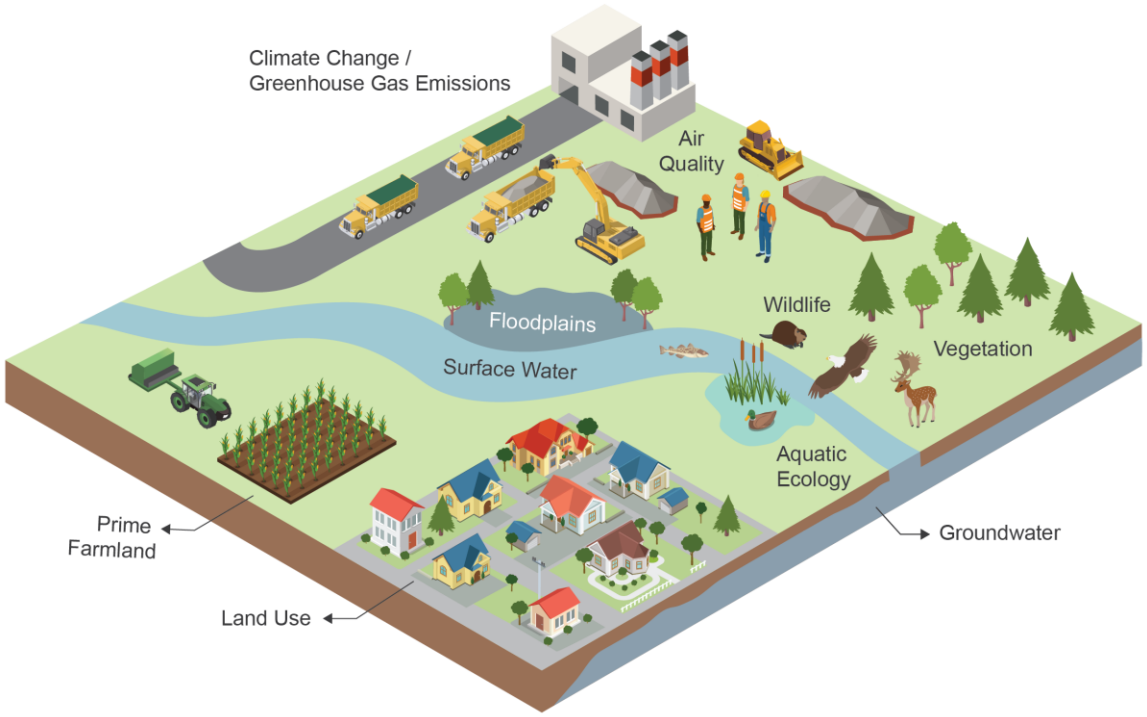
In the PEIS, **TVA identified that CIP would have fewer overall adverse environmental impacts than the CBR alternative and generally would be environmentally preferable.** The observations from EPRI's relative impact framework assessment support TVA's conclusion. The following provides additional detail regarding the environmental review of natural and socioeconomic resource areas that could be affected by each closure method alternative presented in the PEIS. As presented in Appendix C, TVA analyzed potential impacts on the following 22 resource areas, as well as cumulative effects:

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

As indicated in the PEIS cumulative effects evaluation, both CIP and CBR can result in "beneficial cumulative impact to groundwater quality." However, for the CBR alternative, the PEIS states that there would be: **"Adverse cumulative impact to traffic operations within the TVA region. Cumulative impacts to air quality, noise, land use, natural resources[,] socioeconomics, [Environmental Justice] communities and public health and safety would be expected and greater than [CIP] due to greater trucking and secondary effects on regional landfill capacity."**

The PEIS and EPRI assessments also identified potential exposure pathways related to CCR unit closures. The natural and socioeconomic resources and exposure pathways considered in the PEIS and EPRI assessments are illustrated below:

Natural/Socioeconomic Resources and Potential Exposure Pathways Considered in the PEIS



As noted above, Part I of the PEIS and the EPRI analysis also identified the following key screening and evaluation factors to be considered when determining the closure method. These factors provide information about a range of issues relative to the feasibility and reasonableness of the two closure method alternatives.

- Volume of CCR material
- Schedule/duration of closure activities
- Stability
- Risks to human health and safety relating to closure activities
- Potential human health risks associated with CCR constituents
- Potential effects to water resources
- Potential effects to wetlands
- Risks to adjacent environmental resources
- Modes and durations of transport activities
- Risks to human health and safety related to transport of borrow and CCR material
- Cost.

Programmatically, the PEIS provided these screening and evaluation factors identified in Part I of the PEIS that would bound TVA's evaluation of the potential environmental effects of future closure decisions of CCR surface impoundments at its coal-fired power plants. Activities associated with CBR and CIP are described in more detail above in Chapters 5.1.1 and 5.1.2.

5.4 Site-Specific Assessment of Closure Methods

In this CARA Plan, TVA has assessed site-specific information in two evaluation steps to support identification of the planned closure method for each TDEC Order CCR unit. The two-step evaluation process included consideration of findings from prior closure assessments performed for KIF Plant TDEC Order CCR units. As such, this chapter summarizes prior TDEC Order CCR unit closure evaluations performed by TVA, describes the two-step evaluation approach, identifies key site-specific considerations included in the CARA Plan closure assessments, and provides a summary of the overall assessment findings. Chapter 5.5 describes the basis for, and the methods to implement, the planned additional closure actions for each TDEC Order CCR unit at the KIF Plant.

5.4.1 Prior CCR Unit Closure Evaluations

As noted above, the Stilling Pond and Sluice Trench and Area East of Sluice Trench were included in Part II of the PEIS (TVA 2016a). TVA determined that the closure alternatives identified for this CCR unit were consistent with closure conditions evaluated in the Part I of the PEIS. As such, TVA applied the screening and evaluation factors identified in Part I of the PEIS to assess closure alternatives for the Stilling Pond and Sluice Trench and Area East of Sluice Trench. Based on the analysis performed, CIP was the preferred alternative because it would achieve the purpose and need for

the project and would result in closure of the impoundments in a reasonable five-year period. Additionally**, this evaluation identified that CIP can be completed in a shorter time frame than CBR and would cost less and avoid adverse impacts associated with offsite transfer of CCR material.**

5.4.2 Two-Step Evaluation Approach

TVA employed a two-step evaluation approach to determine the appropriate closure methodology for each KIF Plant TDEC Order CCR unit.

First, for each TDEC Order CCR unit, relative potential impacts of CIP compared to CBR were evaluated for the 22 individual natural and socioeconomic resource areas listed in Chapter 5.3 (e.g., air quality, climate change and GHG emissions, surface waters) as well as cumulative impacts and cost. Because each TDEC Order CCR unit was previously closed in place, this assessment compared the relative impacts of additional CIP actions (e.g., installing an engineered geosynthetic cover system and drainage modifications) identified in this CARA Plan to CBR for the three TDEC Order CCR units. The assessment incorporated KIF Plant and TDEC Order CCR unit information that would affect closure implementation as described below. The relative impact assessment used current surrounding demographic information and regulatory designations for protected resources. This detailed assessment of the relative potential impacts of the closure methods on the natural and socioeconomic resource areas for the KIF Plant TDEC Order CCR units is provided in Appendix C. Chapter 5.5 below also contains summaries of these assessments.

Second, a site-specific qualitative evaluation of the key screening and evaluation factors identified in the PEIS and EPRI reports (listed in Chapter 5.3) was also performed to compare the additional CIP actions identified in this CARA Plan to CBR. The PEIS programmatic analysis is also applicable to CCR landfills, because of the similarity of the closure actions required for both decanted surface impoundments and landfills (e.g., excavation of CCR material for CBR or installation of a cover system for CIP). These factors focus on the feasibility and reasonableness of implementing the two closure methods for each of the TDEC Order CCR units. The key factor assessments for the KIF Plant TDEC Order CCR units are provided in Tables 5-2 through 5-4.

5.4.3 Key Site-Specific Considerations

The site-specific closure method assessments for the KIF Plant TDEC Order CCR units incorporated site- and CCR unit-specific information that would affect closure implementation. The assumptions below regarding implementation of CIP or CBR, including identification of the permitted landfill that would receive CCR material for CBR, are made solely for the purposes of the closure evaluation. These assumptions are based on information available to TVA at the time this CARA Plan was prepared, including information from entities outside of TVA, and may change due to unknown future conditions. TVA will continue to refine the assumptions used for the closure alternative evaluations as this CARA Plan is reviewed and finalized. Before implementation of this CARA Plan, TVA will comply with applicable regulations, including for disposal of waste and discharge of water, as appropriate, and obtain required permits. The following summarizes the site- and CCR unit-specific information considered, and the assumptions used, for the closure assessment provided in this CARA Plan.

- The CCR material volumes used are those identified in the EAR for each of the TDEC Order CCR units.
- The existing onsite Peninsula Disposal Area would be used if CBR were to be pursued. Because the onsite landfill would have insufficient capacity for all of the removed CCR material for the CBR alternative, an offsite landfill is also included for the CBR assessment. This evaluation assumes that the potential offsite landfill for

offsite CCR material disposal is the Chestnut Ridge Class I Landfill, located approximately 51 miles northeast of the KIF Plant.

- The borrow area for CIP is assumed to be onsite Kingston Borrow Site No. 3 located north of the Peninsula Disposal Area and south of the Intake Channel. The Kingston Borrow Site No. 3 is approximately one mile south of the TDEC Order CCR units.

- The borrow areas for CBR are assumed to be the to be onsite Kingston Borrow Site No. 3 and the offsite Pine Ridge Borrow site which have approximately 450,000 cubic yards and 2.0 million cubic yards of available borrow, respectively. The Pine Ridge Borrow site is located one mile to the southwest of the KIF Plant. The borrow location(s) for the remaining 1.1 million cubic yards of borrow has not yet been identified. Therefore, a 30-mile radius was assumed for the remaining amount to define the impact area for this assessment.

- CBR with complete removal of the CCR material from the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of the Sluice Trench may be infeasible and unsafe due to structural stability concerns. The stability design of the KRP Ash Landfill relies, in part, on the buttressing effect of the CCR material in these CCR units. Complete removal of CCR material from these adjoining CCR units could destabilize the perimeter of the KRP Ash Landfill and construction of a replacement buttress using fill material may not be feasible. Therefore, this evaluation assumes the following if CBR were to be pursued:

    - Approximately 280,000 cubic yards of CCR material would remain in place within the three TDEC Order CCR units to serve as a structural stability buttress for the KRP Ash Landfill perimeter (see Appendix C for amounts assumed for each CCR unit). This volume estimate has been developed solely to allow for the comparative evaluation of CBR to CIP. A stability analysis and detailed design would be needed to refine this estimate if CBR were to be identified as the closure method.

    - Existing soil cover materials would be excavated to within one foot of CCR material and stockpiled for use as backfill. Remaining soil, CCR material, and liner materials would be removed and placed in the receiving landfills until the proposed subgrade surface is constructed in a manner that leaves CCR material in place to serve as a structural stability buttress for the KRP Ash Landfill perimeter. A geosynthetic cover system would be installed over the remaining CCR material.

    - Each TDEC Order CCR unit would be backfilled to a grade that allows for redevelopment and positive drainage of stormwater to the Plant Intake Channel and the Emory River.

    - CBR construction activities would be conducted from higher to lower elevations across the Interim Ash Staging Area and Sluice Trench and Area East of Sluice Trench collectively (i.e., from the ‘top down’). The complete removal of one of these CCR units before the other could compromise the structural stability of the other and would not be safe due to their adjoining nature. CBR construction activities at the Stilling Pond would be conducted separately from CBR construction activities at the Interim Ash Staging Area and Sluice Trench and Area East of Sluice Trench.

    - The duration of CBR activities in this assessment is based on a maximum of 150 truckloads per day for the disposal of CCR material given the physical constraints for access and egress at the site and construction activities at each CCR unit. In contrast, CIP would require about seven truckloads per day.

- The analysis provides both a site-wide duration and estimated duration of either CIP or CBR closure activities for each applicable TDEC Order CCR unit at the KIF Plant. The duration for CBR closure activities assumes there is sufficient capacity at the identified offsite landfill and that there are no permitting or construction needs, or waste receiving limits at that landfill.

Specific operational and closure implementation considerations and assumptions are discussed in more detail in Appendix C and, as applicable, described for each TDEC Order CCR unit in Chapters 5.5.2.1 through 5.5.2.3.

5.4.4 Summary of Site-Specific Closure Method Assessment

Based on the relative site-specific evaluation presented in Appendix C, CIP is more environmentally beneficial than CBR for the KIF Plant TDEC Order CCR units. Both closure alternatives would be implemented with corrective actions to achieve GWPS and engineering control measures to reduce or minimize erosion, sedimentation, and fugitive dust impacts during implementation.

For many resources evaluated, the relative impacts of CIP and CBR were similar, and for a few, CBR resulted in more beneficial impacts than CIP. These benefits were driven by development of natural habitat through revegetation with native plants and improved socioeconomic resources (see Appendix C for additional information). However, the similar and more beneficial impacts were clearly outweighed by the substantial adverse impacts associated with CBR that are not associated with CIP. This is primarily due to the volume of CCR material to be removed (approximately 4.4 million cubic yards) and transported to the onsite and offsite permitted landfills, and approximately 3.5 million cubic yards of borrow material to backfill the TDEC Order CCR units after the CCR material is excavated. Collectively, this requires approximately 120,000 onsite and 300,000 offsite truckloads of material, and an extended 19- to 22-year timeframe to complete closure for all the TDEC Order CCR units. Compared to CIP, CBR results in greater adverse impacts related to transportation and construction, particularly climate change including GHG emissions, and to human (both worker and community) health and safety. CBR also results in higher risk of potential impacts to surrounding environmental media due to the estimated duration of CBR closure activities and volume of CCR material to be removed. CBR, with disposal of about 1.1 million cubic yards of CCR material at an offsite permitted landfill and offsite borrow soil sources, also introduces potential adverse impacts to the surrounding communities with environmental justice concerns near the KIF Plant as well as those near the offsite landfill and borrow areas.

Cumulative impacts associated with the closure of other CCR units at the KIF Plant and nearby demolition actions associated with plant retirement of the coal-fired units would amplify the adverse impacts for both closure methods at the KIF Plant CCR units. However, the adverse impacts associated with CBR would be expected to be much greater than those for CIP given the duration and magnitude of CBR actions.

Based on these site-specific assessments for the KIF Plant CCR units, there are substantial additional adverse impacts associated with CBR that are not associated with CIP. These are primarily due to the volume of CCR material to be removed, including a substantial amount transported to an offsite landfill, and an extended 19- to 22-year timeframe to complete CBR for all the TDEC Order CCR units.

5.5 Planned CCR Unit Closure Method

TVA has identified CIP as the closure method for each KIF Plant TDEC Order CCR unit. Multiple lines of evidence provide the basis for this closure method, as outlined below.

1. **CIP meets or exceeds the performance standard required by TDEC regulations**, as well as the supporting requirements for cover system design, surface grading, and drainage systems and erosion prevention measures. The effectiveness of geosynthetic cover systems has been demonstrated previously at other TVA sites, where infiltration has been minimized following closure and cover system installation. Additionally, these types of cover systems are the widely-accepted industry standard for closures of solid waste management units and have been identified by USEPA as a 'green remediation best management practice' (USEPA 2023). Chapter 5.5.1.1 and Table 5-5 explain how the planned CIP actions collectively meet or exceed the required closure performance standard and other requirements in the TDEC DSWM regulations, which also fulfills the requirements in the TDEC Order. In addition, TVA will be implementing post-closure care, monitoring, and reporting as specified in the closure and post-closure plans approved by TDEC.

2. **The TDEC Order CCR units will meet the established slope stability factors of safety during closure, the post-closure period, and beyond.** As documented in the EAR, each of the TDEC Order CCR units have adequate structural stability and slopes are stable under current static and seismic loading conditions, except at the Sluice Trench and Area East of Sluice Trench for the pseudostatic global and post-earthquake, global load cases. As described in the introduction to this chapter, TVA is constructing foundation soil ground improvements by stone columns and a buttress of riprap in the Plant Intake Channel along the East Dike as a seismic stability mitigation measure, such that the CCR unit will meet or exceed slope stability criteria for pseudostatic global and post-earthquake global stability. Each of the TDEC Order CCR units has adequate structural integrity, and there is no evidence of voids/cavities in bedrock that could lead to loss of structural support and potential release of overlying CCR materials.

3. **Programmatically, CIP is environmentally more beneficial than CBR, particularly when large volumes of CCR material are to be removed**. As described in Chapter 5.3, based on programmatic evaluations, CIP has fewer overall adverse impacts than CBR and, when considering the resource areas, is environmentally preferable. CBR takes longer to implement, results in more environmental and potential safety exposures related to construction/transportation activities (GHG emissions, worker and public safety impacts), delays groundwater improvements, and is substantially more costly.

4. **At the KIF Plant, there are substantial adverse impacts associated with CBR that are not associated with CIP due to the volume of CCR material to be removed and transported to an offsite landfill, potentially impacting up to 34 communities with environmental justice concerns near the KIF Plant or the offsite receiving landfill or borrow areas.** As explained in Chapter 5.4, the programmatic findings are specifically borne out for the KIF Plant TDEC order CCR units, where only one of the CCR units requires additional CIP actions. Compared to CIP, CBR of about 4.4 million cubic yards of CCR material, requiring about 3.5 million cubic yards of borrow soil for backfill, results in greater adverse impacts related to transportation and construction, particularly climate change and GHG emissions, and worker and transportation safety. Based on the large volume of CCR material to be removed, including about 1.1 million cubic yards transported offsite and import of about 3.1 million cubic yards of borrow soil from offsite sources**, CBR would require 19 to 22 years to complete compared to three to four years required for CIP.** CBR also results in higher potential impacts to surrounding surface stream waters and sensitive habitats and species due to the expected duration and material handling associated with CCR material removal activities. While a few resource areas would have slightly more beneficial impacts from CBR compared to CIP (such as socioeconomic benefits due to local job growth), these are clearly outweighed by the adverse impacts associated with CBR.

5. **CIP actions provide source control faster than CBR.** As discussed above, the additional CIP actions for one TDEC Order CCR unit is expected to be completed within three to four years, compared to the estimated 19 to 22 years required for CBR. Because of the extended construction activities for CCR material removal, CIP provides source control much sooner than CBR, which supports groundwater corrective action as further discussed in Chapter 6.

6. **There are no unacceptable risks for human or ecological receptors from the TDEC Order CCR units at the KIF Plant.** As presented in Chapter 4, the results of the HHERA, performed based on USEPA guidance and relying on the extensive work completed as part of the KRP as well as the EI sampling data for the KIF Plant, support CIP as the closure method. This conclusion is consistent with **TVA's long-term monitoring results and the EAR findings that ecological communities are healthy, and that surface water and sediment quality in the surrounding water bodies are not being adversely impacted by the TDEC Order CCR units**.

With no unacceptable risks related to CIP and with the much longer timeline, greater overall environmental impacts, and substantially higher cost, CBR of the TDEC Order CCR units is not necessary nor justified. With CIP, the current condition of no unacceptable risks will be maintained by TVA's implementation of construction and erosion controls during closure activities.

An overall comparison of the key factors depicting the most substantial differences between CIP and CBR methods considering the three TDEC Order CCR units together at the KIF Plant is presented below:

Qualitative Impacts of CIP vs CBR (All Units)

Key Factors	CIP	CBR
Volume of CCR material to be removed (1)	None	Approximately 4.4 million cubic yards
Duration of closure activities (2)(3)	Approximately three to four years to complete	Approximately 19 to 22 years to complete
Impacts to nearby communities related to closure activities	Lower	Substantially higher (longer duration, increased potential traffic-related accidents/injuries)
Mode/Duration of CCR material transport activities	None	Substantially higher (duration longer)
Impacts to wetlands/sensitive habitat	Lower	Higher (potential release during removal)
Impacts to environment/climate change	Lower	Substantially higher (air and GHG emissions from longer construction/transport duration)
Cost (4)	Lower ($21 million to $41 million)	Substantially higher ($660 million to $1.3 billion)
Source Control (5)	Implemented sooner (completed at two TDEC Order CCR units, and due to shorter closure construction at the remaining CCR unit)	Implemented later (due to longer closure construction)
Conclusion: CIP is More Environmentally Beneficial than CBR (6) CBR would have much higher construction/transportation-related impacts and would take much longer than CIP		

Notes:

1. CBR CCR material volumes used in this evaluation are less than those identified in the EAR to allow about 280,000 cubic yards to remain in place and serve as structural stability buttress for KRP Ash Landfill. See Chapter 5.4.3 and Appendix C for additional information regarding site-specific considerations and assumptions included in the closure comparative analysis.
2. The estimated duration of either CIP or CBR closure activities is for the three TDEC Order CCR units, and assumes the following:
   a. The estimated duration of CIP is for the Interim Ash Staging Area, the only TDEC Order CCR unit at the KIF Plant with planned additional closure actions.
   b. CBR assumes that closure activities at the Interim Ash Staging Area and Sluice Trench and Area East of Sluice Trench would be to remove CCR material from the highest elevations first to maintain structural stability during the removal process.
   c. The duration of CBR activities is based on a maximum of 150 truckloads per day for disposal CCR material given the physical constraints for access and egress at the site and construction activities at each CCR unit.
3. The duration of CBR closure activities may be longer if the offsite receiving landfill(s) have waste-receiving limits or need additional permitting or construction activities prior to receiving CCR material.
4. Preliminary rough order of magnitude costs are based on an engineering estimate for construction activities for the three TDEC Order CCR units combined, including storm water management. The rough order of magnitude costs include design, construction, engineering oversight during construction, and project/construction management activities.
5. Closure actions provide the source control which supports groundwater corrective action and would be implemented sooner for CIP compared to CBR due to a shorter construction period. Costs for implementing groundwater corrective action are not included in the above estimates for CCR unit closure.
6. The overall conclusion for the KIF Plant TDEC Order CCR units is consistent with findings in TVA's 2016 PEIS.

5.5.1 General Approach for Planned Closure Actions and Compliance with State Regulations

This subchapter describes TVA's general approach for the planned additional closure actions for the KIF Plant TDEC Order CCR units and explains how the planned actions meet or exceed State regulatory standards for CCR unit closure, which also fulfills the requirements in the TDEC Order.

TVA's approach to identify the additional closure actions presented in this CARA Plan was based on an evaluation of CCR unit-specific conditions, while also considering current or planned TVA facility operations and other TVA obligations, requirements, programs, or goals.

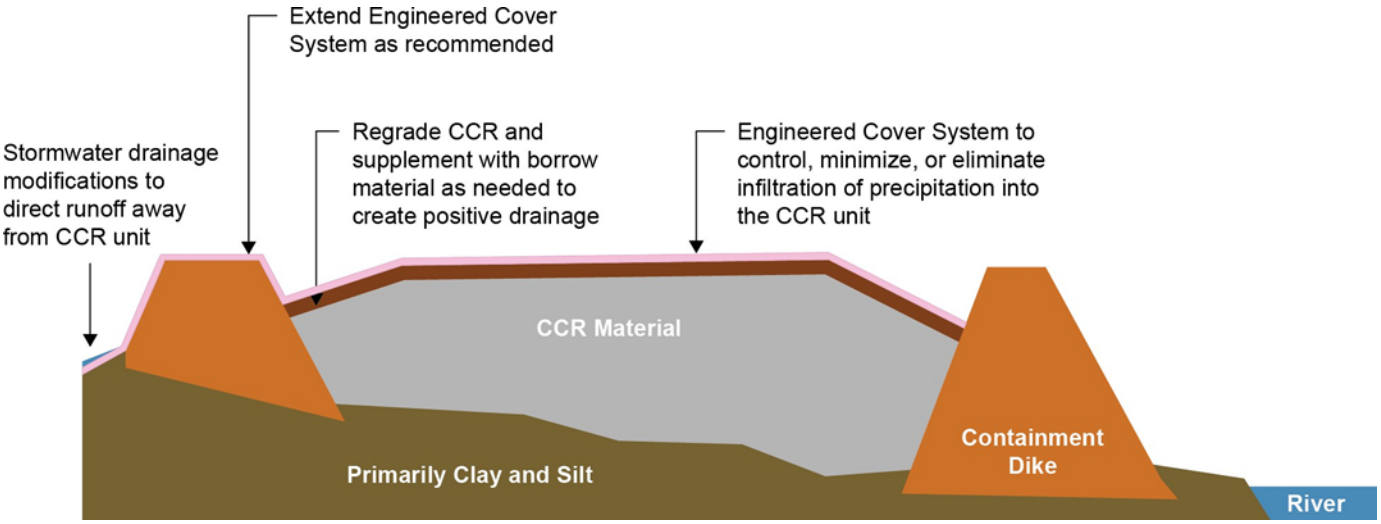
Across the TVA plant sites, CCR unit-specific closure considerations may include compliance with a regulatory closure schedule and/or planned beneficial use activities, in addition to the existing conditions and modeled future conditions at that CCR unit. For example, a CCR unit that already has an effective engineered geosynthetic cover system could require no additional closure action or limited additional closure actions (e.g., drainage modifications) to meet the closure performance standard required by TDEC regulations. Depending on each of the CCR unit's existing and future modeled conditions, pore water extraction to augment the closure action to achieve long-term conditions sooner may be considered.

While planning a CCR unit closure, TVA also considers facility operational schedules, continued operating and maintenance requirements, overall risk mitigation, program management obligations, and long-range facility plans (e.g., plant retirement, future beneficial use planning, or potential site redevelopment). TVA is also obligated to comply with all local, State, or federal regulations, which may influence the type of actions included or the schedule required for closure. TVA also considers its core principles (see Chapter 1.1), such as providing clean, low-cost power, protecting the environment, and promoting economic development. These considerations may influence the need for and type of closure action (CIP or CBR), or ways to enhance the closure action to achieve long-term conditions sooner (e.g., pore water extraction).

Based on these considerations, TVA is planning a comprehensive set of additional closure actions for the Interim Ash Staging Area as shown in Exhibit 5-1. The planned closure actions at certain areas include cover system modifications, including the installation of engineered geosynthetic cover systems and drainage and stormwater modifications. Together, these planned additional actions, along with previous closure actions (see Chapter 2) and TVA's additional actions including construction of foundation soil ground improvements by stone columns and a buttress of riprap in the KIF Plant Intake Channel along the East Dike (see Chapter 5.0), will meet or exceed the closure performance standard as discussed further in Chapter 5.5.1.1 and presented in detail in Table 5-5 for each CCR unit. The basis for and implementation of the planned closure actions are described for each TDEC Order CCR unit in Chapter 5.5.2.

Generalized illustrations of TVA's closure action elements for the KIF Plant CCR units are depicted below.

Planned Closure-in-Place Actions: Cover Systems and Drainage Modifications



5.5.1.1 Compliance with State Regulations for Closure

This subchapter describes how the planned additional closure actions, along with previous closure actions, collectively meet the general performance standard established by TDEC DSWM regulations at 0400-11-01.04(8)(a), described in Chapter 5.2.2, which also fulfills the requirements in the TDEC Order.

The general performance standard requires TVA to close the CCR units in a manner that:

i) Minimizes the need for further maintenance; and

ii) Controls, minimizes, or eliminates, to the extent necessary to prevent threats to public health and the environment, post-closure escape of solid waste, solid waste constituents, leachate, contaminated rainfall, or waste decomposition products to the ground or surface waters or to the atmosphere.

TVA has identified CIP using engineered geosynthetic cover systems and drainage modifications (e.g., lining ditches, installing culverts) where needed at the KIF Plant TDEC Order CCR units to meet the general performance standard. First, using geosynthetic cover systems and lining of upgradient ditches, drainage areas or ponds minimizes future maintenance activities by installing a low permeability barrier that reduces the potential for erosion, sloughing, and CCR material settlement. Second, these actions are effective in controlling and minimizing post-closure escape of CCR constituents because they limit infiltration through the cover system to lower the hydraulic head, in conjunction with the existing low permeability perimeter dikes and foundation soils. As described at the beginning of this chapter, the planned additional closure actions identified in this CARA Plan are in addition to TVA's separate planned seismic stability project, which when completed will meet or exceed slope stability criteria for pseudostatic global and post-earthquake, global stability, thereby controlling and minimizing post-closure escape of CCR material.

Based on TVA's overall considerations as described earlier in this subchapter, TVA is not planning pore water extraction for the TDEC Order CCR units based on the comprehensive actions planned for these CCR units, described above, that are expected to achieve long-term conditions within a reasonable period of time following completion of these actions based on modeling.

In summary, the planned additional closure actions identified for each TDEC Order CCR unit have been identified to achieve long-term closure conditions, given the existing conditions at each CCR unit, to meet or exceed the closure performance standard described above (0400-11-01.04(8)(a)), and TVA's other planning considerations.

The general performance standard also requires TVA to care for the TDEC Order CCR unit after closure in a manner that assures that the general performance standard (provided above) is continuously met. Additionally, TDEC DSWM regulations at 0400-11-01.04(8)(b) require TVA to complete closure activities in accordance with a TDEC-approved closure plan. To meet these requirements, TVA will implement closure and post-closure monitoring and maintenance activities described in TDEC-approved closure and post-closure plans following TDEC Order CCR unit closure. These activities include conducting regularly scheduled inspections to evaluate the integrity of the cover system, stormwater management controls, drainage modifications, and making as-needed repairs.

Finally, TDEC DSWM regulations at 0400-11-01.04(8)(c) require TVA to meet specific requirements for the cover system design, surface grading and drainage systems, erosion prevention measures, and leachate collection systems. TVA will utilize existing cover systems that meet the cover system standards, or where new cover systems or extensions of existing systems must be installed, TVA will install new cover systems consistent with the existing cover systems, or install alternative final cover systems where necessary, that meet the cover system standards. Drainage and erosion will be controlled and minimized through a stormwater management system and site grading plan. Waters generated by the closure actions, including leachate where applicable, will be treated as required in the applicable permit(s), or as otherwise necessary to prevent threats to human health and the environment, to TDEC-approved levels prior to discharge.

5.5.2 CCR Unit-Specific Closure Actions

The following subchapters provide the basis for, and implementation of, the planned closure actions for each TDEC Order CCR unit at the KIF Plant. Exhibit 5-1 depicts a generalized plan for the closure actions for the KIF Plant TDEC Order CCR units. Exhibits 5-2 through 5-4 display additional information in plan and cross section of each TDEC Order CCR unit that compares 2019 conditions to the predicted future long-term conditions following implementation of the additional closure actions at each CCR unit based on modeling (Appendix G). Additionally, design drawings for the planned additional closure actions are presented in Appendix F.1, and draft closure and post-closure plans are provided in Appendix F.2.

The groundwater modeling program used for this study was selected, in part, because it is thoroughly documented; widely used by consultants, government agencies, and researchers; and is consistently accepted by regulators. The model was developed and calibrated in general accordance with international standards. The groundwater model was used to develop Exhibits 5-2 through 5-4 that display the recent and future long-term conditions (following completion of additional closure implementation actions) represents a simplified version of the current understanding of hydrogeologic conditions at the KIF Plant using the data and information available at the time it was developed and used for evaluations in this CARA Plan. As such, there is a potential that the input parameters and underlying assumptions used to develop the model may not be fully representative of the complexities of the KIF Plant groundwater system, and thus may over-predict or under-predict existing or future conditions. However, the calibrated model is considered a reliable tool to meet objectives of the modeling study to support CCR unit closure (and groundwater corrective action) alternatives presented in this CARA Plan.

5.5.2.1 Stilling Pond Closure-in-Place

CIP is planned for the Stilling Pond based on:

(1) There are no unacceptable risks to human or ecological receptors. The HHERA evaluation was conducted using USEPA guidance and reached this conclusion based on extensive KRP and EI data related to this CCR unit. This conclusion is consistent with TVA's long-term monitoring results, and the EAR findings that ecological communities in the surrounding water bodies are healthy and are not being adversely impacted by the CCR units. The previously completed CIP actions would maintain this condition in the future, compared to CBR which is likely to result in increased potential of onsite worker and public exposure to CCR material due to excavation and transport activities.

(2) CBR has substantial relative adverse impacts compared to CIP. Assuming a buttress of CCR material remains in place as described below, the excavation and disposal of approximately 680,000 cubic yards of CCR material and placement of about 360,000 cubic yards of backfill, would require about four to five years of closure-related activities. Approximately 510,000 cubic yards of CCR material would be disposed of at an onsite landfill. Given the onsite landfill capacity and borrow soil constraints, approximately 170,000 cubic yards of CCR material would be transported approximately 51 miles to an offsite landfill and about 310,000 cubic yards of offsite borrow materials would be needed. Collectively these actions result in about 30,000 truckloads to complete CBR, potentially impacting 34 communities with environmental justice concerns. In contrast, this CCR unit had CIP completed in 2018, and the current closure method has been effective meeting the closure performance standard. Because CBR would require the excavation, handling, and offsite transport of CCR material, there is greater potential adverse environmental, human health and safety impacts and a larger potential offsite impact footprint than maintaining CIP. Future CIP actions are comprised of post-closure care activities which require less disturbance, are smaller in scale, and have less potential adverse impacts on the majority of resource areas analyzed.

(3) CBR with complete removal of CCR material from the Stilling Pond may be infeasible and unsafe due to structural stability concerns. The Stilling Pond is adjacent to the southern boundary of the KRP Ash Landfill. Along this boundary, a series of buried cement-bentonite walls were constructed as part of the KRP Ash Landfill PWS component of the PCS described in Chapter 1.3.4. The stability design of the KRP Ash Landfill relies, in part, on the buttressing effect of the CCR material in the Stilling Pond. Complete removal of CCR material from this adjoining CCR unit could destabilize the perimeter of the KRP Ash Landfill and construction of a replacement buttress using fill material may not be feasible. To avoid substantial increased stability risks for the KRP Ash Landfill, a buttress of CCR material within the Stilling Pond is assumed to remain in place to meet stability requirements. Although partial removal of CCR material from this CCR unit may be possible, TVA estimates that approximately 120,000 cubic yards would need to remain in place (with a geosynthetic cover system), to serve as a buttress to meet stability requirements. This volume estimate has been developed solely to allow for the comparative evaluation of CBR to CIP. A stability analysis and detailed design would be needed to refine this estimate were CBR to be identified as the closure method.

(4) CIP using geosynthetic cover systems meets or exceeds regulatory requirements and is the widely accepted industry standard for in-place waste closures to control, minimize, or eliminate infiltration. Based on modeling of future conditions, the current pore water phreatic surface is considered to reflect long-term conditions. Exhibits

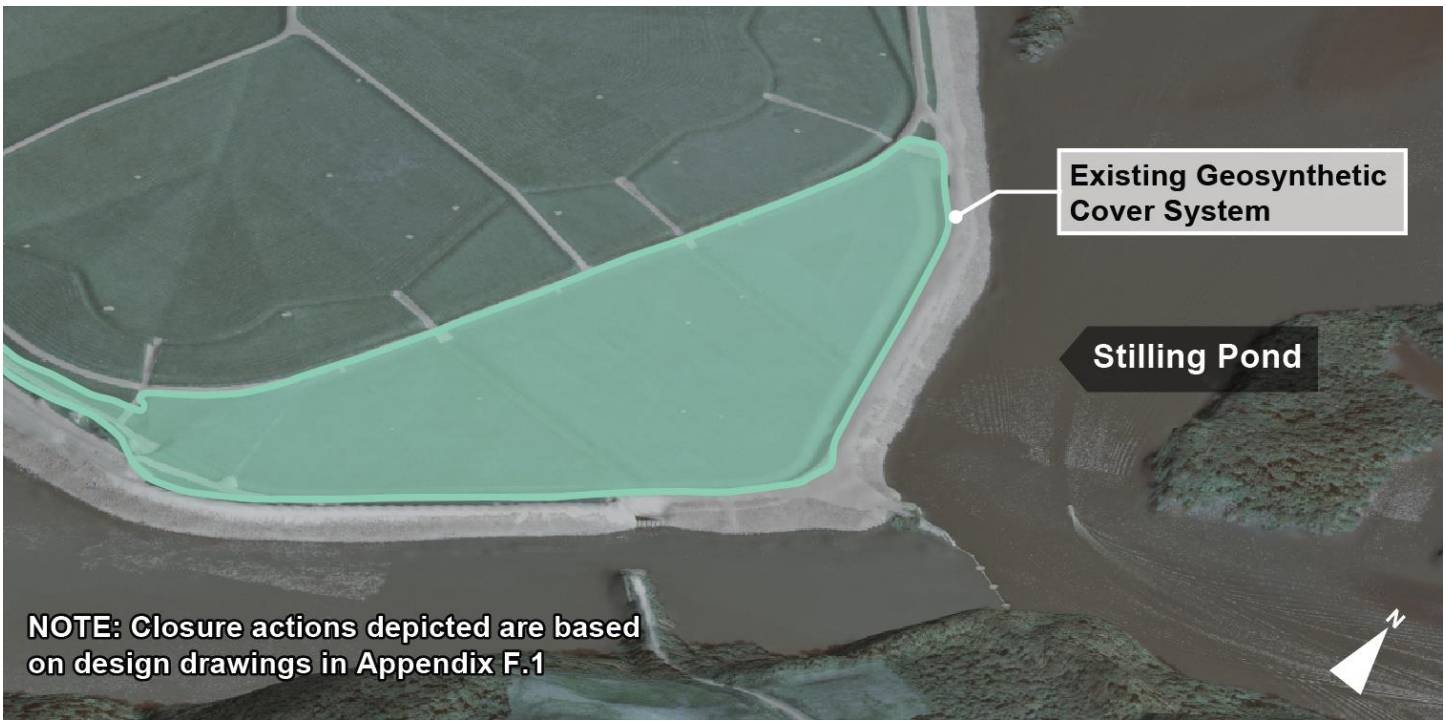
5-2 and 5-3 respectively provide plan and cross section views of the Stilling Pond that depict the recent and predicted future long-term conditions based on modeling (Appendix G).

(5) CIP meets or exceeds the general performance standard for closure in the TDEC DSWM regulations. TVA will continue post-closure monitoring and maintenance activities as required in the existing Closure and Post-Closure Plans (Stantec 2017a and 2017b).

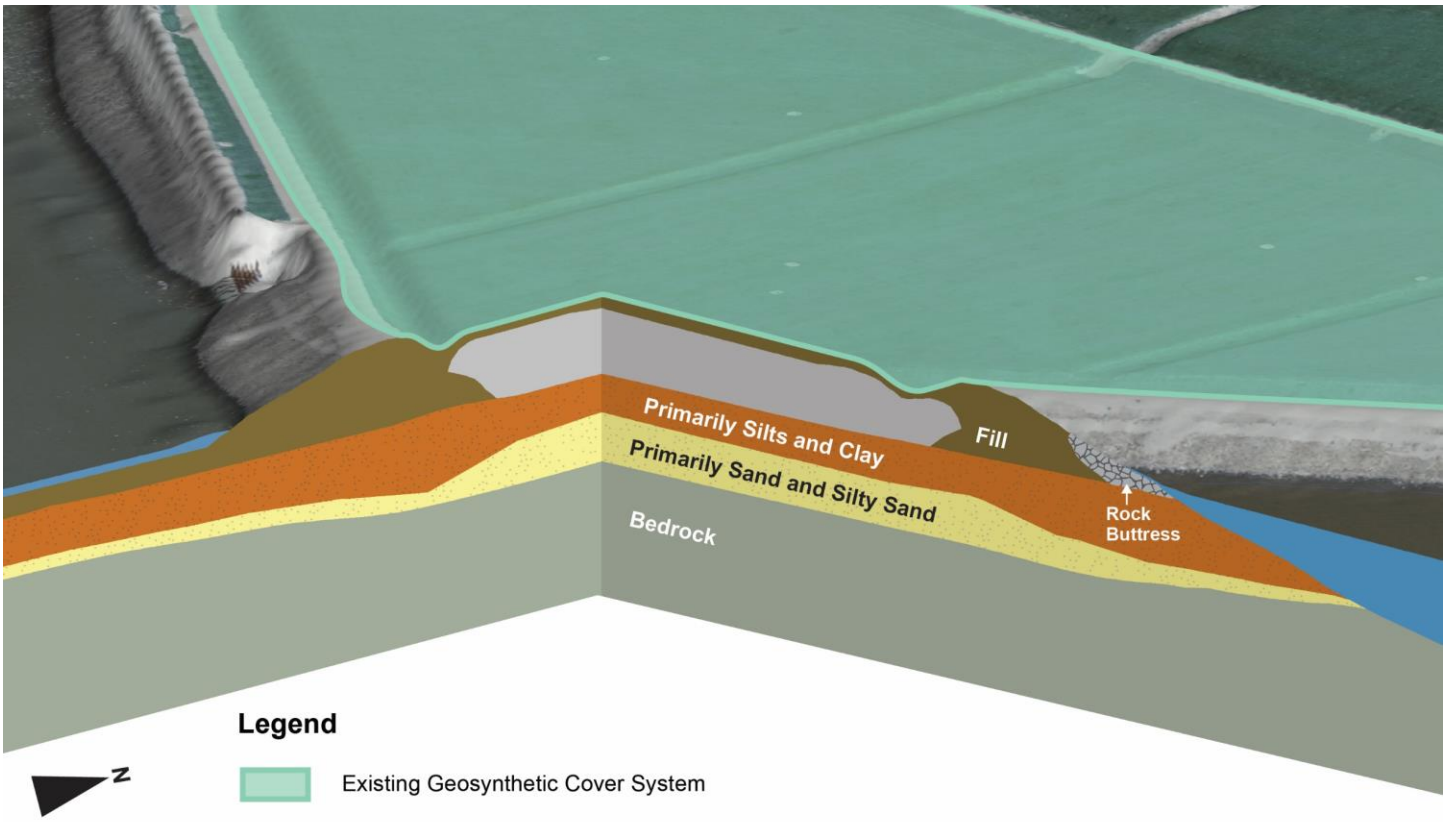
As described in Chapter 2.1.1.1, the Stilling Pond was closed in 2018 by removing free water, partially excavating Dike C for borrow material, and constructing an engineered geosynthetic-soil cover system that meets regulatory requirements, as described in Chapter 5.1.1.

Based on the current performance of the existing cover system and predicted future long-term conditions that are similar to current conditions, TVA is not planning additional closure actions at the Stilling Pond. The following illustration depicts the closure actions already performed at the Stilling Pond:

Stilling Pond Planned Closure Action, Plan View



Stilling Pond Planned Closure Action, Profile View



5.5.2.2 Interim Ash Staging Area Closure-in-Place

CIP, including additional cover system and drainage modifications, is planned for the Interim Ash Staging Area based on:

(1) There are no unacceptable risks to human or ecological receptors. The HHERA evaluation was conducted using USEPA guidance and reached this conclusion based on extensive KRP and EI data related to this CCR unit. This conclusion is consistent with TVA's long-term monitoring results and the EAR findings that ecological communities in the surrounding water bodies are healthy and are not being adversely impacted by the CCR units. The planned CIP actions would maintain this condition in the future, compared to CBR which is likely to result in increased potential of onsite worker and public exposure to CCR material due to excavation and transport activities.

(2) CBR has substantial relative adverse impacts compared to CIP. Assuming a buttress of CCR material remains in place as described below, the excavation and disposal of approximately 2.8 million cubic yards of CCR material and placement of about 2.5 million cubic yards of backfill, would require between 14 to 15 years of closure-related activities. Approximately 2.1 million cubic yards of CCR material would be disposed of at an onsite landfill. Given the onsite landfill capacity and borrow soil constraints, approximately 740,000 cubic yards of CCR material would be transported approximately 51 miles to an offsite landfill and about 2.2 million cubic yards of offsite borrow materials would be needed. Collectively these actions result in about 220,000 offsite truckloads to complete CBR, potentially impacting 34 communities with environmental justice concerns. In contrast, additional CIP actions

require three to four years to complete, using approximately 2,000 truckloads for transport of borrow material from an onsite source, resulting in far fewer potential community, worker and public safety impacts, as well as substantially lower GHG emissions from transportation and construction activities than CBR.

(3) CBR with complete removal of CCR material from the Interim Ash Staging Area may be infeasible and unsafe due to structural stability concerns. The Interim Ash Staging Area is adjacent to the southwestern boundary of the KRP Ash Landfill. Along this boundary, a series of buried cement-bentonite walls were constructed as part of the KRP Ash Landfill PWS component of the PCS described in Chapter 1.3.4. The stability design of the KRP Ash Landfill relies, in part, on the buttressing effect of the CCR material in the Interim Ash Staging Area. Complete removal of CCR material from this adjoining CCR unit could destabilize the perimeter of the KRP Ash Landfill and construction of a replacement buttress using fill material may not be feasible. To avoid substantial increased stability risks for the KRP Ash Landfill, a buttress of CCR material within the Interim Ash Staging Area is assumed to remain in place to meet stability requirements. Although partial removal of CCR material from this CCR unit may be possible, TVA estimates that approximately 150,000 cubic yards would need to remain in place (with a geosynthetic cover system), to serve as a buttress to meet stability requirements. This volume estimate has been developed solely to allow for the comparative evaluation of CBR to CIP. A stability analysis and detailed design would be needed to refine this estimate were CBR to be identified as the closure method.

(4) CIP using geosynthetic cover systems meets or exceeds regulatory requirements and is the widely accepted industry standard for in-place waste closures to control, minimize, or eliminate infiltration. The planned closure action at the Interim Ash Staging Area to install a similar geosynthetic cover system, along with drainage modifications in adjacent and upgradient areas, would further control and minimize infiltration through the cover system into the CCR unit, thereby minimizing post-closure escape of CCR constituents. Based on modeling of future conditions, the pore water phreatic surface is expected to keep declining until long-term conditions are reached. Exhibits 5-2 and 5-4 respectively provide a plan view and cross sections of the Interim Ash Staging Area that depict the recent and the predicted future long-term conditions following implementation of the additional closure actions based on modeling (Appendix G).

(5) CIP meets or exceeds the general performance standard for closure in the TDEC DSWM regulations. TVA will implement the additional closure actions and conduct post-closure care and maintenance activities as described in the Closure and Post-Closure Plans provided in Appendix F.2 following approval of this CARA Plan.

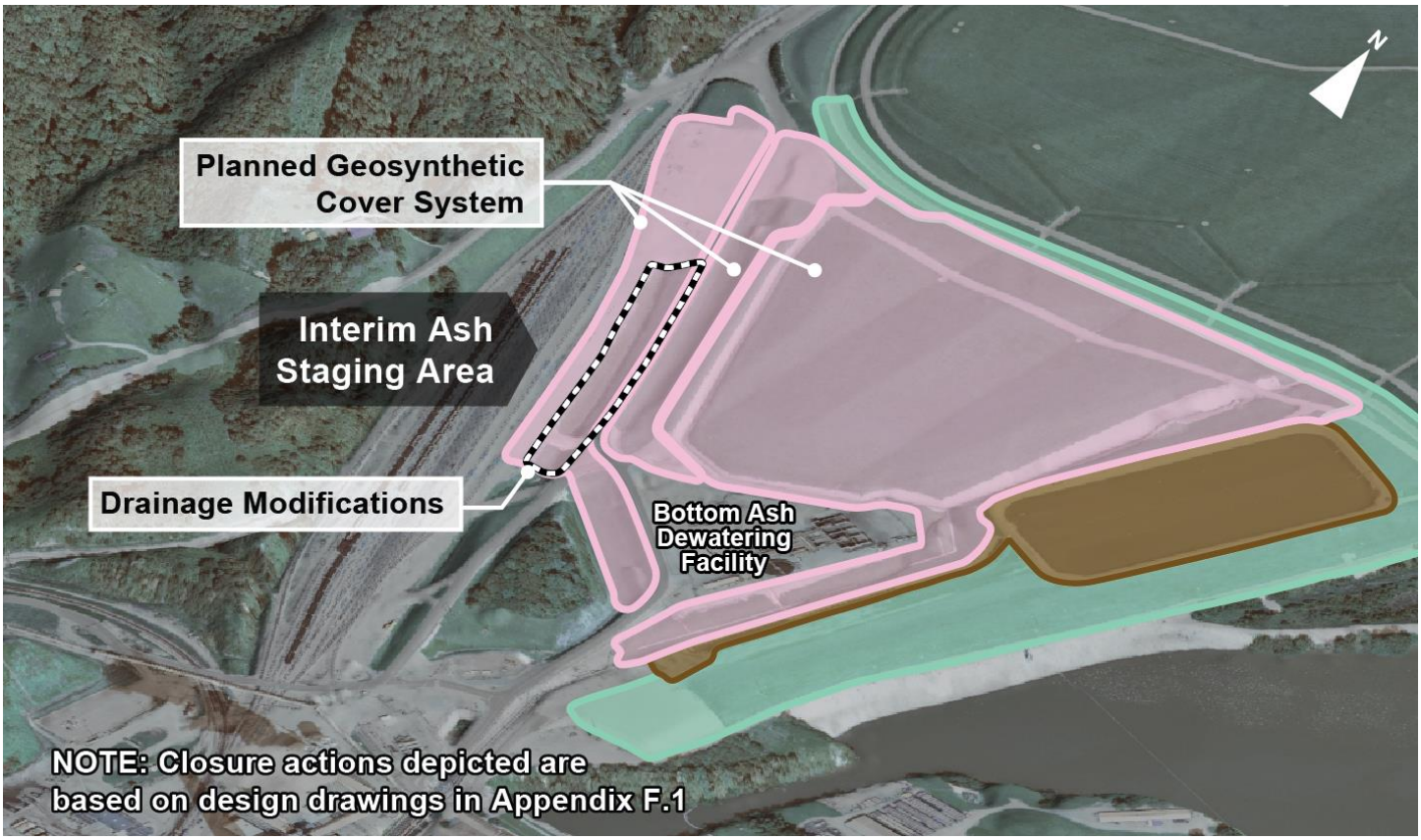
As described in Chapter 2.1.1.2, the Interim Ash Staging Area was closed in 2016 using an engineered soil cover system that meets regulatory requirements. TVA plans modify the existing cover system at this CCR unit with a geosynthetic cover system to further control and minimize infiltration through the cover system, thereby reducing post-closure escape of CCR constituents. The proposed engineered geosynthetic cover system will extend beyond the existing limits of the soil cover system along the western and southern edges of the Interim Ash Staging Area and tie into the existing geosynthetic cover systems in the Sluice Trench and Area East of Sluice Trench and Ditch 11. Areas within the limits of the proposed geosynthetic cover system will be regraded to promote site drainage using existing material or onsite borrow material. If CCR material is exposed during regrading operations, the material will be placed within the cover system limits. Once final grades are achieved, a geosynthetic-soil cover system or a geosynthetic-engineered turf cover system, as described in Chapter 5.1.1, will be installed. Stormwater drainage modifications will include replacement of existing stormwater culverts disturbed during construction and installation of new stormwater culverts as necessary. The stormwater ditch to the east of the railroad tracks will be regraded to improve drainage conditions. Following completion of the regrading and cover

system extensions, exposed areas will be stabilized with seed or sod, and gravel roadways will be repaired or replaced as necessary.

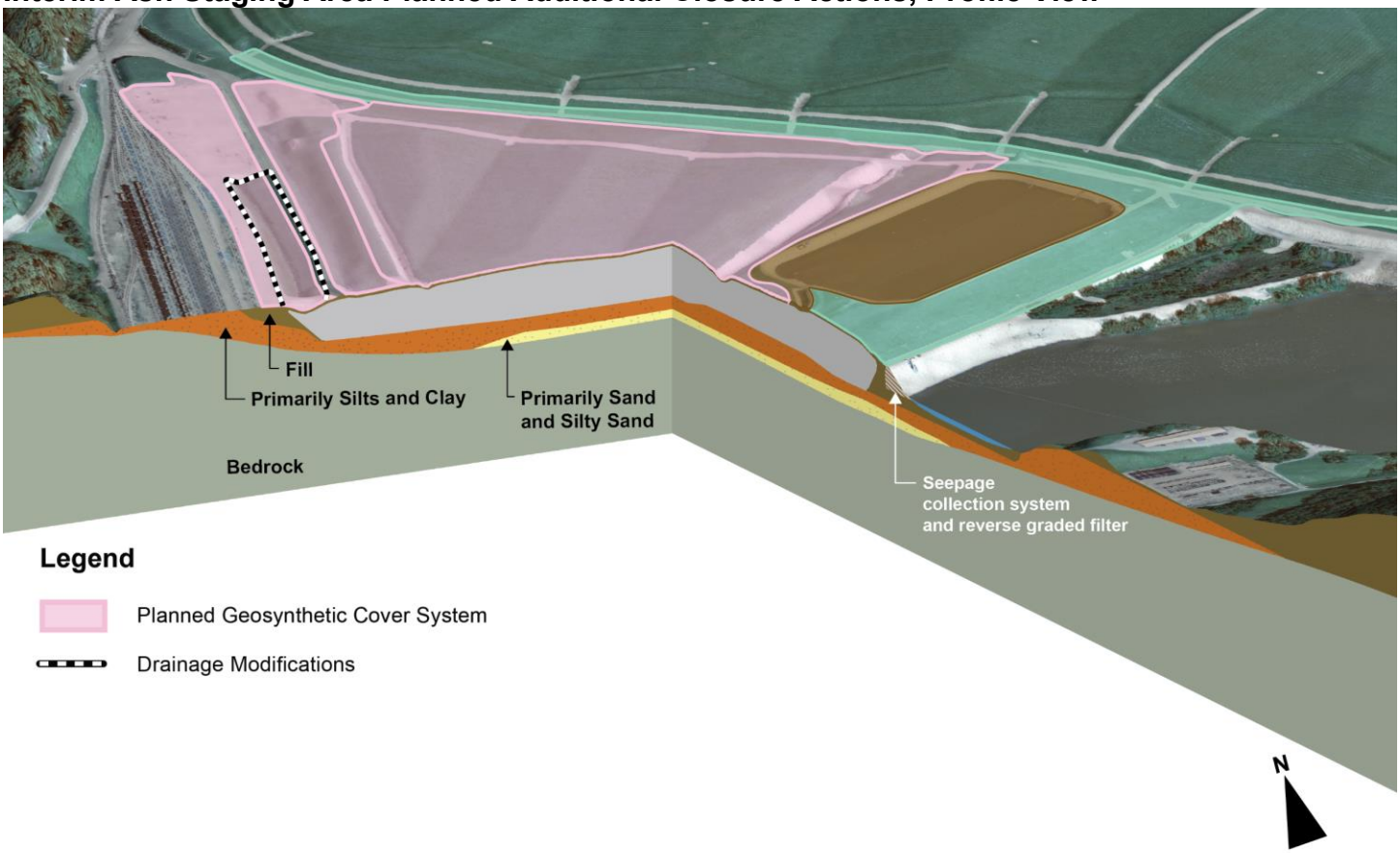
As noted in Chapter 2.1.1.2, a final cover system has not been constructed at the Bottom Ash Dewatering Facility. Because the Bottom Ash Dewatering Facility is still active, TVA has not included planned closure actions for this area in this CARA Plan.

The planned comprehensive closure actions for this CCR unit are displayed in the illustrations below:

Interim Ash Staging Area Planned Additional Closure Actions, Plan View



Interim Ash Staging Area Planned Additional Closure Actions, Profile View



5.5.2.3 Sluice Trench and Area East of Sluice Trench Closure-in-Place

CIP is planned for the Sluice Trench and Area East of Sluice Trench based on:

(1) There are no unacceptable risks to human or ecological receptors. The HHERA evaluation was conducted using USEPA guidance and reached this conclusion based on extensive KRP and EI data related to this CCR unit. This conclusion is consistent with TVA's long-term monitoring results and the EAR findings that ecological communities in the surrounding water bodies are healthy and are not being adversely impacted by the CCR units. The planned CIP actions would maintain this condition in the future, compared to CBR which is likely to result in increased potential of onsite worker and public exposure to CCR material due to excavation and transport activities.

(2) CBR has substantial relative adverse impacts compared to CIP. Assuming a buttress of CCR material remains in place as described below, the excavation and disposal of approximately 880,000 cubic yards of CCR material and placement of about 670,000 cubic yards of backfill, would require about 5 to 6 years of closure-related activities. Approximately 650,000 cubic yards of CCR material would be disposed of at an onsite landfill. Given the onsite landfill capacity and borrow soil constraints, approximately 230,000 cubic yards of CCR material would be transported approximately 51 miles to an offsite landfill and about 580,000 cubic yards of offsite borrow materials would be needed. Collectively these actions result in about 48,000 offsite truckloads to complete CBR, potentially

impacting 34 communities with environmental justice concerns. In contrast, this CCR unit had CIP completed in 2018, and the current closure method has been effective meeting the closure performance standard. Because CBR would require the excavation, handling, and offsite transport of CCR material, there is greater potential adverse environmental, human health and safety impacts and a larger potential offsite impact footprint than maintaining CIP. Future CIP actions are comprised of post-closure care activities which require less disturbance, are smaller in scale, and have less potential adverse impacts on the majority of resource areas analyzed.

(3) CBR with complete removal of CCR material from the Sluice Trench and Area East of Sluice Trench may be infeasible and unsafe due to structural stability concerns. The Sluice Trench and Area East of Sluice Trench is adjacent to the southern boundary of the KRP Ash Landfill. Along this boundary, a series of buried cement-bentonite walls were constructed as part of the KRP Ash Landfill PWS component of the PCS described in Chapter 1.3.4. The stability design of the KRP Ash Landfill relies, in part, on the buttressing effect of the CCR material in the Sluice Trench and Area East of Sluice Trench. Complete removal of CCR material from this adjoining CCR unit could destabilize the perimeter of the KRP Ash Landfill and construction of a replacement buttress using fill material may not be feasible. To avoid substantial increased stability risks for the KRP Ash Landfill, a buttress of CCR material within the Sluice Trench and Area East of Sluice Trench is assumed to remain in place to meet stability requirements. Although partial removal of CCR material from this CCR unit may be possible, TVA estimates that approximately 8,900 cubic yards would need to remain in place (with a geosynthetic cover system), to serve as a buttress to meet stability requirements. This volume estimate has been developed solely to allow for the comparative evaluation of CBR to CIP. A stability analysis and detailed design would be needed to refine this estimate were CBR to be identified as the closure method.

(4) CIP using geosynthetic cover systems meets or exceeds regulatory requirements and is the widely accepted industry standard for in-place waste closures to control, minimize, or eliminate infiltration. Based on modeling of future conditions, the current pore water phreatic surface is considered to reflect long-term conditions. Exhibits 5-2 and 5-4 respectively provide plan and cross section views of the Sluice Trench and Area East of Sluice Trench that depict the recent and predicted future long-term conditions based on modeling (Appendix G).

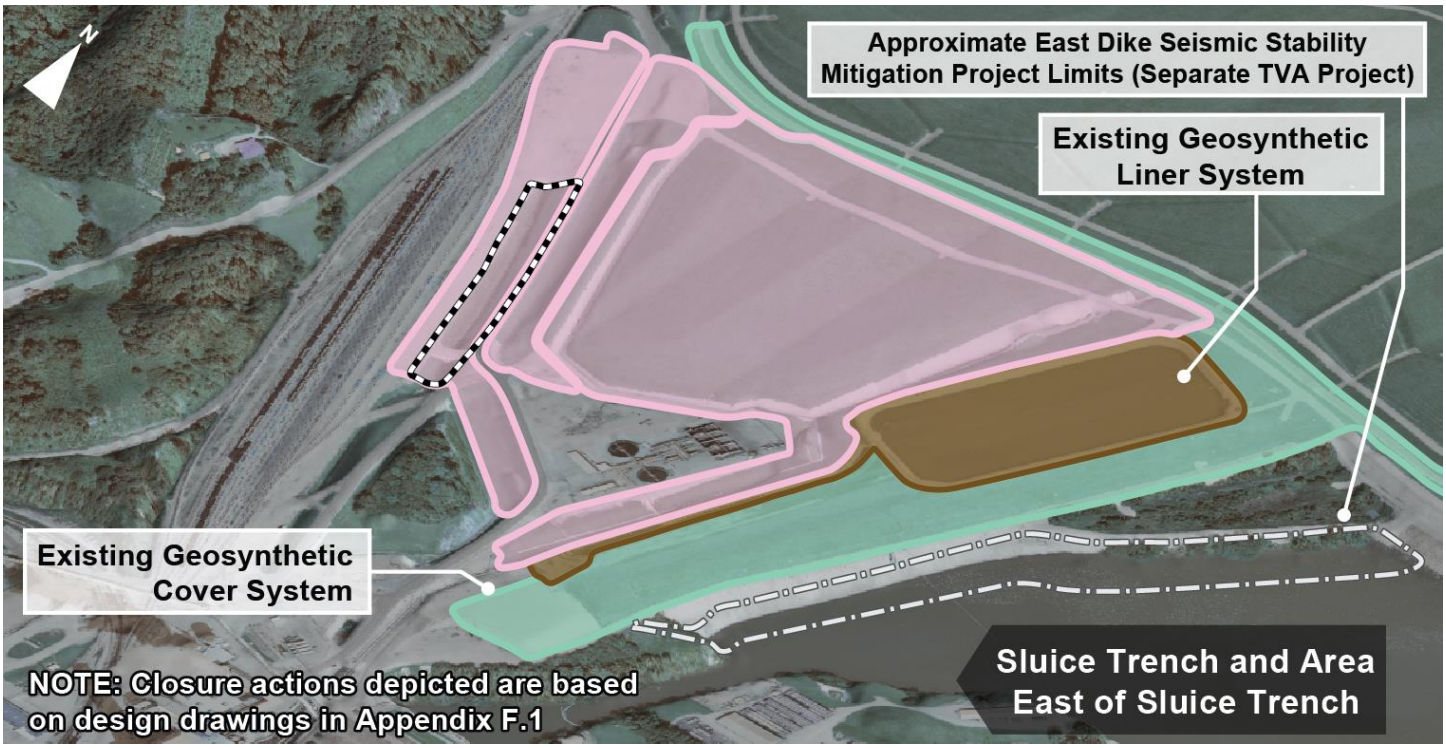
(5) CIP meets or exceeds the general performance standard for closure in the TDEC DSWM regulations. TVA will continue post-closure monitoring and maintenance activities as required in the existing Closure and Post-Closure Plans (AECOM 2018, 2019).

As described in Chapter 2.1.1.3, the Sluice Trench and Area East of Sluice Trench was closed in 2018 by constructing engineered soil and geosynthetic-soil cover systems that meet regulatory requirements, as described in Chapter 5.1.1. The existing soil cover system located between the Water Quality Channel and Bottom Ash Dewatering Facility will be modified with a geosynthetic cover system as part of the Interim Ash Staging Area planned additional closure actions, as described in Chapter 5.5.2.2. As described in the introduction of this chapter, TVA is constructing an East Dike seismic stability mitigation project at this TDEC Order CCR unit as a separate project prior to CARA Plan implementation. TVA anticipates completing the construction phase of the project in 2025. The project includes the construction of a stability berm, which will also function as a working platform, and foundation soil ground improvements by stone columns as a seismic mitigation measure, such that the CCR unit will meet or exceed slope stability criteria for pseudostatic global and post-earthquake global stability.

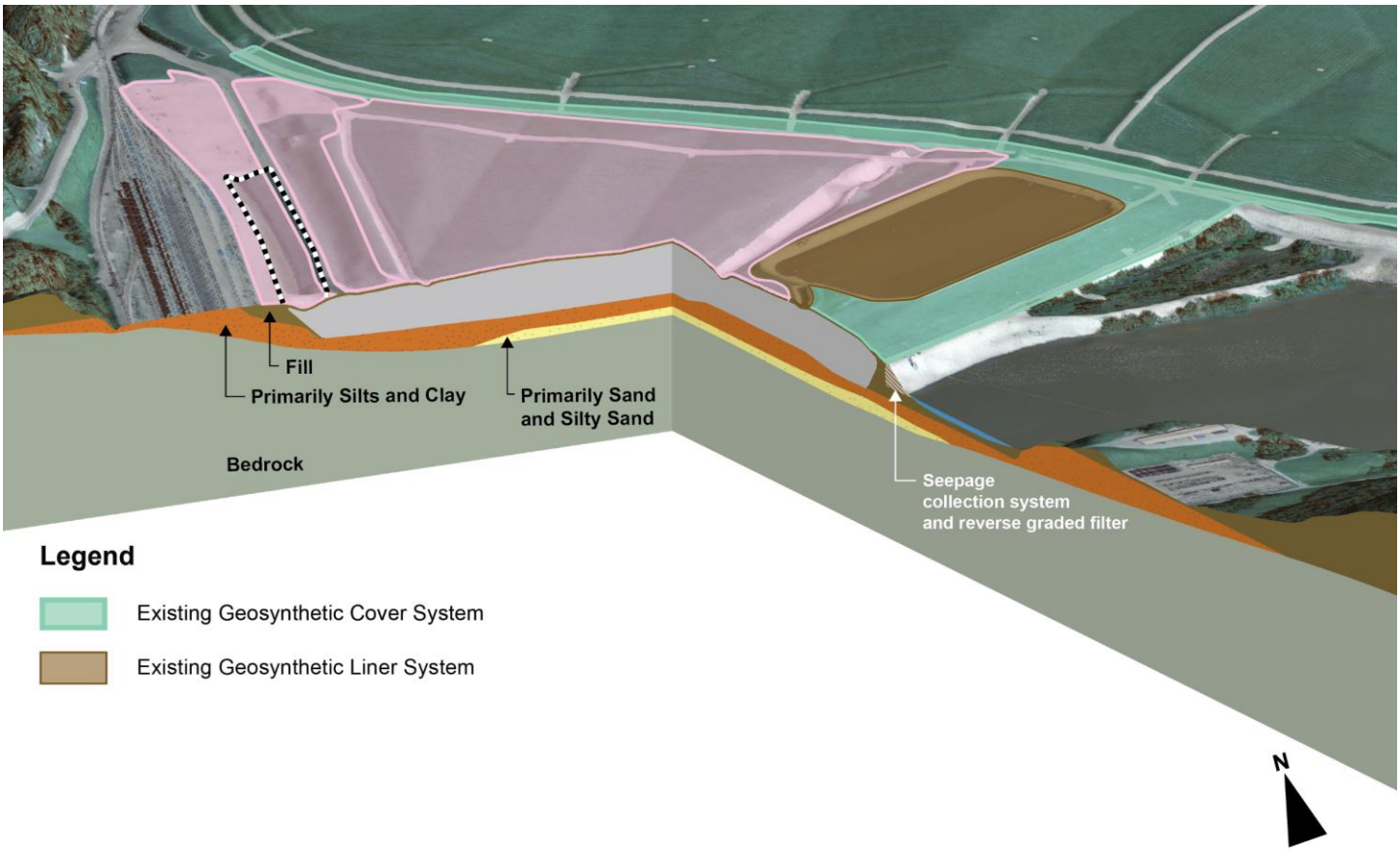
Based on the current performance of the existing cover systems and predicted future long-term conditions that are similar to current conditions, TVA is not planning additional closure actions at the Sluice Trench and Area East of Sluice Trench.

The following illustration depicts the closure actions already performed at the Sluice Trench and Area East of Sluice Trench:

Sluice Trench and Area East of Sluice Trench Planned Closure Action, Plan View



Sluice Trench and Area East of Sluice Trench Planned Closure Action, Profile View



5.6 CCR Unit Closure Method Summary

Based on the findings of the EI, the HHERA conclusions, comparison of closure method alternatives, and evaluation of regulatory standards, TVA is planning CIP as the closure method for each KIF Plant TDEC Order CCR unit. Multiple lines of evidence were used to provide this basis for the planned closure and support development of associated closure actions, as outlined below:

- CIP is environmentally more beneficial than CBR, particularly for the KIF Plant TDEC Order CCR units where about 4.4 million cubic yards of CCR material would have to be removed and transported to alternate landfills (including about 1.1 million cubic yards to an offsite landfill). Additionally, CBR requires about 3.8 million cubic yards of borrow soil for backfill of the TDEC Order CCR units, most of which is obtained offsite (approximately 3.1 million cubic yards).
- Compared to CIP, CBR results in substantially greater adverse impacts related to transportation and construction, particularly climate change and GHG emissions, worker and transportation safety, and potential impacts to nearby communities with environmental justice concerns.

- Once closure begins, CBR would require 19 to 22 years to complete compared to the three to four years for CIP for the three KIF Plant TDEC Order Plant CCR units.
- CIP provides source control faster than CBR due to the extended construction activities required to complete CBR.
- CBR with complete removal of the CCR material from the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of the Sluice Trench may be infeasible and unsafe due to structural stability concerns. The stability design of the KRP Ash Landfill relies, in part, on the buttressing effect of the CCR material in these CCR units. Complete removal of CCR material from these adjoining CCR units could destabilize the perimeter of the KRP Ash Landfill and construction of a replacement buttress using fill material may not be feasible.
- TVA's long-term monitoring results and the EAR findings indicate that ecological communities in the surrounding water bodies are healthy and are not being adversely impacted by the TDEC Order CCR units.
- There are no unacceptable risks for onsite or offsite human or ecological receptors from the TDEC Order CCR units at the KIF Plant based on the HHERA evaluation conducted using USEPA guidance.
- There are no onsite or downgradient offsite uses of groundwater as a drinking water source.
- CIP meets or exceeds the closure performance standards required by TDEC regulations and is consistent with industry standards for solid waste management closures.
- Geosynthetic cover systems are effective in controlling, minimizing or eliminating infiltration through the cover system as previously demonstrated at other TVA sites.
- Based on modeling of future conditions, after the additional closure actions are completed at the Interim Ash Staging Area the pore water phreatic surface is expected to decline until long-term conditions are reached
- Once the stability berm and foundation soil ground improvements are constructed at the East Dike, the TDEC Order CCR units will meet the established slope stability factor of safety during closure, the post-closure period, and beyond.

With no unacceptable risks related to CIP, CBR of the CCR units is not necessary nor justified with its much longer timeline to complete closure, greater overall environmental impacts, and substantially higher cost.

Chapter 6 Basis and Methods of CCR Unit Corrective Action

This chapter describes the basis and methods of TVA's planned corrective actions at the KIF Plant TDEC Order CCR units, including discussion of the applicable State requirements that govern CCR unit corrective action. TVA has evaluated general corrective measure strategies, considered regulatory requirements, and assessed site-specific conditions to identify the corrective measure technologies planned for implementation. Corrective measures are the individual technologies considered and evaluated. Also as described in this chapter, 'corrective action' simply means the approach TVA plans to use to improve groundwater quality consistent with regulatory requirements (also sometimes referred to as a "remedy").

As presented in this CARA Plan, TVA plans to implement corrective actions to address two well locations at the Sluice Trench and Area East of Sluice Trench and Interim Ash Staging Area CCR units, and three well locations at the Stilling Pond CCR unit. These corrective actions are consistent with TDEC regulations and supported by site-specific evaluations of potential corrective measures. Details regarding the corrective measures assessment for the KIF Plant TDEC Order CCR units are presented in Appendix D. The following subchapters describe the information evaluated by TVA that forms the basis for, and methods to implement, the planned groundwater corrective actions at the TDEC Order CCR units:

- Chapter 6.1 provides the basis for groundwater corrective measures.
- Chapter 6.2 describes the general corrective measure strategies considered by TVA.
- Chapter 6.3 summarizes the TDEC Order and TDEC DSWM requirements for corrective action.
- Chapter 6.4 presents the overall assessment process and site-specific considerations of the potential corrective measures evaluated.
- Chapter 6.5 summarizes the assessment of corrective measures and describes the planned corrective actions for the TDEC Order CCR units.
- Chapter 6.6 provides a high-level summary of the basis and methods for the planned groundwater corrective actions.

Because the Sluice Trench and Area East of Sluice Trench lies between the Interim Ash Staging Area and the downgradient groundwater monitoring wells, and because there is a single groundwater monitoring system for these two TDEC Order CCR units (the three wells that comprise the monitoring system for the Interim Ash Staging Area are also part of the monitoring system for the Sluice Trench and Area East of Sluice Trench), corrective measures for groundwater have been evaluated for these two CCR units together. For the purposes of the groundwater corrective measures evaluation, these two TDEC Order CCR units are collectively referred to as the 'Sluice Trench/Interim Ash Area' in this CARA Plan.

As presented in Chapters 3 and 4, respectively, environmental media evaluated in this CARA Plan are based on EAR findings and HHERA results. The EAR findings (summarized in Chapter 3.2) were based on comparison of groundwater analytical results for CCR constituents to TDEC-approved screening levels, and on the KRP data evaluation of surface stream water, sediment, and ecology. The HHERA included in this CARA Plan conducted further evaluation of these environmental media. As explained in Chapter 4, the HHERA evaluation concluded that there are no unacceptable risks to

human or ecological receptors based on USEPA guidance for assessing potential exposures to sediment, surface stream water, or groundwater. Therefore, corrective action is only required for groundwater in order to attain GWPS at five identified wells (AD-2, 6AR, KIF-103, KIF-104, and KIF-105) consistent with regulatory requirements.

6.1 Basis for Groundwater Corrective Measures

TVA is establishing a common list of CCR parameters as the basis for groundwater corrective measures for the CCR units included in the TDEC Order. To develop this list, TVA considered TDEC DSWM requirements for groundwater protection as well as other appropriate standards for groundwater protection. To provide alignment with standards beyond the TDEC DSWM requirements, TVA developed GWPS for the parameters listed in Table 1-1 and is applying these GWPS for TVA sites within the Tennessee Valley. The GWPS is defined as the Maximum Contaminant Level (MCL) for CCR constituents that have an MCL. The MCLs included in the TDEC DSWM regulations are consistent with federal MCLs. For CCR constituents that do not have an MCL listed in Appendix III of TDEC DSWM regulations, including cobalt, lithium, molybdenum, and radium-226 and radium-228, human health risk-based values were adopted for this CARA Plan. Based on this approach, TVA has identified the GWPS in Table 1-1 for this CARA Plan.

As such, the specific CCR units, constituents, and wells requiring corrective action at the KIF Plant are presented below and depicted in Exhibit 3-4:

Summary of Findings That Require Corrective Action in the CARA Plan	
CCR Unit	**Groundwater**
Sluice Trench/Interim Ash Area (Sluice Trench and Area East of Sluice Trench and Interim Ash Staging Area)	Cobalt (Wells AD-2 and KIF-105)
Stilling Pond	Cobalt (Wells 6AR, KIF-103, and KIF-104)

The findings above, which require the assessment of corrective measures and identification of planned corrective actions in this CARA Plan, are based on the conclusions of a statistical evaluation of groundwater data collected through December 2022 as presented in the EAR. TVA is continuing to monitor groundwater at the TDEC Order CCR units, and these data will further inform the type and extent of, or need for, groundwater corrective action. For context, the statistical evaluation in the EAR asked the question, “Do the available data show that, at a statistically significant level, the concentration of a given CCR constituent is above a GWPS?” As additional groundwater data are collected during the CARA Plan finalization and corrective action final design processes, an additional question becomes important: “Do current groundwater monitoring data confirm that there continue to be statistically significant constituent concentrations above GWPS, and are those concentrations increasing, stable, or decreasing?” This question gets to the issue of changing groundwater conditions, and of whether implementation of an active, passive, or no corrective measure is ultimately needed.

6.2 General Description of Corrective Measures

Three primary corrective measure strategies have been identified as potentially applicable to address groundwater exhibiting statistically significant concentrations above the GWPS at the KIF Plant TDEC Order CCR units:

- Hydraulic Control and Treatment: Hydraulic control (also often called hydraulic containment) is a technology that has been employed for decades to control movement of groundwater. Hydraulic control approaches that may be considered include groundwater collection galleries or trenches, groundwater extraction wells, or a combination of these features. The applicability and design 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 targeted CCR constituents, and presence of receiving water bodies or groundwater production wells.

- Enhanced *In Situ* Treatment: *In situ* treatment of groundwater is an established technology for a variety of site conditions and contaminants. This approach includes measures implemented *in situ* (i.e., treatment is within the uppermost aquifer) to immobilize and reduce the concentrations of targeted CCR constituents. *In situ* technologies can be deployed in a variety of configurations depending on the extent of targeted constituents and the groundwater geochemical conditions.
- Monitored Natural Attenuation (MNA): MNA is a corrective measure approach 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 concentration or mobility of site CCR constituents present above GWPS in a time frame that is acceptable and can be comparable to other technologies.

Additional information regarding these corrective measure strategies is presented in Appendix D, Attachment A.

6.3 State Regulatory Requirements

TDEC Order and TDEC DSWM regulatory requirements for corrective action are described below.

6.3.1 TDEC Order

The TDEC Order specifies that the CARA Plan must include all actions TVA plans to take at the site and the basis for those actions. As appropriate for the site, the TDEC Order specifies that the final approved CARA Plan shall include "the method(s) TVA will employ to remediate CCR contaminated soil, surface water, and ground water at the site." The GWPS established for this CARA Plan are based on regulatory requirements and are presented in Table 1-1.

The TDEC Order also requires that the CARA Plan include a schedule of activities to be completed along with a public input process on the draft CARA Plan before it is finalized by TVA and approved by TDEC. The CARA Plan schedule, public notice and input process, and finalization of the CARA Plan are discussed further in Chapter 8.

6.3.2 TDEC DSWM

Under the TDEC DSWM regulations, CCR units must meet the GWPS and monitoring requirements in 0400-11-01-.04(7). When a constituent has been detected at a statistically significant level above a GWPS, a corrective measures assessment must be performed to evaluate potential options to address the constituent and identify a remedy. In accordance with TDEC DSWM regulations, the assessment of corrective measures includes consideration of:

(I) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies

(II) The time required to begin and complete the remedy

(III) The cost of remedy implementation

(IV) The institutional requirements such as State or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s).

Similar to the TDEC Order, TDEC DSWM regulations require a public meeting with interested and affected parties to discuss the results of the assessment prior to selection of a remedy.

Based on the results of the final corrective measures assessment, the owner or operator must select a remedy that, at a minimum, meets the following performance standards. As specified in the regulation, remedies must:

(I) Be protective of human health and the environment

(II) Attain the GWPS

(III) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent practicable, any further releases of constituents into the environment that may pose a threat to human health and the environment

(IV) Comply with standards for management of wastes.

Pursuant to TDEC DSWM 0400-11-01-.04(7)(a)9(v), the corrective actions will be considered complete when the GWPS have been achieved for the constituents shown in Table 1-1, concentrations of those constituents have not exceeded the GWPS for three consecutive years, and the actions required to complete the corrective measures are satisfied. The Commissioner may specify an alternative length of time during which the owner or operator must demonstrate that concentrations of constituents listed in Table 1-1 have not exceeded the GWPS taking into consideration the extent of the release(s), behavior characteristics of the CCR constituents; accuracy of monitoring techniques; and characteristics of the groundwater.

Table 6-1 provides the complete citation of the assessment of corrective measures requirements, GWPS, evaluation factors, and completion of corrective actions discussed in this chapter.

6.4 Site-Specific Assessment of Corrective Measures

TVA has assessed site-specific information to identify the corrective measures presented in this CARA Plan for the KIF Plant TDEC Order CCR units. Details regarding the specific corrective measures assessment and basis for the planned corrective actions for the KIF Plant TDEC Order CCR units are presented in Appendix D. This subchapter first provides an overview of the process used by TVA to perform those assessments, followed by a discussion of the types of site-specific information used to support the planned corrective actions. Chapter 6.5 provides a summary of the assessments and planned corrective actions.

The corrective actions identified in this CARA Plan encompass consideration of TDEC DSWM criteria in 0400-11-01-.04(7), which provides the following evaluation factors for consideration in making a remedy recommendation:

- Short- and long-term effectiveness and protectiveness, along with the degree of certainty that the remedy will prove successful
- Effectiveness of source control
- Ease or difficulty of implementation
- Consideration of community concerns.

Table 6-1 provides the complete citation of these evaluation factors when identifying a corrective action. TVA has considered these assessment and evaluation factors using site-specific information to identify both the types and deployment of corrective measures, as well as to develop groundwater flow and geochemical modeling simulations of corrective measure alternatives for the KIF Plant TDEC Order CCR units. This approach provides a consistent evaluation process for the TDEC Order CCR units and fulfills the TDEC Order requirement to provide the basis for planned corrective measures.

TVA evaluated the three potential corrective measure strategies presented in Chapter 6.2 (hydraulic control and treatment, *in situ* treatment, and MNA) considering site-specific conditions at the Sluice Trench/Interim Ash Area and the Stilling Pond. Relevant site-specific conditions include, but are not limited to, the CCR constituents targeted for corrective measures; geochemistry of the unconsolidated materials; groundwater flow rates, gradient, and flux; hydraulic barriers; topographic or other physical constraints; and as applicable, other planned operational or closure activities at the site.

Corrective actions for groundwater include a requirement for the implementation of source control measures. The goal of source control is to reduce or eliminate, to the maximum extent practicable, further releases of CCR constituents into the environment. Typical source control measures work by limiting the infiltration of precipitation into a source area or extracting water from within a source to lower the hydraulic head and potential for further releases. The key is to lower the hydraulic head within the source to facilitate the attainment of GWPS at compliance points along the downgradient edge of the source.

Corrective measures for groundwater at a given CCR unit are assessed in the context of the previously completed and planned additional CIP actions for that CCR unit because the CIP actions provide the source control to support the groundwater corrective actions. The planned additional closure actions are presented in Chapter 5.5.2 and include installation of a geosynthetic cover system and drainage modifications at the Interim Ash Staging Area.

6.5 PLANNED CCR UNIT CORRECTIVE ACTIONS

TVA is planning *in situ* treatment as the groundwater corrective action to address cobalt at the Sluice Trench/Interim Ash Area (wells AD-2 and KIF-105) and the Stilling Pond (wells 6AR, KIF-103, and KIF-104). TVA will continue to monitor groundwater and further evaluate MNA while the CARA Plan is finalized and the corrective action final design is developed, and if warranted based on those new groundwater monitoring results and evaluations, will coordinate any proposed modifications with, and obtain approval from, TDEC.

The HHERA evaluation concluded that there are no unacceptable risks to human or ecological receptors based on USEPA guidance for assessing potential exposures to sediment, surface stream water, or groundwater. Therefore, corrective action is only required for groundwater in order to attain GWPS at five wells (Sluice Trench/Interim Ash Area wells AD-2 and KIF-105, and Stilling Pond wells 6AR, KIF-103, and KIF-104), consistent with regulatory requirements. The following key factors provide the basis for TVA's planned corrective actions for the KIF Plant TDEC Order CCR units:

- *In situ* treatment bench testing indicates that *in situ* treatment can immobilize and reduce concentrations of CCR constituents until GWPS are attained and maintained, providing both short- and long-term effectiveness.
- *In situ* treatment is an established technology anticipated to require only occasional reagent injection events that would have fewer adverse environmental impacts than construction and continuous operation of a groundwater extraction and treatment system.

- Given the close proximity of the *in situ* treatment system to the monitoring wells (i.e., immediately upgradient of monitoring wells AD-2, KIF-105, 6AR, KIF-103, and KIF-104 along the downgradient boundaries of the TDEC Order CCR units), it is anticipated that GWPS would be attained at the monitoring wells within just a few years following *in situ* treatment implementation.

- After GWPS are attained at the monitoring wells, the *in situ* treatment system would continue to operate, reducing concentrations of target constituents in groundwater moving downgradient of the TDEC Order CCR units. Over time, the physical and geochemical processes that occur during the natural flow of groundwater through foundation soils, supported by the source control provided by the previously completed and planned additional closure actions (Chapter 5), will reduce the concentrations of targeted constituents in the upgradient uppermost aquifer such that concentrations at the monitoring wells will remain below GWPS after the corrective action concludes. The time required to achieve this condition where GWPS have been attained and would be maintained without continued corrective action is uncertain due to a variety of factors. However, routine groundwater monitoring at other TVA Plant CCR units has shown that implemented source control measures started to have a beneficial effect on groundwater quality within a five- to 10-year timeframe. The horizontal groundwater flow rate at the Stilling Pond is relatively slow, and so it is anticipated that groundwater quality improvement in the upgradient uppermost aquifer may take longer to be reflected in the monitoring results at the downgradient wells.

- Table 6-2 explains how the planned groundwater corrective action meets the TDEC regulatory requirements, which also fulfills the requirements in the TDEC Order.

As noted above, the groundwater corrective measure evaluations in this CARA Plan are based on the conclusions of a statistical evaluation of groundwater data available as of December 2022. Groundwater data continue to be collected at the Sluice Trench/Interim Ash Area and at the Stilling Pond in accordance with existing monitoring plans, and the extent and type of, or need for, groundwater corrective measures will be reevaluated in response to changing groundwater conditions. If concentrations of the target constituents were to fall below GWPS during approval and final design of the groundwater corrective measures such that groundwater corrective action is no longer required, then the planned corrective actions in the CARA Plan would not be implemented. The groundwater corrective measures to be implemented will be driven by the groundwater data and trends at the time of implementation. Any changes to the planned groundwater corrective actions would be coordinated with and approved by TDEC.

Based on the groundwater sampling results considered in this CARA Plan, the evaluation of corrective measure technologies and identification of planned corrective actions for the Sluice Trench/Interim Ash Area and Stilling Pond are described in more detail in Chapters 6.5.1 and 6.5.2 below and presented in full in Appendix D. Exhibit 6-1 displays the locations of the planned *in situ* treatment implementations used for evaluation in this CARA Plan for the Sluice Trench/Interim Ash Area and Stilling Pond. The actual locations of the *in situ* treatment deployments and associated details would be developed in the corrective action final design process following the CARA Plan approval. Additional information regarding implementation of closure and corrective action activities and schedule is provided in Chapter 8.

In the future, as the implemented corrective actions progress and conditions change, other evaluated technologies may be applicable for further study and considered for targeted implementation as part of the groundwater corrective actions. The future integration of additional corrective measures or modifications of the implemented corrective actions would be completed using an adaptive management process in coordination with, and with approval by, TDEC and in accordance with applicable regulations.

Adaptive management is a systematic project management approach centered on incorporating flexibility in site activities to account for: uncertainty, changes in site conditions, new information, an expanded understanding of the site, or new technology. This technique uses a systematic re-evaluation of site activities to account for new information and changing site conditions and adjusting plans to assure that objectives are met. For the Sluice Trench/Interim Ash Area and Stilling Pond groundwater, CARA Plan implementation will include monitoring groundwater quality in accordance with the TDEC-approved groundwater monitoring plans, and preparing a corrective action performance monitoring plan that will include methods to evaluate the effectiveness of the groundwater corrective actions. Implementing the corrective action performance monitoring plan will provide data to determine when GWPS have been met and when the corrective action is no longer needed. The corrective action performance monitoring plan will also include criteria for evaluating the progress of the corrective action toward meeting final GWPS goals. Changing groundwater chemistry or adverse trends could indicate that site conditions have changed, or the corrective action is not performing as intended and that a modified corrective measure is appropriate. Additional information regarding performance monitoring and adaptive management is provided in Chapter 7.2.2.

6.5.1 Stilling Pond

The following describes the corrective measures assessed for the Stilling Pond and the basis for identifying *in situ* treatment as the planned corrective action.

6.5.1.1 Corrective Measures Considered and Assessed

MNA, *in situ* treatment, and hydraulic control were evaluated as potential corrective measures to address cobalt concentrations in groundwater above GWPS at Stilling Pond wells 6AR, KIF-103, and KIF-104.

MNA relies on the natural geochemical system to attenuate concentrations of target constituents by adsorption onto unconsolidated materials or by other geochemical or physical processes. Generally, it appears that MNA could be an effective corrective measure for cobalt in groundwater at the Stilling Pond (Appendix D). A statistical evaluation of available groundwater monitoring data through March 2025 (Appendix L) showed that the cobalt concentration at well 6AR exhibited a statistically significant increasing trend prior to the installation of the geosynthetic soil cover system at the Stilling Pond in 2018, and a statistically significant decreasing trend after cover system installation. There are no data available prior to 2019 for wells KIF-103 and KIF-104, but the cobalt concentration at well KIF-103 after installation of the cover system exhibited a statistically significant decreasing trend, and the cobalt concentration was below the GWPS in seven of the eleven samples collected from well KIF-104 between September 2022 and March 2025. The site-specific mechanism of cobalt natural attenuation is currently under evaluation, and if supported by additional assessment, TVA will complete the four-tiered evaluation consistent with USEPA's MNA guidance (USEPA 2015b). Based on the above, MNA was not retained as a primary groundwater corrective measure alternative for the Stilling Pond at this time, but the further evaluation of natural attenuation mechanisms for cobalt at the Stilling Pond will continue, and MNA may be reconsidered as a potential primary groundwater corrective measure at a future time.

In situ treatment is an established technology that relies on the corrective measure to change geochemical conditions within the aquifer to immobilize and reduce the concentrations of the target constituents. As described in the *In Situ* Treatment Technical Memorandum (Appendix I.1), bench scale testing showed that appropriate dosing with sodium hydroxide (NaOH) reduced the cobalt concentration below the GWPS in the final Stilling Pond test column while maintaining concentrations of other metals below GWPS. The cobalt concentration was not consistently maintained below the GWPS in this final test column, suggesting that a higher target pH range may be necessary in a field scale application.

The ongoing *in situ* treatment field pilot test at the Watts Bar Fossil Plant (WBF Plant) is expected to provide insights that will also be applicable to the KIF Plant. The results of this pilot test are expected to inform the design of additional bench scale testing and a field pilot test at the downgradient boundary of the Stilling Pond to further evaluate site-specific geochemical responses to pH adjustments as well as reagent delivery effectiveness. On this basis, *in situ* treatment was retained as a primary groundwater corrective measure alternative for the Stilling Pond.

Hydraulic control relies on groundwater extraction to control movement of groundwater. Groundwater extraction and treatment is used worldwide as a reliable, proven technology for hydraulic control, and is easily implemented and sustainable. Groundwater extraction was evaluated using the calibrated numerical groundwater flow model to demonstrate that this approach would provide hydraulic control until GWPS are attained and maintained (Appendix G). Although hydraulic control using groundwater extraction and treatment is a feasible corrective action for the Stilling Pond, *in situ* treatment is anticipated to require only occasional reagent injection events that would have fewer adverse environmental impacts than construction and continuous operation of a groundwater extraction and treatment system. MNA, which remains a potentially effective corrective action approach pending further evaluation, would have even fewer adverse environmental impacts. Therefore, hydraulic control using groundwater extraction and treatment was not retained as a primary groundwater corrective measure alternative for the Stilling Pond.

6.5.1.2 Planned Corrective Action

Based on the evaluation presented above of potential corrective measures to address cobalt in groundwater above GWPS at the downgradient boundary of the Stilling Pond, the planned groundwater corrective action is *in situ* treatment. Although this corrective action has been further developed within this CARA Plan as the planned corrective action, TVA will continue to perform routine groundwater monitoring and further evaluate MNA prior to preparing detailed designs for an *in situ* treatment system. If future data and evaluations confirm that MNA will be effective, then TVA will coordinate with and obtain approval from TDEC to implement MNA as the corrective action. A summary of the planned groundwater corrective action is provided below, and design drawings further describing the planned corrective action are provided in Appendix F.1.

The *in situ* treatment system would be installed immediately upgradient of the monitoring wells (along the downgradient boundary of the Stilling Pond near wells 6AR, KIF-103, and KIF-104). The *in situ* treatment system would establish a treatment zone such that the normal flow of groundwater in the uppermost aquifer is intercepted by the *in situ* treatment zone, reducing the concentration of cobalt below the GWPS as the groundwater moves downgradient of the Stilling Pond. Because of the close proximity of the *in situ* treatment zone to the monitoring wells, the time to achieve the GWPS at these wells would be relatively short – anticipated to be on the order of just a few years. After GWPS are attained at Stilling Pond monitoring wells 6AR, KIF-103, and KIF-104, the *in situ* treatment system would continue to operate, immobilizing and reducing the concentration of cobalt in groundwater moving downgradient of the Stilling Pond.

Over time, the physical and geochemical processes that occur during the natural flow of groundwater through foundation soils, supported by the source control provided by the existing closure actions (Chapter 5), will reduce the concentrations of cobalt in the uppermost aquifer such that concentrations at the downgradient monitoring wells will remain below the GWPS after the corrective action concludes. Achieving this condition is the ultimate objective of the groundwater corrective action.

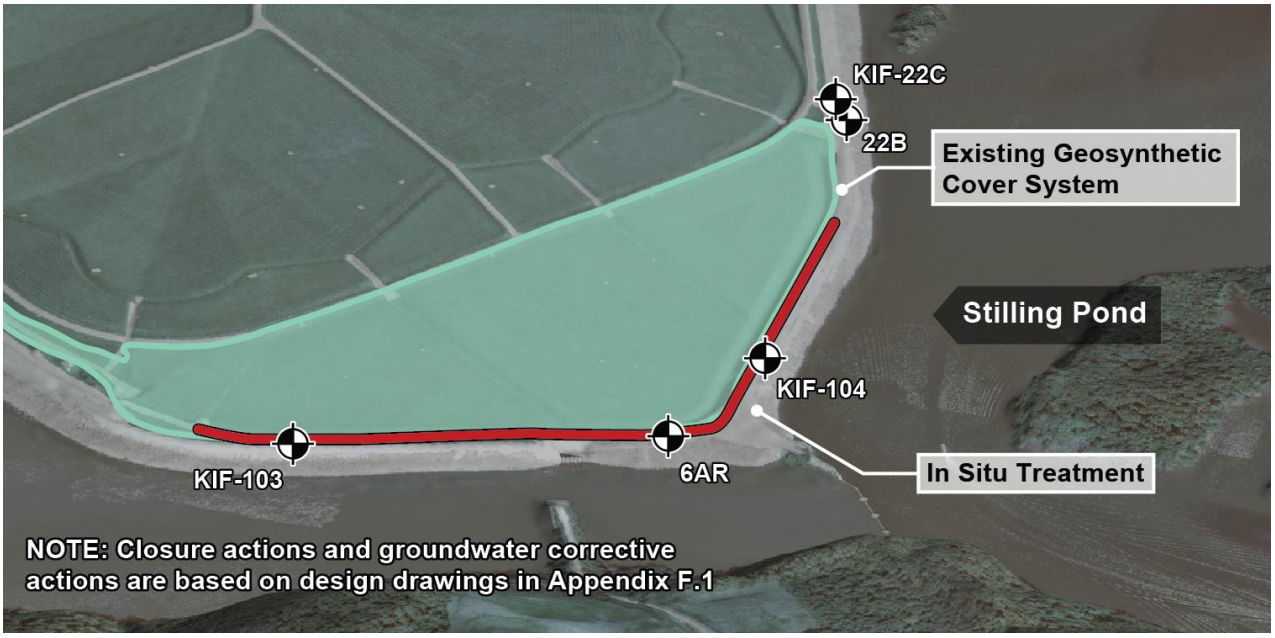
The time required to achieve this groundwater corrective action objective is uncertain due to a variety of factors. These factors include, for example, the initial magnitude of concentrations above the GWPS, the variable manner in which

physical and geochemical processes act on different CCR constituents, and the rate of groundwater flow within the uppermost aquifer. Routine groundwater monitoring at other TVA Plant CCR units has shown that implemented source control measures started to have a beneficial effect on groundwater quality within a five- to 10-year timeframe. The horizontal groundwater flow rate at the Stilling Pond is relatively slow, and so it is anticipated that groundwater quality improvement in the upgradient uppermost aquifer may take longer to be reflected in the monitoring results at the downgradient wells. Nevertheless, some apparent improvements have already been observed, such as the cobalt concentration having been below the GWPS in six of seven samples collected from well KIF-104 between September 2022 and March 2024. Also note that the groundwater corrective action objective may be achieved at some locations sooner than others, and corrective action in such locations may conclude sooner as part of the routine monitoring, operation, and maintenance of the corrective action.

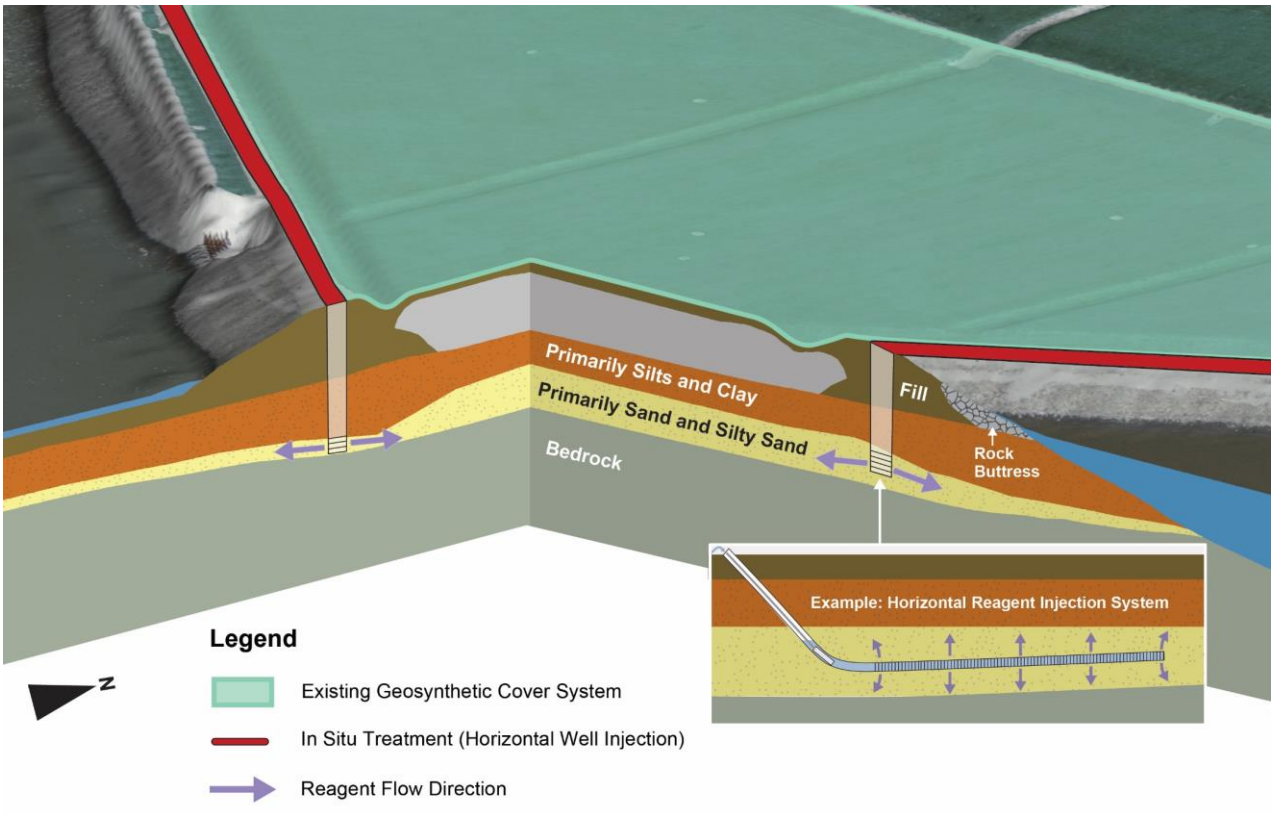
Table 6-2 explains how the corrective action requirements contained in TDEC DSWM regulations were considered and are addressed by the planned corrective action, which also fulfills the requirements in the TDEC Order.

The planned groundwater corrective action for the Stilling Pond, along with the existing closure actions that provide source control, are displayed in the illustrations below:

In Situ Treatment Planned Groundwater Corrective Action and Source Control, Plan View



In Situ Treatment Planned Groundwater Corrective Action and Source Control, Profile View



6.5.2 Sluice Trench/Interim Ash Area

The following describes the corrective measures assessed for the Sluice Trench/Interim Ash Area and the basis for identifying *in situ* treatment as the planned corrective action.

6.5.2.1 Corrective Measures Considered and Assessed

MNA, *in situ* treatment, and hydraulic control were evaluated as potential corrective measures to address cobalt concentrations in groundwater above GWPS at Sluice Trench/Interim Ash Area wells AD-2 and KIF-105.

MNA relies on the natural geochemical system to attenuate concentrations of target constituents by adsorption onto unconsolidated materials or by other geochemical or physical processes. As at the Stilling Pond, MNA could be an effective corrective measure for cobalt in groundwater at the Sluice Trench/Interim Ash Area. The site-specific mechanism of cobalt natural attenuation is currently under evaluation, and if supported by additional assessment, TVA will complete the four-tiered evaluation consistent with USEPA's MNA guidance (USEPA 2015b). Based on the above, MNA was not retained as a primary groundwater corrective measure alternative for the Sluice Trench/Interim Ash Area at this time, but the further evaluation of natural attenuation mechanisms for cobalt at the Sluice Trench/Interim Ash Area will continue, and MNA may be reconsidered as a potential primary groundwater corrective measure at a future time.

In situ treatment is an established technology that relies on the corrective measure to change geochemical conditions within the aquifer to immobilize and reduce the concentrations of the targeted constituents. As described in the *In Situ*

Treatment TM (Appendix I.1), bench scale testing showed that appropriate dosing with NaOH reduced the cobalt concentration below the GWPS in the final Sluice Trench/Interim Ash Area test column, though the cobalt concentration was not consistently maintained below the GWPS in this final test column. These results are generally favorable, but a higher target pH range may be necessary to consistently maintain cobalt concentrations below the GWPS in a field scale application, and the potential to mobilize arsenic was also noted. The ongoing *in situ* treatment field pilot test at the WBF Plant is expected to provide insights that will also be applicable to the KIF Plant. The results of this pilot test are expected to inform the design of additional bench scale testing and a field pilot test at the downgradient boundary of the Sluice Trench/Interim Ash Area to further evaluate site-specific geochemical responses to pH adjustments as well as reagent delivery effectiveness. On this basis, *in situ* treatment was retained as a primary groundwater corrective measure alternative for the Sluice Trench/Interim Ash Area.

Hydraulic control relies on groundwater extraction to control movement of groundwater. Groundwater extraction and treatment is used worldwide as a reliable, proven technology for hydraulic control, and is easily implemented and sustainable. Groundwater extraction was evaluated using the calibrated numerical groundwater flow model to demonstrate that this approach would provide hydraulic control until GWPS are attained and maintained (Appendix G). Although hydraulic control using groundwater extraction and treatment is a feasible corrective action for the Sluice Trench/Interim Ash Area, *in situ* treatment is anticipated to require only occasional reagent injection events that would have fewer adverse environmental impacts than construction and continuous operation of a groundwater extraction and treatment system. MNA, which remains a potentially effective corrective action approach pending further evaluation, would have even fewer adverse environmental impacts. Therefore, hydraulic control using groundwater extraction and treatment was not retained as a primary groundwater corrective measure alternative for the Sluice Trench/Interim Ash Area.

6.5.2.2 Planned Corrective Action

Based on the evaluation presented above of potential technologies to address cobalt in groundwater above GWPS at the downgradient boundary of the Sluice Trench/Interim Ash Area, the planned groundwater corrective action is *in situ* treatment. Although this corrective action has been further developed within this CARA Plan as the planned corrective action, TVA will continue to perform routine groundwater monitoring and further evaluate MNA prior to preparing detailed designs for an *in situ* treatment system. If future data and evaluations confirm that MNA will be effective, then TVA will coordinate with and obtain approval from TDEC to implement MNA as the corrective action. A summary of the planned groundwater corrective action is provided below, and design drawings further describing the planned corrective action are provided in Appendix F.1.

The *in situ* treatment system would be installed immediately upgradient of the monitoring wells (along the downgradient boundary of the Sluice Trench/Interim Ash Area near wells AD-2 and KIF-105). The *in situ* treatment system would establish a treatment zone such that the normal flow of groundwater in the uppermost aquifer is intercepted by the *in situ* treatment zone, reducing the concentration of cobalt below the GWPS as the groundwater moves downgradient of the Sluice Trench/Interim Ash Area. Because of the close proximity of the *in situ* treatment zone to the monitoring wells, the time to achieve the GWPS at these wells would be relatively short – anticipated to be on the order of just a few years. After GWPS are attained at Sluice Trench/Interim Ash Area monitoring wells AD-2 and KIF-105, the *in situ* treatment system would continue to operate, reducing the concentration of cobalt in groundwater moving downgradient of the Sluice Trench/Interim Ash Area.

Over time, the physical and geochemical processes that occur during the natural flow of groundwater through foundation soils, supported by the source control provided by the existing and planned additional closure actions (Chapter 5), will reduce cobalt concentrations in the upgradient uppermost aquifer such that concentrations at the monitoring wells will remain below the GWPS after the corrective action concludes. Achieving this condition is the ultimate objective of the groundwater corrective action.

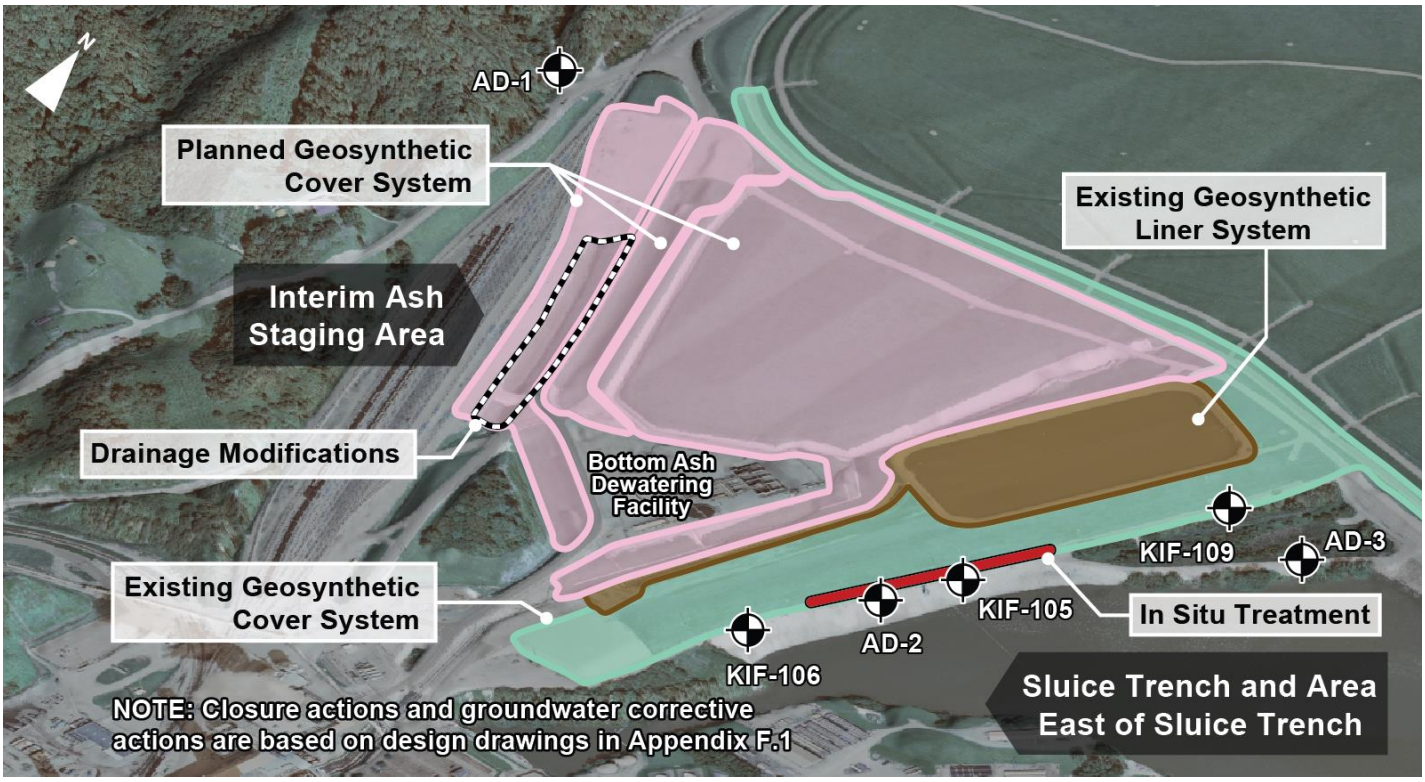
The time required to achieve this groundwater corrective action objective is uncertain due to a variety of factors. These factors include, for example, the initial magnitude of concentrations above the GWPS, the variable manner in which physical and geochemical processes act on different CCR constituents, the rate at which pore water hydraulic heads decrease following implementation of the planned additional closure actions, and the rate of groundwater flow within the uppermost aquifer. Routine groundwater monitoring at other TVA Plant CCR units has shown that implemented source control measures started to have a beneficial effect on groundwater quality within a five- to 10-year timeframe. Also, the groundwater corrective action objective may be achieved at some locations sooner than others, and corrective action in such locations may conclude sooner as part of the routine monitoring, operation, and maintenance of the corrective action.

During the final design of the corrective action, a corrective action performance monitoring plan that includes an adaptive management process will be developed to facilitate corrective action implementation and provide data to assess if the desired results are achieved. The performance monitoring plan and adaptive management process are further described in Chapter 7.2.2.

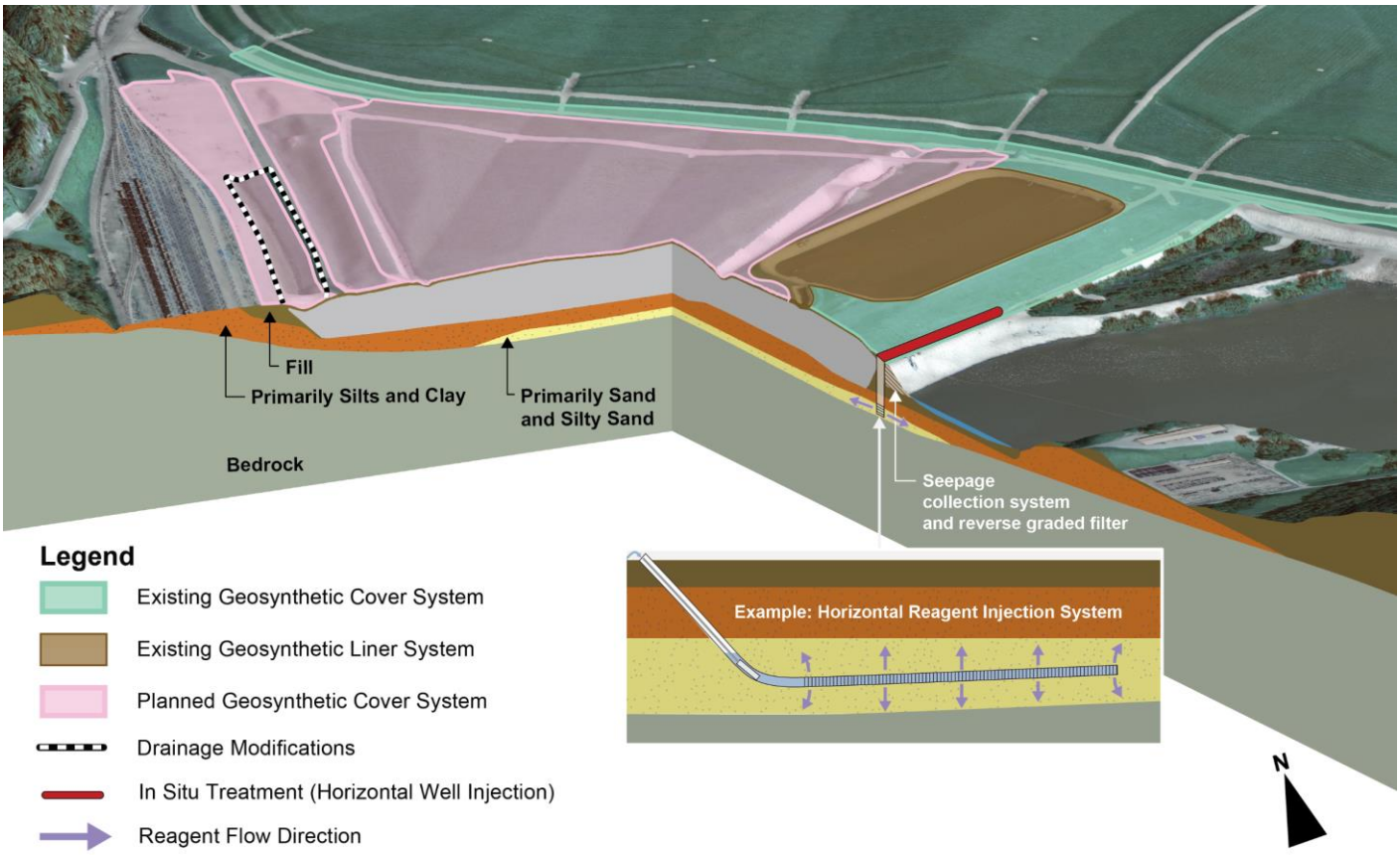
Table 6-2 explains how the corrective action requirements contained in TDEC DSWM regulations were considered and would be addressed by the planned corrective action, which also fulfills the requirements in the TDEC Order.

The planned groundwater corrective action for the Sluice Trench/Interim Ash Area along with the existing and additional closure actions that provide source control, are displayed in the illustrations below:

In Situ Groundwater Treatment Planned Corrective Action and Source Control, Plan View



In Situ Groundwater Treatment Planned Corrective Action and Source Control, Profile View



6.6 CCR UNIT CORRECTIVE ACTION SUMMARY

TVA is planning *in situ* treatment as the corrective action approach for the Stilling Pond and Sluice Trench/Interim Ash Area. These planned corrective actions are based on groundwater sampling results through December 2022 as presented in the EAR. TVA will continue to monitor groundwater and further evaluate MNA while the CARA Plan is finalized and the corrective action final design is developed, and if warranted based on those new groundwater monitoring results and evaluations, will coordinate any proposed modifications with, and obtain approval from, TDEC.

The HHERA concluded that there are no unacceptable risks to human or ecological receptors based on USEPA guidance for assessing potential exposures to sediment, surface stream water, or groundwater. Therefore, corrective action is only required for groundwater in order to attain GWPS at five wells (Stilling Pond wells 6AR, KIF-103, and KIF-104, and Sluice Trench/Interim Ash Area wells AD-2 and KIF-105), consistent with regulatory requirements. The following key factors provide the basis for TVA's planned corrective actions for the KIF Plant TDEC Order CCR units:

- *In situ* treatment bench testing indicates that *in situ* treatment can immobilize and reduce the concentrations of CCR constituents until GWPS are attained and maintained, providing both short- and long-term effectiveness.

- *In situ* treatment is an established technology anticipated to require only occasional reagent injection events that would have fewer adverse environmental impacts than construction and continuous operation of a groundwater extraction and treatment system.

- Given the close proximity of the *in situ* treatment system to the monitoring wells (i.e., immediately upgradient of monitoring wells AD-2, KIF-105, 6AR, KIF-103, and KIF-104 along the downgradient boundaries of the KIF Plant TDEC Order CCR units), it is anticipated that GWPS would be attained at the monitoring wells within just a few years following *in situ* treatment implementation.

- After GWPS are attained at the monitoring wells, the *in situ* treatment system would continue to operate, reducing the concentrations of target constituents in groundwater moving downgradient of the TDEC Order CCR units. Over time, the physical and geochemical processes that occur during the natural flow of groundwater through foundation soils, supported by the source control provided by the previously completed and planned additional closure actions (Chapter 5), will reduce the concentrations of targeted constituents in the uppermost aquifer such that concentrations at the downgradient monitoring wells will remain below GWPS after the corrective action concludes. The time required to achieve this condition where GWPS have been attained and would be maintained without continued corrective action is uncertain due to a variety of factors, but routine groundwater monitoring at other TVA Plant CCR units has shown that implemented source control measures started to have a beneficial effect on groundwater quality within a five- to 10-year timeframe. The horizontal groundwater flow rate at the Stilling Pond is relatively slow, and so it is anticipated that groundwater quality improvement in the upgradient uppermost aquifer may take longer to be reflected in the monitoring results at the downgradient wells.

- Table 6-2 explains how the planned groundwater corrective action meets the TDEC regulatory requirements, which also fulfills the requirements in the TDEC Order.

Chapter 7 Supporting Plans

This chapter describes the scope of the supporting plans to meet the requirements presented in the TDEC Order related to natural resources restoration, air and water monitoring during implementation of corrective actions, the protection of public and private water supplies, and short-term and long-term management of CCR material, as appropriate for the KIF Plant TDEC Order CCR units.

Environmental sampling, closure, and corrective action activities described herein will be performed under an approved plant-specific health and safety plan and in accordance with TVA safety policies and procedures.

7.1 Natural Resource Restoration Plan

As described in Chapter 4, the results of the HHERA evaluation are based on KRP and EI sampling results and multiple lines of evidence incorporating historical and EI environmental data. The HHERA evaluation concluded there are no unacceptable risks for human or ecological receptors exposed to natural resources (e.g., surface stream water, sediment, fish) in the Emory, Clinch, and Tennessee Rivers from effects of CCR wastewater treatment or onsite CCR management at the KIF Plant TDEC Order CCR units. Similarly, the overall results of the water use survey concluded that current and historical CCR management associated with the KIF Plant TDEC Order CCR units has not affected offsite water supply wells or springs located in the vicinity of the KIF Plant. As such, corrective action for surface stream water, sediment or ecological communities is not warranted, and neither corrective action nor natural resource restoration of these media is included in this CARA Plan.

7.2 Air and Water Monitoring Plans

The following describes the overall approach for TVA's proposed groundwater, surface water, and air monitoring plans to support implementation of the CARA Plan. As described below, some plans will be prepared following approval of the final CARA Plan and provided to TDEC for review and approval once the final closure and corrective action designs are completed.

7.2.1 Groundwater Monitoring Plan

The Groundwater Monitoring Plan, provided in Appendix E, presents groundwater compliance monitoring and associated activities in fulfillment of the TDEC Order once the CARA Plan is approved. The scope of the document pertains to the groundwater monitoring systems at the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench. The Groundwater Monitoring Plan provides the procedures for groundwater monitoring activities according to TVA's quality assurance/quality control requirements and is intended to align and meet the different State and federal monitoring requirements in a single plan.

Groundwater compliance monitoring activities to be conducted at the Stilling Pond and Sluice Trench and Area East of Sluice Trench under this plan will fulfill State regulatory requirements and the federal CCR Rule requirements. Groundwater compliance monitoring activities to be conducted at the Stilling Pond, Interim Ash Staging Area, and Sluice Trench, and Area East of Sluice Trench will be conducted in accordance with the Groundwater Monitoring Plan following TDEC approval of the CARA Plan.

TVA has identified a unified groundwater monitoring plan for the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench to meet the following objectives:

- Comply with regulatory requirements and permits issued under State programs (Chapter 1.3.3) and regulatory requirements of the CCR Rule (Chapter 1.3.2) prior to, during, and after the implementation of the groundwater corrective action, as applicable.
- Demonstrate that the current level of protection for water supplies, which were found to be protective in the site-specific HHERA and water use survey, will be maintained during implementation of the additional closure and corrective actions in the TDEC-approved CARA Plan.

7.2.1.1 Sample Analyses and Frequency

The planned constituent list for groundwater monitoring will include CCR Rule Appendix III and IV parameters. The GWPS for the groundwater monitoring plan are the same as those in this CARA Plan. The five additional TDEC Appendix I parameters are not included in the planned monitoring constituent list because they were below the TDEC-approved groundwater screening levels based on data presented in the KIF Plant EAR (TVA 2024c). Additional details are provided in Appendix E.

The sampling frequency will be semiannual as presented in Appendix E. TVA plans to conduct two sampling events per year to characterize groundwater flow direction, groundwater flow rates, and groundwater quality in the uppermost aquifer.

7.2.1.2 Sampling Locations

The planned groundwater monitoring systems associated with the CCR units are shown on Exhibit 7-1 for the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench. The planned groundwater monitoring systems provide for a sufficient number of monitoring wells installed upgradient and downgradient of the CCR units at depths that yield groundwater from the uppermost aquifer. Groundwater level data from other wells shown on Exhibit 7-1 may be used to provide spatial distribution for developing groundwater elevation contour maps. Details on the planned groundwater monitoring systems are provided in Appendix E.

In addition to the groundwater monitoring systems described in Appendix E, TVA may identify additional wells to be installed and monitored to evaluate the performance of the groundwater corrective action at the Stilling Pond, Interim Ash Staging Area, and Sluice Trench and Area East of Sluice Trench as approved by TDEC in the CARA Plan. The corrective action performance monitoring plan is further described in Chapter 7.2.2. TVA will update the Groundwater Monitoring Plan as needed following final design or during implementation if changes to the monitoring network are required for the TDEC Order CCR units. Changes to the Groundwater Monitoring Plan will be coordinated with and approved by TDEC.

7.2.1.3 Data Evaluation and Reporting

Two semiannual groundwater monitoring reports will be prepared for the KIF Plant TDEC Order CCR units to summarize the results from the two semiannual sampling events each year. The reports will incorporate the requirements from TDEC DSWM 0400-11-01-.04. The statistical evaluations used to determine whether CCR-related constituents listed in Table 1-1 are detected at statistically significant concentrations above GWPS will be prepared for each semiannual reporting period. Each semiannual report will be submitted to TDEC within 120 days of completing the semiannual groundwater sampling events. Separate annual groundwater monitoring and corrective action reports will be prepared for the Stilling

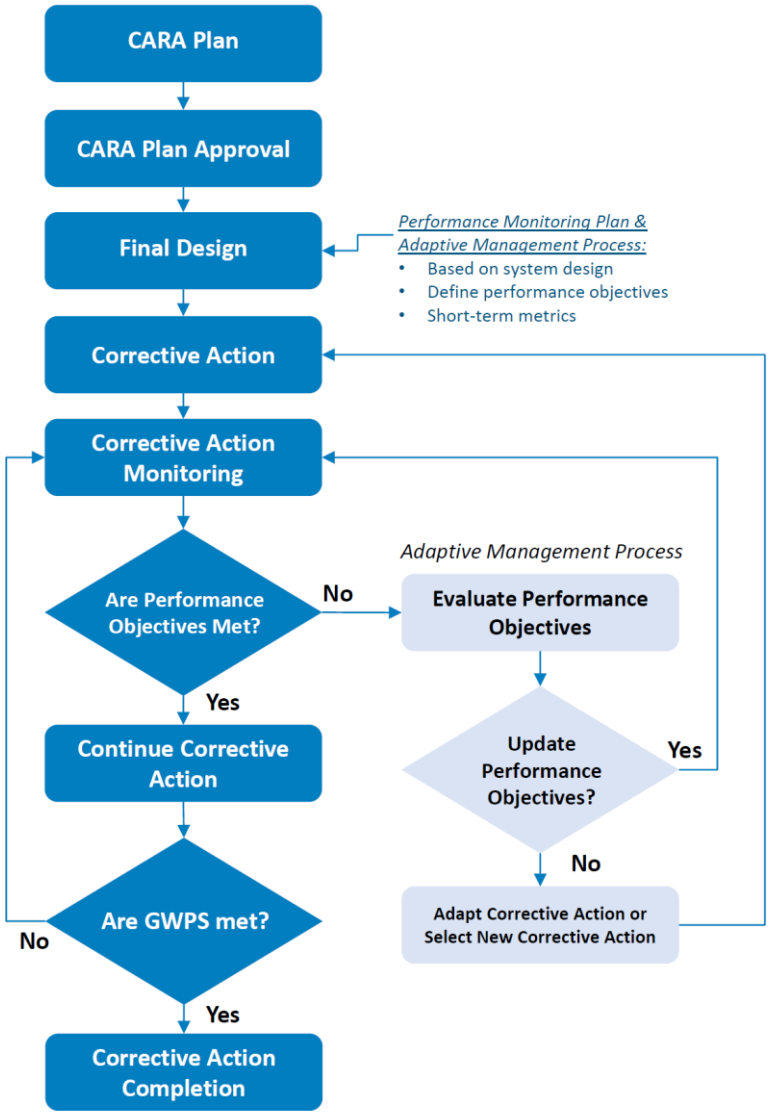
Pond and Sluice Trench and Area East of Sluice Trench TDEC Order CCR units to comply with the CCR Rule. Annual reports will be posted to the facility operating record and submitted to TDEC within 30 days to coincide with posting the reports to the TVA CCR Compliance and Data Information website.

7.2.2 Performance Monitoring Plan and Adaptive Management Process

During the final design of the corrective action, a corrective action performance monitoring plan will be developed. The plan will specify monitoring locations and define the performance objectives for the corrective action (i.e., attain GWPS). The effectiveness of the corrective action will be evaluated by comparing the performance of the corrective action to the performance metrics and objectives. When the GWPS are met for the prescribed period, the corrective action will be complete. The corrective action performance monitoring plan will be coordinated with, and approved by, TDEC.

An adaptive management process will be incorporated into the corrective action performance monitoring program. Performance monitoring data will be systematically compared to interim performance standards (sometimes called “adaptive triggers”) to provide a basis for proactively responding to changing conditions. Monitoring locations will be identified, and interim performance standards will be established (e.g., statistically increasing trends) to evaluate corrective action progress. If an interim performance standard is not met, that will initiate a review of the system and the performance standards as depicted on the Performance Monitoring and Adaptive Management Process flowchart below. Not meeting an interim performance standard will not automatically result in an adaptation of the corrective action, but it will initiate a holistic evaluation of the system and performance standards. This approach results in ongoing evaluation of site activities to account for new information and changing site conditions or regulations. The following diagram outlines the performance monitoring and adaptive management process.

Performance Monitoring and Adaptive Management Process



7.2.3 Surface Water Monitoring Plan

TVA currently conducts effluent monitoring in accordance with NPDES Permit No. TN0005452 and the TMSP. Multiple parameters are monitored on a regular basis including various metals, total suspended solids, and total dissolved solids. Depending upon how future flows are routed (i.e., to the existing outfall or to a new outfall), permit modifications may be needed. TVA will continue monitoring in accordance with the current TMSP and NPDES permits and related documents/approvals until a modified NPDES permit is issued, if one is required.

TVA conducted a pilot test to determine efficacy of pore water extraction at the Sluice Trench and Area East of Sluice Trench. The intent of the pilot test was to allow evaluation of this technology for applicability elsewhere. Prior to conducting the test, TDEC approved the discharge of pore water through Outfall 001 during the pilot test. During the test,

pore water was pumped from one vertical extraction well to an equalization tank which discharged to the Water Quality Channel. The Water Quality Channel flows to the Polishing Pond, which discharges to Outfall 001, and ultimately to the Clinch River in accordance with NPDES Permit No. TN0005452. Therefore, the pilot test system was internal to the overall site wastewater treatment processes and did not change the volume or characteristics of the authorized discharge. The pilot test was conducted in two, 45-day intervals. Pilot test 1 was conducted from July 30 through September 13, 2024 and Pilot Test 2 was conducted from November 11, 2024 through January 6, 2025.

7.2.4 Air Monitoring Plan

TVA currently executes a CCR Fugitive Dust Control Plan previously prepared for the KIF Plant (TVA 2019). The requirements of this plan will be adhered to during implementation of the TDEC-approved additional closure and corrective actions. An Air Monitoring Plan that complies with applicable state and federal environmental and health and safety regulations will be prepared to support the additional closure and corrective action activities. As applicable for the planned actions, the plan will include perimeter and work area air monitoring. The Air Monitoring Plan will be submitted to TDEC for review prior to implementation of the additional closure and corrective action activities.

7.3 Water Supply Protection Plan

Based on the HHERA findings as discussed in Chapter 4.1.2, there are no unacceptable risks related to CCR management at the KIF Plant for offsite residents potentially exposed to potable water supplied by either a domestic water well or from water withdrawn by municipal water departments from the Emory River in the vicinity of the KIF Plant. As discussed in Chapter 7.2, TVA will execute groundwater and surface water monitoring plans to demonstrate that the current level of protection of water supplies will be maintained during implementation of the TDEC-approved corrective actions.

7.4 Short- and Long-Term Management of CCR Material

Plans for the short-term and long-term management of CCR material are discussed in Chapters 7.4.1 and 7.4.2, respectively.

7.4.1 Short-Term CCR Material Management Plan

As needed, TVA will develop and execute a short-term CCR material management plan to meet requirements of the TDEC Order. The plan will detail the short-term management of CCR material during implementation of the closure and corrective actions identified herein. The plan would include, as applicable, the following elements:

- Drawdown and dewatering plan
- Fugitive dust control
- Construction drawings
- Construction quality assurance plan
- Proposed sequence of construction
- Temporary staging of CCR material

- Management of contact water
- Stormwater management
- Erosion protection and sediment control measures
- Spill prevention and control plan.

This plan may be updated based on conditions encountered in the field with notification to TDEC for concurrence prior to implementation. Also, the plan will provide the guidelines that a contractor must follow regardless of the construction means and methods a contractor may use.

7.4.2 Long-Term Management of CCR Material

TVA is currently implementing post-closure plans for the Stilling Pond (Stantec 2017a and 2017b) and the Sluice Trench and Area East of Sluice Trench (AECOM 2018 and 2019) and post-closure care activities at the Interim Ash Staging Area. The scope of the post-closure plans includes post-closure monitoring and maintenance activities for the existing cover and groundwater monitoring systems. TVA will implement the additional closure actions and conduct post-closure care and maintenance activities as described in the updated closure and post-closure plans provided in Appendix F.2 following approval of this CARA Plan.

Chapter 8 Summary and Next Steps

This CARA Plan has been prepared to fulfill the requirements of the TDEC Order and specifies the basis and actions TVA plans to take for closure and groundwater corrective action at the KIF Plant CCR units. The following summarizes TVA's planned actions, and the basis for those actions. Next steps, including TVA's planned public involvement approach to finalize the CARA Plan, and the implementation activities and schedule for the planned actions are also discussed.

8.1 Summary of Planned Actions and Their Basis

The CARA Plan builds upon information gained during TVA's prior and ongoing environmental investigation and monitoring programs overseen by TDEC and USEPA, as well as a comprehensive environmental investigation overseen by TDEC that included characterizing the KIF Plant site hydrogeology and the TDEC Order CCR units. Together, these investigations and monitoring programs collected more than 20,000 samples of CCR material, groundwater, background soils, surface stream water, sediment, air, and ecological communities (e.g., fish); and conducted a water use survey of offsite wells. Using these data, a risk assessment based on USEPA guidance was performed to evaluate potential risks to human and ecological receptors (e.g., fish) from potential exposures to CCR constituents related to the TDEC Order CCR units. Additionally, the investigation results were used to conduct site-specific assessments of CCR unit closure methods and groundwater corrective measure technologies to form the basis for TVA's planned closure approach and groundwater corrective actions identified in this CARA Plan.

As presented in Chapter 1, TVA's mission is to supply affordable and reliable power to the people of the Tennessee Valley while protecting the natural resources of this region and supporting the communities we serve. TVA's goal within this CARA Plan is to make the best, most appropriate choices for closure and corrective action to ensure that the TDEC Order CCR units at the KIF Plant are safe, secure, and protective of human health and the environment, consistent with TVA's mission.

TVA evaluated two options in this CARA Plan for closure of the TDEC Order CCR units, CIP and CBR, as well as several alternatives to address groundwater quality at the TDEC Order CCR units. **Based on the comprehensive investigations and conclusions of the site-specific evaluations, TVA plans continued CIP of the TDEC Order CCR units at the KIF Plant, with targeted groundwater corrective actions.** TVA believes that CIP of the TDEC Order CCR units, along with targeted groundwater corrective actions, is the best way to safely and securely close the TDEC Order CCR units, achieve its mission, and comply with the TDEC Order and State regulations. TVA's plans, along with an implementation schedule, are shown in Exhibit 8-1 and in the graphics at the end of this summary. While not currently planned for the KIF Plant TDEC Order CCR units, TVA continues to evaluate means to beneficially use CCR material in a manner consistent with regulatory requirements while maximizing value to the Tennessee Valley.

Because each of the KIF Plant TDEC Order CCR units was previously closed, TVA has identified a collective set of additional closure actions including cover system and drainage modifications to enhance the existing closures to achieve long-term conditions sooner. At the Interim Ash Staging Area, TVA will implement additional closure actions including the installation of an engineered geosynthetic cover system and drainage modifications in adjacent and upgradient areas. Based on the demonstrated effectiveness of the existing geosynthetic cover systems at the Sluice Trench and Area East of Sluice Trench and Stilling Pond, TVA is not planning additional closure actions for these TDEC Order CCR units.

In addition to the closure actions, TVA will implement corrective actions to improve groundwater quality and meet GWPS at the TDEC Order CCR units. The human health and ecological risk assessment evaluation concluded that there are no unacceptable risks to human or ecological receptors from the TDEC Order CCR units at the KIF Plant; therefore, corrective action is only required for groundwater to attain GWPS consistent with regulatory requirements. Based on the evaluations conducted as part of this CARA Plan, *in situ* treatment will be conducted at the Sluice Trench/Interim Ash Area and the Stilling Pond.

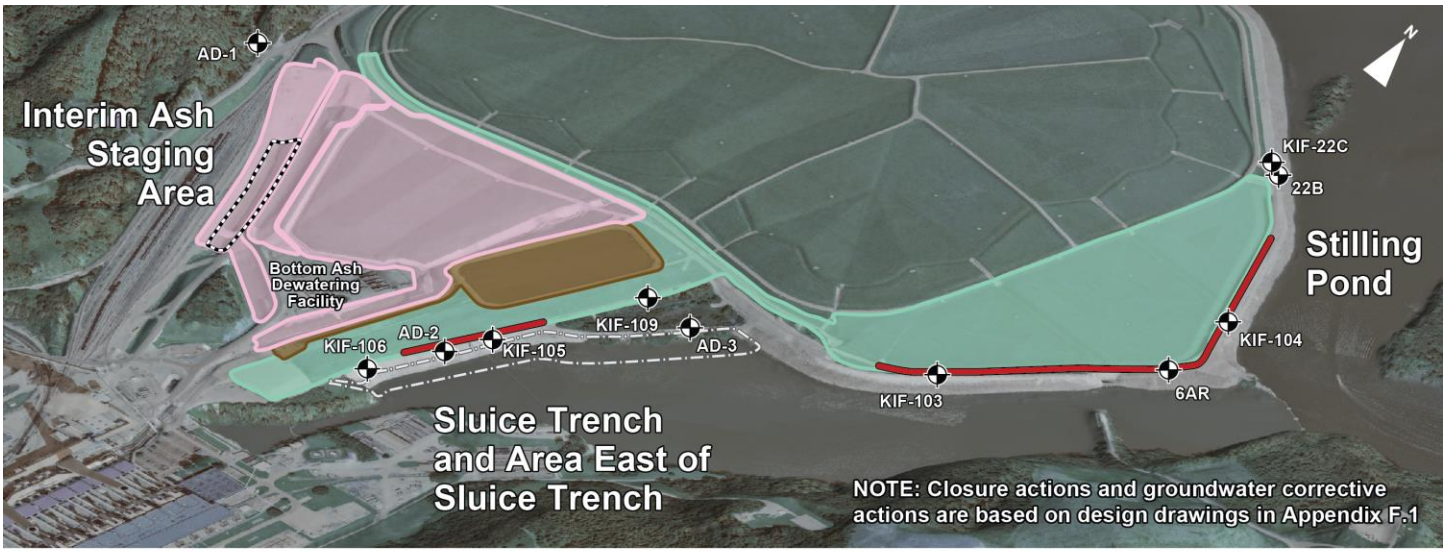
The wide-ranging, site-specific evaluations presented in this CARA Plan provide a clear basis for TVA's planned continuation of CIP with targeted groundwater corrective actions for the KIF Plant TDEC Order CCR units. CIP and the planned corrective actions are consistent with TVA's mission, protect the people and resources of the Tennessee Valley, comply with State regulations, and are the most appropriate actions when considering and balancing all relevant factors. The reasons why TVA is planning these closure and corrective actions (i.e., the basis for closure and corrective action) are provided below:

- **CIP is environmentally more beneficial than CBR,** particularly for the KIF Plant TDEC Order CCR units where over four million cubic yards of CCR material would have to be removed and transported to alternate landfills and require over three million cubic yards of borrow soils that would have to be obtained from offsite sources.
- **Compared to CIP, CBR results in substantially greater adverse impacts** related to transportation and construction, particularly climate change and GHG emissions, worker and transportation safety, and potential impacts to nearby communities with environmental justice concerns.
- **Once closure begins, CBR would require 19 to 22 years to complete compared to the three to four years required for CIP** of all the TDEC Order CCR units due to the volume of CCR material.
- **CBR with complete removal of the CCR material from the three TDEC Order CCR units may be infeasible and unsafe** due to structural stability concerns at the adjacent KRP Ash Landfill.
- **CIP provides source control faster than CBR** due to the extended CBR construction activities.
- **CIP meets or exceeds the closure performance standards** required by TDEC regulations.
- **Geosynthetic cover systems are effective** in controlling, minimizing or eliminating infiltration through the cover system.
- **Once the East Dike stability berm and foundation soil ground improvements are constructed, the TDEC Order CCR units will meet the established slope stability factors of safety** during closure, the post-closure period, and beyond.
- **Ecological communities are healthy and are not being adversely impacted** by the CCR units.
- ***In situ* treatment is an established technology** that is expected to attain GWPS within a few years after implementation and would maintain this condition until effects of source control make it unnecessary.
- **There are no onsite or downgradient offsite uses of groundwater as a drinking water source.**
- **There are currently no unacceptable risks to onsite or offsite human or ecological receptors, and this will continue during closure, corrective action, and beyond.**

With no unacceptable risks related to Closure-in-Place, Closure-by-Removal is not necessary or justified with its much longer timeline to complete closure, greater overall environmental impacts, and substantially higher cost.

Continued Closure-in-Place with targeted groundwater corrective actions is the best solution to protect the people and resources of the communities near the KIF Plant consistent with TVA's mission.

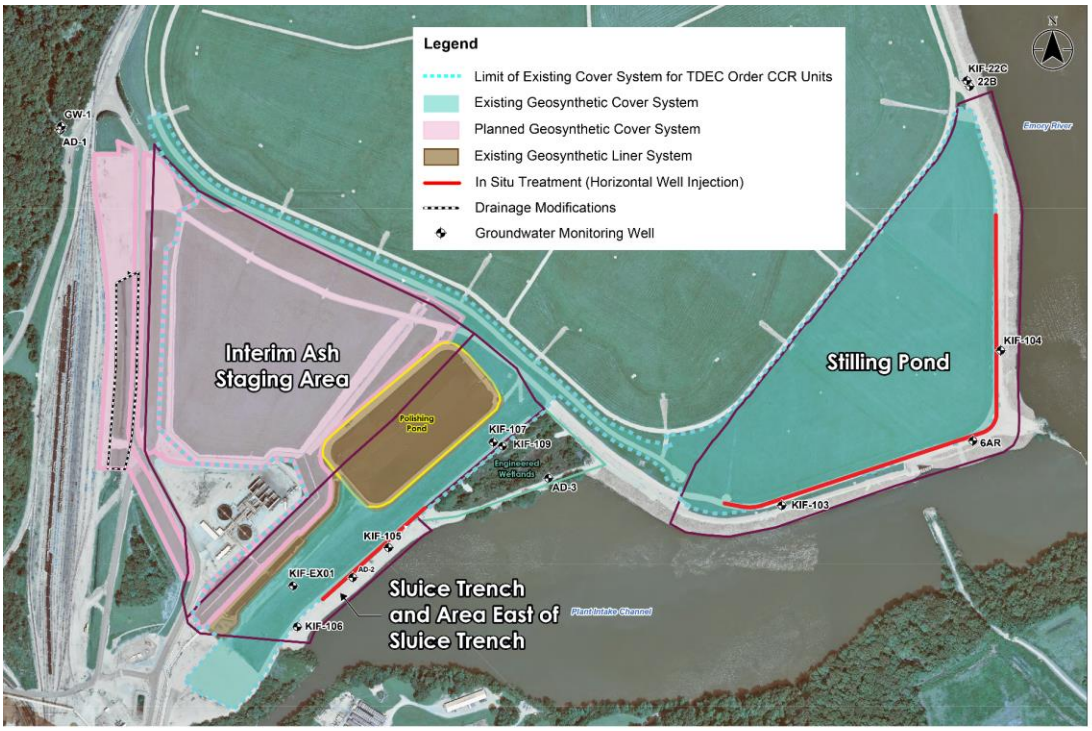
Planned KIF Plant CCR Unit Closure and Corrective Actions



Legend

- Existing Geosynthetic Cover System
- Existing Geosynthetic Liner System
- Planned Geosynthetic Cover System
- Drainage Modifications
- In Situ Treatment (Horizontal Well Injection)
- Groundwater Monitoring Well
- Approximate East Dike Seismic Stability Mitigation Project Limits (Separate Project)

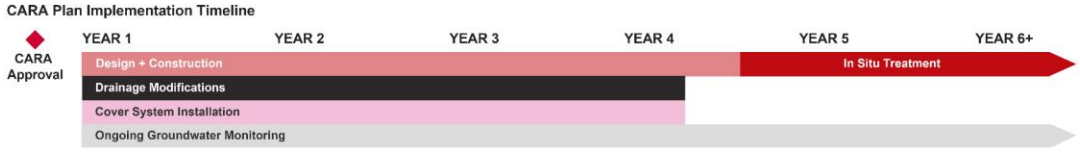
Planned KIF Plant CCR Unit Closure and Corrective Actions, and Implementation Schedule



CCR Unit	Planned Closure and Corrective Action
Stilling Pond	In Situ Treatment
Interim Ash Staging Area	Drainage Modifications Cover System Installation
Sluice Trench and Area East of Sluice Trench	In Situ Treatment

Emory River
No Corrective Action Required

NOTE: Closure actions and groundwater corrective actions are based on design drawings in Appendix F.1



8.2 Public Involvement

This draft CARA Plan will be revised to address TDEC comments until it is accepted by TDEC and considered ready for public review and input. TVA will engage with the public within the framework established by the TDEC Order and State regulation. Under the TDEC Order, the specified public engagement process includes providing public notice that the draft CARA Plan is available for review along with a summary of the proposed plan. The public will have a minimum of 30 days to comment on the draft CARA Plan, and if comments are received, then TVA will have 30 days to provide responses to the comments to TDEC. After consideration of the public comments and TVA's responses, TVA will modify this draft CARA Plan if needed until it is finalized and approved by TDEC. Received public comments and TVA's responses to those comments will be provided in an appendix to this plan.

Prior to public review of this draft CARA Plan, TDEC and TVA will finalize the details of the public engagement process and reflect the plans in this chapter.

8.3 CARA Plan Implementation Schedule

The illustration in Chapter 8.1 provides a summary schedule for the completion of the additional planned closure actions and implementation of corrective action identified in this CARA Plan. Exhibit 8-1 provides further details regarding the schedule for activities included during implementation.

TVA will substantially complete the additional cover system actions and drainage modifications for the Interim Ash Staging Area within three to four years of approval of the CARA Plan. TVA will continue to conduct current post-closure care activities for the TDEC Order CCR units as specified in existing closure plans while the CARA Plan is finalized, and then implement the Closure and Post-Closure Plans provided in Appendix F.2 once the CARA Plan is approved.

Concurrent with the cover system actions and drainage modifications, TVA will begin design, permitting, and construction of the *in situ* treatment systems upon approval of the CARA Plan. Operations of these systems are expected to begin within three to four years of CARA Plan approval, following design, permitting, and construction. As discussed in Chapter 6, if warranted based on newer groundwater monitoring results, proposed changes to the groundwater corrective measures would be coordinated with, and approved by, TDEC. TVA will continue to monitor groundwater in accordance with the existing plans while the CARA Plan is finalized, and then implement the Groundwater Monitoring Plan provided in Appendix E once the CARA Plan is approved.

The overall schedule for implementation of additional closure actions and completion of the groundwater corrective actions considers requirements and factors referenced in TDEC DSWM regulations. These factors are listed in Table 5-5 for CCR unit closure and Table 6-2 for groundwater corrective action.

Implementation will begin upon approval of the CARA Plan by TDEC. The activities will commence with the detailed design of the planned actions with permitting (if needed) generally proceeding simultaneously. Once the detailed design phase is complete, procurement and then construction will proceed. Following construction completion, TVA will implement post-closure care activities for the TDEC Order CCR units, operate the *in situ* treatment systems, and conduct groundwater monitoring and corrective action performance monitoring. Each of these phases are described below.

Design and Permitting

Detailed design will build upon the plans included within this document and provide detailed specifications for construction.

In some cases, additional delineation (installation of additional monitoring wells and subsequent monitoring, or collection of additional subsurface characterization data) and/or additional pilot testing may be performed to refine the design of the *in situ* treatment systems. As needed, TVA will prepare permitting packages and plans for review and approval by TDEC, as appropriate, and other regulatory agencies using the information provided in this CARA Plan. As needed, TVA will complete other pre-construction environmental reviews necessary to implement the planned project.

Additionally, TVA will complete the following supporting program plans described in Chapter 7 as needed for implementation of the additional closure actions and groundwater corrective action:

- Surface Water Monitoring Plan
- Air Monitoring Plan

- Water Supply Protection Plan
- Short-Term and Long-Term CCR Material Management.

Procurement, Construction, and Operation

Procurement will include bidding, selection of contractor(s) to implement the construction phase, and associated contracting, as well as procurement of long-lead materials if needed. Following a procurement or contracting phase and once any necessary permits are approved, the construction period will commence. Estimated construction periods for the additional closure actions and groundwater corrective action by TDEC Order CCR unit are shown on Exhibit 8-1.

Operation of the *in situ* treatment system will begin following a commissioning phase during which operability of the *in situ* treatment processes will be confirmed.

Groundwater Monitoring Plan

Groundwater compliance monitoring activities will be conducted in accordance with the Groundwater Monitoring Plan following TDEC approval of the CARA Plan (see Chapter 7.2.1 and Appendix E). The Groundwater Monitoring Plan will be implemented during the design and implementation of corrective action, and during the closure and post-closure care and maintenance phases of the project. TVA will update the Groundwater Monitoring Plan as needed following final design or during implementation if changes to the monitoring network are required for the TDEC Order CCR units. Changes to the Groundwater Monitoring Plan will be coordinated with and approved by TDEC.

Performance Monitoring Plan

During the final design of the corrective action, a corrective action performance monitoring plan will be developed as discussed in Chapter 7.2.2. The effectiveness of the corrective action will be evaluated by comparing the performance of the corrective action to the performance metrics and objectives developed for each corrective action. An adaptive management process will be incorporated into the performance monitoring plan to systematically compare monitoring data to interim performance standards (adaptive triggers) to provide a basis for proactively responding to changing conditions and to evaluate the corrective action process. The corrective action performance monitoring plan will be coordinated with and approved by TDEC.

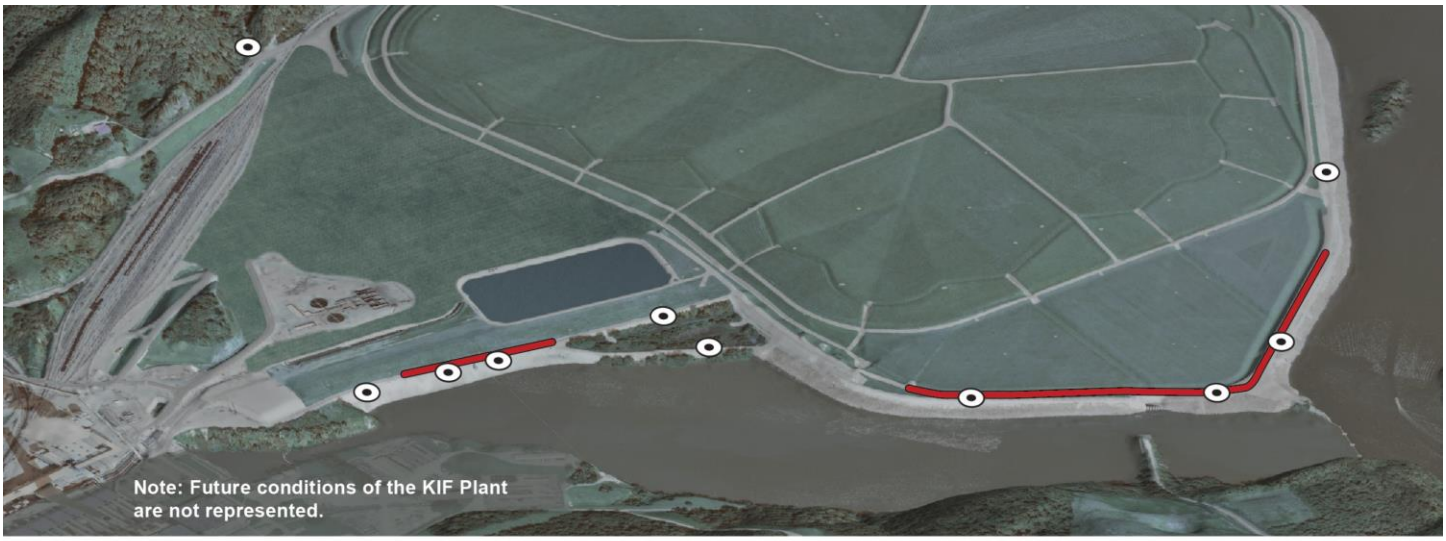
The performance monitoring plan will be implemented after the *in situ* treatment systems have been commissioned and until GWPS are attained for the TDEC Order CCR units and would be maintained without continued corrective action.

Post-Closure Care Activities

TVA will conduct post-closure care and maintenance activities as described in the closure and post-closure plans provided in Appendix F.2. Post-closure care activities typically include vegetative cover monitoring and maintenance, maintenance of the approved final contours, drainage and groundwater monitoring systems maintenance, groundwater sampling, analysis, and reporting, and post-closure inspections.

The following graphic depicts the future condition of the KIF Plant TDEC Order CCR units following implementation of the planned closure and groundwater corrective actions identified in this CARA Plan. Future conditions of the KIF Plant and other non-CCR unit infrastructure are not projected or depicted in the graphic.

Future Conditions of the KIF Plant CCR Units Following CARA Plan Implementation



Legend

In Situ Treatment (Horizontal Well Injection)

Monitoring Wells

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TABLES

Table 1-1. Groundwater Protection Standards Established for the Corrective Action / Risk Assessment Plan

CCR Constituents	Values	Units
Antimony	6	µg/L
Arsenic	10	µg/L
Barium	2,000	µg/L
Beryllium	4	µg/L
Cadmium	5	µg/L
Chromium (total)	100	µg/L
Cobalt	6	µg/L
Fluoride	4,000	µg/L
Lead	15	µg/L
Lithium	40	µg/L
Mercury	2	µg/L
Molybdenum	100	µg/L
Radium-226 & 228	5	pCi/L
Selenium	50	µg/L
Thallium	2	µg/L

Notes:

Compliance with a GWPS is determined not by comparison to any single sample result, but by comparison to multiple sample results collected over time using statistical methods.

µg/L: micrograms per liter

pCi/L: picoCuries per liter

DRAFT

Table 5-1 – TDEC Division of Solid Waste Management Closure Requirements
Kingston Fossil Plant

TDEC Solid Waste Management TDEC Rule (0400-11-01-.04)			
Action	**Regulatory Citation(s)**	**Tennessee Rule Closure Criteria**	
Required Performance Standards for Closure	TDEC DSWM 0400-11-01-.04(8)(a)	1	The operator must close the disposal facility or disposal facility parcel in a manner that:
			i) Minimizes the need for further maintenance; and
			ii) Controls, minimizes, or eliminates, to the extent necessary to prevent threats to public health and the environment, post-closure escape of solid waste, solid waste constituents, leachate, contaminated rainfall, or waste decomposition products to the ground or surface waters or to the atmosphere.
		2	The operator must care for a disposal facility or disposal facility parcel for the period of time after closure in a manner that assures that the performance objectives of part 1. of this subparagraph are continuously met.
	TDEC DSWM 0400-11-01.04(8)(b)	The operator must initiate and complete closure activities and conduct post-closure care activities in accordance with the approved closure/post-closure plan if such a plan has been prepared and approved for the disposal facility or disposal facility parcel being closed.	
	TDEC DSWM 0400-11-01.04(8)(c) - excerpts specific to design and schedule for CARA Plan	For active portions of the facility, the operator must complete closure activities including grading and establishing vegetative cover in the shortest practicable time, not to exceed 180 days, after any fill areas or any portion of the fill areas have achieved final grade, unless the Commissioner allows otherwise in the permit.	
		At Class I and Class II facilities the depth of final cover system shall be at least 36 inches of soil of which a minimum of 12 inches shall be for the support of vegetative cover. An alternate final cover system may be used provided that it is demonstrated to the satisfaction of the Commissioner that the final cover system provides equivalent or superior performance to the minimum performance standard in this subpart.	
		The design of the final cover system shall be such that the infiltration volume of water will be equal to or less than the percolation volume through the bottom liner system or a design which includes a compacted soil layer of at least 24 inches which has a permeability no greater than 1 x 10-7 cm/sec, whichever is less.	
		The final surface of the disposal facility or disposal facility parcel shall be graded and/or provided with drainage facilities in a manner that:	
		(i)	Minimizes precipitation run-on from adjacent areas onto the disposal facility or disposal facility parcel;
		(ii)	Minimizes erosion of cover material (e.g., no steep slopes);
		(iii)	Optimizes drainage of precipitation falling on the disposal facility or disposal facility parcel (e.g., prevent pooling); and
		(iv)	Provides a surface drainage system which is consistent with the surrounding area and in no way significantly adversely affects proper drainage from these adjacent lands.
		In order to minimize soil erosion, as soon as practicable after final grading, the operator shall take steps as necessary to establish a protective vegetative cover of acceptable grasses over disturbed areas of the site. These steps shall include seeding, mulching, and any necessary fertilization at a minimum, and may include additional activities such as sodding of steeper slopes and drainage ways if such are necessary.	
		The operator shall take other measures as may be necessary to minimize and control erosion and sedimentation (e.g., soil stabilization, sediment ponds) at the site.	
		As required in the CCR unit permit, or as otherwise necessary to prevent threats to human health and the environment, the operator shall establish and/or complete a system for collecting, removing, and treating leachate generated by the disposal facility or disposal facility parcel.	

Table 5-2 - Qualitative Assessment of Impacts of CIP vs CBR for the Stilling Pond
Kingston Fossil Plant

Key Factors	Closure-in-Place (CIP)	Closure-by-Removal (CBR)
Volume of Coal Combustion Residual (CCR) materials to be removed [1]	None	Approximately 680,000 cubic yards
Schedule/Duration of closure activities [2][3]	Already complete	Five years to complete (assumes closure conducted sequentially)
Impacts to nearby communities related to closure activities	Lower (impacts associated with operations/maintenance of cover system)	Substantially higher (longer duration, increased traffic-related accidents/injuries)
Mode/Duration of CCR waste transport activities	None	Higher (trucking, duration longer)
Impacts to wetlands/sensitive habitat	Lower (impacts associated with operations/maintenance of cover system)	Higher (impacts associated with potential release during removal)
Impacts to environment/climate change	Lower (impacts associated with operations/maintenance of cover system)	Higher (impacts associated with greenhouse gas emissions from longer construction/transport duration)
Cost [4]	None	Substantially higher ($100 million to $190 million)
Source Control [5]	Implemented sooner (due to shorter closure construction)	Implemented later (due to longer closure construction)
Conclusion: CIP More Environmentally Beneficial than CBR [6] CBR would have substantially higher construction/transportation-related impacts and takes longer than CIP		

Notes:

1. CBR CCR material volumes used in this evaluation is less than that identified in the EAR to allow about 120,000 cubic yards to remain in place and serve as structural stability buttress for KRP Landfill. See Chapter 5.4.3 and Appendix C for additional information regarding site-specific considerations and assumptions included in the closure comparative analysis.
2. The estimated duration of either CIP or CBR closure activities is for the three TDEC Order CCR units, and assumes the following:
    a. CIP has been completed at this CCR unit.
    b. The duration of CBR activities is based on a maximum of 150 truckloads per day for disposal CCR material given the physical constraints for access and egress at the site and construction activities at each CCR unit.
3. The duration of CBR closure activities may be longer if the offsite receiving landfill(s) need additional permitting or construction activities prior to receiving CCR material.
4. Preliminary rough order of magnitude costs are based on an engineering estimate for construction activities for the Stilling Pond, including storm water management. The rough order of magnitude costs include design, construction, engineering oversight during construction, and project/construction management activities.
5. Closure actions provide the source control which supports groundwater corrective action and would be implemented sooner for CIP compared to CBR because CIP is completed at this CCR unit. Costs for implementing groundwater corrective action are not included in the above estimates for CCR unit closure.
6. The overall conclusion for the KIF Plant TDEC Order CCR units is consistent with findings in TVA's 2016 PEIS.

Acronyms:

CBR	Closure-by-Removal
CCR	Coal Combustion Residue
CIP	Closure-in-Place
KIF Plant	Kingston Fossil Plant
PEIS	Programmatic Environmental Impact Statement

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Table 5-3 - Qualitative Assessment of Impacts of CIP vs CBR for the Interim Ash Staging Area
Kingston Fossil Plant

Key Factors	Closure-in-Place (CIP)	Closure-by-Removal (CBR)
Volume of Coal Combustion Residual (CCR) materials to be removed [1]	None	Approximately 2.8 million cubic yards
Schedule/Duration of closure activities [2][3]	Three to four years (assumes closure conducted concurrently)	14 to 18 years to complete (assumes closure conducted sequentially)
Impacts to nearby communities related to closure activities	Lower	Substantially higher (longer duration, increased traffic-related accidents/injuries)
Mode/Duration of CCR waste transport activities	None	Higher (trucking, duration longer)
Impacts to wetlands/sensitive habitat	Lower	Higher (impacts associated with potential release during removal)
Impacts to environment/climate change	Lower	Higher (impacts associated with greenhouse gas emissions from longer construction/transport duration)
Cost [4]	Lower ($21 million to $40 million)	Substantially higher ($410 million to $790 million)
Source Control [5]	Implemented sooner (due to shorter closure construction)	Implemented later (due to longer closure construction)
Conclusion: CIP More Environmentally Beneficial than CBR [6] CBR would have substantially higher construction/transportation-related impacts and takes longer than CIP		

Notes:

1. CBR CCR material volume used in this evaluation is less than that identified in the EAR to allow about 150,000 cubic yards to remain in place and serve as structural stability buttress for KRP Landfill. See Chapter 5.4.3 and Appendix C for additional information regarding site-specific considerations and assumptions included in the closure comparative analysis.
2. The estimated duration of either CIP or CBR closure activities is for the three TDEC Order CCR units, and assumes the following:
    a. The estimated duration of CIP is for the Interim Ash Staging Area, the only TDEC Order CCR unit at the KIF Plant with planned additional closure actions.
    b. The estimated duration of CBR assumes that closure activities at the Interim Ash Staging Area and Sluice Trench and Area East of Sluice Trench would be to remove CCR material from the highest elevations first to maintain structural stability during the removal process, and that CBR activities at the Stilling Pond would be conducted separately.
3. The duration of CBR closure activities may be longer if the offsite receiving landfill(s) need additional permitting or construction activities prior to receiving CCR material.
4. Preliminary rough order of magnitude costs are based on an engineering estimate for construction activities for the Interim Ash Staging Area, including storm water management. The rough order of magnitude costs include design, construction, engineering oversight during construction, and project/construction management activities.
5. Closure actions provide the source control which supports groundwater corrective action and would be implemented sooner for CIP compared to CBR due to a shorter construction period. Costs for implementing groundwater corrective action are not included in the above estimates for CCR unit closure.
6. The overall conclusion for the KIF Plant TDEC Order CCR units is consistent with findings in TVA's 2016 PEIS.

Acronyms:

CBR	Closure-by-Removal
CCR	Coal Combustion Residue
CIP	Closure-in-Place
KIF Plant	Kingston Fossil Plant
PEIS	Programmatic Environmental Impact Statement

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Table 5-4 - Qualitative Assessment of Impacts of CIP vs CBR for the Sluice Trench and Area East of Sluice Trench
Kingston Fossil Plant

Key Factors	Closure-in-Place (CIP)	Closure-by-Removal (CBR)
Volume of Coal Combustion Residual (CCR) materials to be removed (1)	None	Approximately 880,000 cubic yards
Schedule/Duration of closure activities (2)(3)	Already complete	Five to six years to complete (assumes closure conducted sequentially)
Impacts to nearby communities related to closure activities	Lower (impacts associated with operations/maintenance of cover system)	Substantially higher (longer duration, increased traffic-related accidents/injuries)
Mode/Duration of CCR waste transport activities	None	Higher (trucking, duration longer)
Impacts to wetlands/sensitive habitat	Lower (impacts associated with operations/maintenance of cover system)	Higher (impacts associated with potential release during removal)
Impacts to environment/climate change	Lower (impacts associated with operations/maintenance of cover system)	Higher (impacts associated with greenhouse gas emissions from longer construction/transport duration)
Cost (4)	None	Substantially higher ($120 million to $230 million)
Source Control (5)	Implemented sooner (due to shorter closure construction)	Implemented later (due to longer closure construction)
Conclusion: CIP More Environmentally Beneficial than CBR (6) CBR would have substantially higher construction/transportation-related impacts and takes longer than CIP		

Notes:

1. CBR CCR material volume used in this evaluation is less than that identified in the EAR to allow about 8,900 cubic yards to remain in place and serve as structural stability buttress for KRP Landfill. See Chapter 5.4.3 and Appendix C for additional information regarding site-specific considerations and assumptions included in the closure comparative analysis.
2. The estimated duration of either CIP or CBR closure activities is for the three TDEC Order CCR units, and assumes the following:
    a. CIP has been completed at this CCR unit.
    b. CBR assumes that closure activities at the Interim Ash Staging Area and Sluice Trench and Area East of Sluice Trench would be to remove CCR material from the highest elevations first to maintain structural stability during the removal process.
    c. The duration of CBR activities is based on a maximum of 150 truckloads per day for disposal CCR material given the physical constraints for access and egress at the site and construction activities at each CCR unit.
3. The duration of CBR closure activities may be longer if the offsite receiving landfill(s) need additional permitting or construction activities prior to receiving CCR material.
4. Preliminary rough order of magnitude costs are based on an engineering estimate for construction activities for the Sluice Trench and Area East of Sluice Trench, including storm water management. The rough order of magnitude costs include design, construction, engineering oversight during construction, and project/construction management activities.
5. Closure actions provide the source control which supports groundwater corrective action and would be implemented sooner for CIP compared to CBR because CIP is completed at this CCR unit. Costs for implementing groundwater corrective action are not included in the above estimates for CCR unit closure.
6. The overall conclusion for the KIF Plant TDEC Order CCR units is consistent with findings in TVA's 2016 PEIS.

Acronyms:

CBR	Closure-by-Removal
CCR	Coal Combustion Residue
CIP	Closure-in-Place
KIF Plant	Kingston Fossil Plant
PEIS	Programmatic Environmental Impact Statement

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Table 5-5 - TDEC Division of Solid Waste Management Regulatory Compliance for Closure
Kingston Fossil Plant

State Closure Performance Standards	Stilling Pond	Interim Ash Staging Area	Sluice Trench and Area East of Sluice Trench
Operator must close the disposal facility in a manner that:	The Stilling Pond was closed in 2018. The closure included the removal of free water, partial excavation of Dike C for borrow material, and the construction of an engineered geosynthetic-soil cover system that meets regulatory requirements. Based on the current performance of the existing cover system, TVA is not planning modifications to the cover system or drainage at the Stilling Pond.	The Interim Ash Staging Area was closed in 2016 with an engineered soil cover system that meets regulatory requirements. TVA plans to modify the existing soil cover system at this CCR unit with a geosynthetic cover system to further control and minimize infiltration. This includes extending the cover system beyond the existing limits of the soil cover system along the western and southern edges of the Interim Ash Staging Area and tie into the existing geosynthetic cover system in the Sluice Trench and Area East of Sluice Trench. Areas within the planned limits of the cover system extension will be regraded to promote site drainage. Stormwater drainage modifications will include replacement of existing stormwater culverts disturbed during construction and installation of new stormwater culverts as necessary. The stormwater ditch to the east of the railroad tracks will be regraded to improve drainage conditions. Following completion of the drainage modifications, CCR unit regrading, and cover system extensions, exposed areas will be stabilized with seed or sod, and gravel roadways will be repaired or replaced as necessary.	The Water Quality Channel and Polishing Pond were constructed in the Sluice Trench and Area East of Sluice Trench in 2015 to support the transition from wet to dry CCR material handling. The Sluice Trench and Area East of Sluice Trench was closed in 2018. The Water Quality Channel and Polishing Pond areas of the Sluice Trench and Area East of Sluice Trench were closed using a geosynthetic liner system. The area east of the Water Quality Channel and Polishing Pond was closed using a geosynthetic soil cover system. The area between the Water Quality Channel and the Bottom Ash Dewatering Facility was closed using an engineered soil cover system. These existing final cover systems meet regulatory requirements. Based on the current performance of the existing cover systems, TVA is not planning modifications to the cover systems or drainage at the Sluice Trench and Area East of Sluice Trench. TVA is constructing an East Dike seismic stability mitigation project at the Sluice Trench and Area East of Sluice Trench as a separate project prior to CARA Plan implementation. The project includes the construction of a stability berm, which will also function as a working platform, foundation soil ground improvements by stone columns, and a buttress of riprap in the Plant Intake Channel along the East Dike from the boat ramp to the Engineered Wetlands as a seismic mitigation measure, such that the CCR unit will meet or exceed slope stability criteria for pseudostatic global and post-earthquake global stability.
• Minimizes the need for further maintenance	The cover system installed in 2018 minimizes the need for further maintenance. TVA will continue to control of infiltration and releases through: - site grading plan - (positive drainage, no ponding) - compaction and settlement monitoring - engineered cover system (limit precipitation infiltration and atmospheric exposure to CCR) - stormwater management system (run-on and run-off controls) - fugitive dust control measures - periodic structural inspections	Prior to and following the installation of the geosynthetic cover system, TVA will continue to conduct regularly scheduled inspections to evaluate post-closure conditions and conduct necessary repairs related to: - drainage and erosion - cover system integrity - pooling, wet areas, seeps - bare areas - sloughing and other structural defects The scheduled inspections and as-needed repairs will minimize the need for further maintenance on the CCR unit.	The cover systems completed in 2018 minimize the need for further maintenance. TVA will continue to control infiltration and releases through: - site grading plan - (positive drainage, no ponding) - compaction and settlement monitoring - engineered cover system (limit precipitation infiltration and atmospheric exposure to CCR) - stormwater management system (run-on and run-off controls) - fugitive dust control measures - periodic structural inspections
• Controls, minimizes, or eliminates, to the extent necessary to prevent threats to public health and the environment, post-closure escape of solid waste, solid waste constituents, leachate, contaminated rainfall, or waste decomposition to the ground or surface waters or to the atmosphere	The completed closure actions included elements to control and minimize infiltration through the cover system of the CCR unit and post-closure escape of CCR constituents. These methods included installation of geosynthetic cover systems that meet RCRA standards, establishing vegetative covers, regrading surfaces to promote stormwater runoff, and lining storm water conveyance systems. Control and minimization of post-closure escape is achieved through: - site grading plan (positive drainage, no ponding) - compaction and settlement monitoring - engineered cover system (limit precipitation infiltration and atmospheric exposure to CCR) - stormwater management system (run-on and run-off controls) - fugitive dust control measures - periodic structural inspections - geosynthetic liner installation	The planned additional closure actions include elements to control and minimize infiltration through the cover system of the CCR unit and post-closure escape of CCR constituents. These methods include installation of geosynthetic cover systems that meet RCRA standards, establishing vegetative covers, regrading surfaces to promote storm runoff, and lining storm water conveyance systems. Coupled with the comprehensive measures planned for additional unit closure actions, control and minimization of post-closure escape will be achieved through: - site grading plan (positive drainage, no ponding) - compaction and settlement monitoring - engineered cover system (limit precipitation infiltration and atmospheric exposure to CCR) - stormwater management system (run-on and run-off controls) - fugitive dust control measures - periodic structural inspections - geosynthetic liner installation	The completed closure actions included elements to control and minimize infiltration through the cover systems of the CCR unit and post-closure escape of CCR constituents. These methods included installation of geosynthetic and soil cover systems that meet RCRA standards, establishing vegetative covers, regrading surfaces to promote stormwater runoff, and lining storm water conveyance systems. TVA is constructing stability berm and foundation soil ground improvements at the East Dike to meet or exceed slope stability criteria for pseudostatic global and post-earthquake global stability. Control and minimization of post-closure escape is achieved through: - site grading plan (positive drainage, no ponding) - compaction and settlement monitoring - engineered cover system (limit precipitation infiltration and atmospheric exposure to CCR) - stormwater management system (run-on and run-off controls) - fugitive dust control measures - periodic structural inspections - geosynthetic liner installation
The operator must complete closure activities including grading and establishing vegetative cover in the shortest practicable time, not to exceed 180 days, after any fill areas or any portion of the fill areas have achieved final grade, unless the Commissioner allows otherwise in the permit.	Not applicable - the cover system was installed in 2018.	Additional unit closure actions will be completed in a practicable timeframe consistent with recognized and generally accepted good engineering practices and with ensuring the safety of site workers, the public, and the environment. The CARA Plan includes a schedule for approval by the Commissioner.	Not applicable - the cover systems were completed in 2018.

Table 5-5 - TDEC Division of Solid Waste Management Regulatory Compliance for Closure
Kingston Fossil Plant

State Closure Performance Standards	Stilling Pond	Interim Ash Staging Area	Sluice Trench and Area East of Sluice Trench
Final Cover System:			
• The depth of final cover system shall be at least 36 inches of soil of which a minimum of 12 inches shall be for the support of vegetative cover. • The design of the final covers system shall be such that the infiltration volume of water will be equal to or less than the percolation volume through the bottom liner system or a design which includes a compacted soil layer of at least 24 inches which has a permeability no greater than 1 x 10-7 cm/sec, whichever is less. This design shall be supported by the use of the HELP model or other equivalent method approved by the Commissioner. • An alternative final cover system may be used provided that it is demonstrated to the satisfaction of the Commissioner that the final cover system provides equivalent or superior performance to the minimum performance standard in this subpart.	The existing final cover system meets the minimum standards in this subpart. The final cover system provides superior performance to the minimum regulatory performance standards. The permeability of the final cover system exceeds TDEC standards by ranging from 10-13 to 10-14 cm/sec. The final cover system includes: - 40-mil textured LLDPE flexible geomembrane cover - Geocomposite drainage layer - 18-inches protective cover soil - 6-inches vegetative cover soil Based on the performance of the existing cover system, TVA is not recommending additional closure actions at the Stilling Pond.	The existing final cover system meets the minimum standards in this subpart. TVA plans to modify the existing soil cover system with an alternative final cover system and install an alternative final cover system in additional areas around the perimeter of the unit. The design of the alternative final cover system provides superior performance to the minimum regulatory performance standards. The permeability of alternative final cover system exceeds TDEC standards by ranging from 10-13 to 10-14 cm/sec. Alternative final cover system to include: - 40-mil textured LLDPE flexible geomembrane - Geocomposite drainage layer - 18-inches protective cover soil 6-inches vegetative cover soil A final cover system has not been constructed at the Bottom Ash Dewatering Facility. Because the Bottom Ash Dewatering Facility is still active, TVA has not included planned closure actions for this area in this CARA Plan.	The existing final cover systems meet the minimum standards in this subpart. The final cover system provides superior performance to the minimum regulatory performance standards. The permeability of the Polishing Pond, Water Quality Channel, and area east of the Water Quality Channel final cover systems exceed TDEC standards by ranging from 10-13 to 10-14 cm/sec. The Polishing Pond final cover system includes (AECOM 2018): - Geosynthetic clay liner (layer 2) - Geosynthetic clay liner (layer 1) - 60-mil textured LLDPE geomembrane cover - Non-woven geotextile cushion - 6-inches aggregate - 12-inches gravel protective layer The Water Quality Channel final cover system includes (Trans-Ash 2015): - 60-mil textured HDPE flexible membrane liner - 18-inches sand layer - Geotextile fabric - 18 inches rip rap The final cover system for the area east of the Water Quality Channel and Polishing Pond includes: - 40-mil textured LLDPE flexible geomembrane cover - geocomposite drainage layer - 18-inches protective cover soil - 6-inches vegetative cover soil TVA plans to modify the existing engineered soil cover system located between the Water Quality Channel and the Bottom Ash Dewatering Facility with an alternative final cover system as part of the Interim Ash Staging Area planned additional closure actions. Based on the performance of the existing cover systems, TVA is not recommending additional closure actions at the Sluice Trench and Area East of Sluice Trench.
The final surface of the disposal facility shall be graded and/or provided with drainage facilities in a manner that:			
• Minimizes precipitation run-on from adjacent areas onto the disposal facility • Minimizes erosion of cover material (e.g., no steep slopes) • Optimizes drainage of precipitation falling on the disposal facility (e.g., prevent pooling) • Provides a surface drainage system which is consistent with the surrounding area and in no way significantly affects proper drainage from these adjacent lands	TVA conducts post-closure care activities in accordance with the closure and post-closure plans submitted to TDEC. Post-closure care activities include vegetative cover monitoring and maintenance, maintaining the approved final contours, drainage and post-closure inspections.	Precipitation run-on from adjacent areas and erosion of cover material will be controlled and minimized through a stormwater management system and site grading plan that will prevent pooling and promote proper drainage from adjacent lands.	TVA conducts post-closure care activities in accordance with the closure and post-closure plans. Post-closure care activities include vegetative cover monitoring and maintenance, maintaining the approved final contours, drainage and post-closure inspections.
In order to minimize soil erosion, as soon as practicable after final grading, the operator shall take steps as necessary to establish a protective vegetative cover of acceptable grasses over disturbed areas of the site. These steps shall include seeding, mulching, and any necessary fertilization at a minimum, and may include additional activities such as sodding of steeper slopes and drainage ways if such are necessary.	TVA conducts post-closure care activities in accordance with the closure and post-closure plans submitted to TDEC. Post-closure care activities include vegetative cover monitoring and maintenance, maintaining the approved final contours, drainage and post-closure inspections.	Protective vegetative cover will be established as soon as practicable in disturbed areas and will include seeding, mulching, fertilizing, and necessary additional activities to minimize soil erosion	TVA conducts post-closure care activities in accordance with the closure and post-closure plans prepared per CCR Rule requirements. Post-closure care activities include vegetative cover monitoring and maintenance, maintaining the approved final contours, drainage and post-closure inspections.

Table 5-5 - TDEC Division of Solid Waste Management Regulatory Compliance for Closure
Kingston Fossil Plant

State Closure Performance Standards	Stilling Pond	Interim Ash Staging Area	Sluice Trench and Area East of Sluice Trench
In addition to the drainage and grading requirements and vegetative cover requirements, the operator shall take other measures as may be necessary to minimize and control erosion and sedimentation (e.g., soil stabilization, sediment ponds) at the site.	Post-closure inspections are conducted to identify settlement, subsidence, erosion, and other surface defects. Post-closure repairs are conducted as needed to correct erosion and surface defects.	Post-closure inspections will be conducted to identify settlement, subsidence, erosion, and other surface defects. Post-closure repairs will be conducted to correct erosion and surface defects.	Post-closure inspections are conducted to identify settlement, subsidence, erosion, and other surface defects. Post-closure repairs are conducted as needed to correct erosion and surface defects.
As required in the permit, or as otherwise necessary to prevent threats to human health and the environment, the operator shall establish and/or complete a system for collecting, removing, and treating leachate generated by the disposal facility.	Potential seeps are investigated and evaluated in accordance with the facility's Seepage Action Plan. Visual inspections of the dikes and toe are conducted quarterly, and areas of concern are identified by a unique number, date of discovery, description, size, mitigation status and current status.	Potential seeps are investigated and evaluated in accordance with the facility's Seepage Action Plan. Visual inspections of the dikes and toe are conducted quarterly, and areas of concern are identified by a unique number, date of discovery, description, size, mitigation status and current status.	Potential seeps are investigated and evaluated in accordance with the facility's Seepage Action Plan. Visual inspections of the dikes and toe are conducted quarterly, and areas of concern are identified by a unique number, date of discovery, description, size, mitigation status and current status.

Acronyms:

CARA	Corrective Action/Risk Assessment
CCR	Coal Combustion Residuals
cm/sec	centimeters per second
HDPE	High-Density Polyethylene
LLDPE	Linear Low-Density Polyethylene
mil	A mil equals one-thousandth of an inch, or 0.001 inch
RCRA	Resource Conservation and Recovery Act
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority

Table 6-1 – TDEC Division of Solid Waste Management Groundwater Requirements
Kingston Fossil Plant

TDEC Solid Waste Management TDEC Rule (0400-11-01-.04)			
Action	**Regulatory Citation(s)**	**Performance Standards and Evaluation Factors**	
Assessment of Corrective Measures	TDEC Rule 0400-11-01-.04(7)(a)7(iii)	The assessment shall include an analysis of the effectiveness of potential corrective measures to meet the requirements and objectives of a remedy as described in part 8 of this subparagraph. Analyses to assess and evaluate potential remedies shall address at least the following:	
		(I)	The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination,
		(II)	The time required to begin and complete the remedy,
		(III)	The cost of remedy implementation, and
		(IV)	The institutional requirements such as State or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s).
Required Performance Standards for Remedy	TDEC Rule 0400-11-01-.04(7)(a)8(ii)	Remedies must:	
		(I)	Be protective of human health and the environment,
		(II)	Attain the groundwater protection standard as specified pursuant to part 1 of this subparagraph,
		(III)	Control the source(s) of releases so as to reduce or eliminate, to the maximum extent practicable, further releases of constituents listed in [Table 1-1][1] into the environment that may pose a threat to human health or the environment, and
		(IV)	Comply with standards for management of wastes as specified in subpart 9(iv) of this subparagraph.
Evaluation Factors for Selecting Remedy	TDEC Rule 0400-11-01-.04(7)(a)8(iii)(I)	The long-and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful based on consideration of the following:	
		I.	Magnitude of reduction of existing risks,
		II.	Magnitude of residual risks in terms of likelihood of further releases due to waste remaining following implementation of a remedy,
		III	The type and degree of long-term management required, including monitoring, operation, and maintenance,
		IV.	Short-term risks that might be posed to the community, workers, or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal or containment,
		V.	Time until full protection is achieved,
		VI.	Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment,
		VII.	Long-term reliability of the engineering and institutional controls, and
		VIII.	Potential need for replacement of the remedy.
	TDEC Rule 0400-11-01-.04(7)(a)8(iii)(II)	The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of the following factors:	
		I.	The extent to which containment practices will reduce further releases, and
		II.	The extent to which treatment technologies may be used.

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Table 6-1 – TDEC Division of Solid Waste Management Groundwater Requirements
Kingston Fossil Plant

TDEC Solid Waste Management TDEC Rule (0400-11-01-.04)				
Action	**Regulatory Citation(s)**	**Performance Standards and Evaluation Factors**		
	TDEC Rule 0400-11-01-.04(7)(a)8(iii)(III)	The ease or difficulty of implementing a potential remedy(s) based on consideration of the following types of factors:		
		I.	Degree of difficulty associated with constructing the technology,	
		II.	Expected operational reliability of the technologies,	
		III.	Need to coordinate with and obtain necessary approvals and permits from other agencies,	
		IV.	Availability of necessary equipment and specialists, and	
		V.	Available capacity and location of needed treatment, storage, and disposal services.	
	TDEC Rule 0400-11-01-.04(7)(a)8(iii)(IV)	The degree to which community concerns are addressed by a potential remedy(s).		
Factors to Consider in Establishing a Remediation Schedule	TDEC Rule 0400-11-01-.04(7)(a)8(iv)	The owner or operator shall specify as part of the selected remedy a schedule(s) for initiating and completing remedial activities. Such a schedule must require the initiation of remedial activities within a reasonable period of time taking into consideration the factors set forth in items (I) through (VI) of this subpart. The owner or operator must consider the following factors in determining the schedule of remedial activities:		
		(I)	Extent and nature of contamination,	
		(II)	Practical capabilities of remedial technologies in achieving compliance with ground water protection standards established under part 1 of this subparagraph and other objectives of the remedy,	
		(III)	Availability of treatment or disposal capacity for wastes managed during implementation of the remedy,	
		(IV)	Desirability of utilizing technologies that are not currently available, but which may offer significant advantages over already available technologies in terms of effectiveness, reliability, safety, or ability to achieve remedial objectives,	
		(V)	Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy, and	
		(VI)	Resource value of the aquifer including:	
			I.	Current and future uses,
			II.	Proximity and withdrawal rate of users,
			III.	Ground water quantity and quality,
			IV.	The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents,
			V.	The hydrogeologic characteristic of the facility and surrounding land,
			VI.	Ground water removal and treatment costs,
			VII.	The cost and availability of alternative water supplies, and
			VIII.	Other relevant factors.

Table 6-1 – TDEC Division of Solid Waste Management Groundwater Requirements
Kingston Fossil Plant

TDEC Solid Waste Management TDEC Rule (0400-11-01-.04)				
Action	**Regulatory Citation(s)**	**Performance Standards and Evaluation Factors**		
Determination that Remediation of Release is not Necessary	TDEC Rule 0400-11-01-.04(7)(a)8(v)	The Commissioner may determine that remediation of a release of an Appendix II constituent from a Solid Waste Landfill unit is not necessary if the owner or operator demonstrates to the satisfaction of the Commissioner that:		
		(I)	The ground water is additionally contaminated by substances that have originated from a source other than a SWLF unit and those substances are present in concentrations such that cleanup of the release from the SWLF unit would provide no significant reduction in risk to actual or potential receptors, or	
		(II)	The constituent(s) is present in ground water that:	
			I.	Is not currently or reasonably expected to be a source of drinking water, and
			II.	Is not migrating or is not likely to migrate in a concentration(s) that would exceed the GWPS to other hydraulically connected waters, or
		(III)	Remediation of the release(s) is technically impracticable, or	
		(IV)	Remediation results in unacceptable cross-media impacts.	
	TDEC Rule 0400-11-01-.04(7)(a)8(vi)	A determination by the Commissioner pursuant to subpart (v) of this part shall not affect the authority of the State to require the owner or operator to undertake source control measures or other measures that may be necessary to eliminate or minimize further releases to the ground water, to prevent exposure to the ground water, or to remediate the ground water to concentrations that are technically practicable and significantly reduce threats to human health or the environment.		
Implementation of the Corrective Action Program	TDEC Rule 0400-11-01-.04(7)(a)9(v)	Remedies selected pursuant to part 8. of this subparagraph shall be considered complete when:		
		(I)	The owner or operator complies with the ground water protection standard at all points within the plume of contamination that lie beyond the ground water monitoring well system established under part 3 of this subparagraph.	
		(II)	Compliance with the ground water protection standard has been achieved by demonstrating that concentrations of constituents listed in [Table 1-1][1] of this rule have not exceeded the ground water protection standard(s) for a period of three consecutive years using approved statistical procedures and performance standards. The Commissioner may specify an alternative length of time during which the owner or operator must demonstrate that concentrations of constituents listed in [Table 1-1][1] of this rule have not exceeded the ground water protection standard(s) taking into consideration:	
			I.	Extent and concentration of the release(s);
			II.	Behavior characteristics of the hazardous constituents in the ground water;
			III.	Accuracy of monitoring or modeling techniques, including any seasonal, meteorological, or other environmental variables that may affect the accuracy; and
			IV.	Characteristics of the ground water.
		(III)	All actions required to complete the remedy have been satisfied.	

[1] The citation has been modified to reflect the constituents listed in Table 1-1 of the CARA Plan. See Chapter 6.1 for further discussion regarding the basis of GWPS.

Table 6-2 - TDEC Division of Solid Waste Management Regulatory Compliance for Groundwater Corrective Action
Kingston Fossil Plant

State Groundwater Corrective Action Requirements	Stilling Pond	Sluice Trench/Interim Ash Area
Remedies must:		
• Be protective of human health and the environment	An evaluation of the risk to human health and the environment is provided in the CARA Plan, which details the review of sensitive receptors, analysis of exposure pathways, and evaluation of future conditions. As discussed in the CARA Plan, there are currently no unacceptable risks to onsite or offsite human or ecological receptors based on USEPA guidance for assessing potential exposures to sediment, surface stream water, or groundwater. Implementation of *in situ* treatment, will continue to provide for the protection of human health and the environment.	An evaluation of the risk to human health and the environment is provided in the CARA Plan, which details the review of sensitive receptors, analysis of exposure pathways, and evaluation of future conditions. As discussed in the CARA Plan, there are currently no unacceptable risks to onsite or offsite human or ecological receptors based on USEPA guidance for assessing potential exposures to sediment, surface stream water, or groundwater. Implementation of additional closure actions and source control actions, coupled with *in situ* treatment, will continue to provide for the protection of human health and the environment.
• Attain GWPS	Based on the results of bench testing and geochemical modeling, *in situ* treatment, coupled with existing closure actions, can attain GWPS. *In situ* treatment is an established technology to address groundwater quality until GWPS are attained. TVA will document groundwater quality improvements.	Based on the results of bench testing and geochemical modeling, *in situ* treatment, coupled with planned additional closure actions, can attain GWPS. *In situ* treatment is an established technology to address groundwater quality until GWPS are attained. TVA will document groundwater quality improvements.
• Control the sources of releases so as to reduce or eliminate, to the maximum extent practicable, further releases of constituents listed in Appendix II of this rule into the environment that may pose a threat to human health or the environment	The Stilling Pond was closed in 2018. The closure included the removal of free water, partial excavation of Dike C for borrow material, and the construction of a geosynthetic soil cover system.	Additional source control measures will be implemented to reduce or eliminate releases of constituents into the environment. Planned additional unit closure actions include installation of a geosynthetic cover system and drainage modifications to promote site drainage, and construction of a stability berm and foundation soil ground improvements to improve stability. Once final grades are attained, either a geosynthetic-soil or geosynthetic-engineered turf cover system will be installed. The planned geosynthetic cover system will extend beyond the existing limits of the soil cover system along the western and southern edges of the Interim Ash Staging Area and tie into the existing geosynthetic cover systems in the Sluice Trench and Area East of Sluice Trench and Ditch 11. Other planned source control actions include stormwater drainage modifications by regrading the stormwater ditch to the east of the railroad tracks to improve drainage conditions. The stormwater modifications will include replacement of existing stormwater culverts disturbed during construction and installation of new stormwater culverts as necessary.
• Comply with standards for management of wastes	Not applicable because management of waste is not needed for these corrective actions.	Not applicable because management of waste is not needed for these corrective actions.

Table 6-2 - TDEC Division of Solid Waste Management Regulatory Compliance for Groundwater Corrective Action
Kingston Fossil Plant

State Groundwater Corrective Action Requirements	Stilling Pond	Sluice Trench/Interim Ash Area
In selecting a remedy, the owner/operator shall consider the following evaluation factors:	Evaluation criteria:	Evaluation criteria:
• The long- and short-term effectiveness and protectiveness of the potential remedy, along with the degree of certainty that the remedy will prove successful based on consideration of the following:	Long- and short-term results will be achieved through existing source control actions, coupled with implementation of *in situ* treatment, as an established corrective action until GWPS are attained.	Long- and short-term results will be achieved through implementation of additional source control actions, coupled with *in situ* treatment, as an established corrective action until GWPS are attained.
○ Magnitude of reduction of existing risks	There are no offsite unacceptable risks. The planned groundwater corrective action will address regulatory requirements to meet GWPS, regardless of whether unacceptable risks exist or not.	There are no offsite unacceptable risks. The planned groundwater corrective action will address regulatory requirements to meet GWPS, regardless of whether unacceptable risks exist or not.
○ Magnitude of residual risks in terms of likelihood of further releases due to waste remaining following implementation of a remedy	There are no offsite unacceptable risks. The existing closure and source control actions will be maintained reduce or eliminate releases of constituents into the environment.	There are no offsite unacceptable risks. The planned additional closure and source control actions will be implemented to reduce or eliminate releases of constituents into the environment.
○ The type and degree of long-term management required, including monitoring, operation, and maintenance	The *in situ* treatment system will require regular monitoring, O&M, including treatment system monitoring, routine groundwater monitoring, and continual data evaluation. O&M will include upkeep of treatment system infrastructure components (pumps, pipes, tanks, instrumentation and controls) and handling of treatment residuals.	The *in situ* treatment system will require regular monitoring, O&M, including treatment system monitoring, routine groundwater monitoring, and continual data evaluation. O&M will include upkeep of treatment system infrastructure components (pumps, pipes, tanks, instrumentation and controls) and handling of treatment residuals.
○ Short-term risks that might be posed to the community, workers, or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, re-disposal or containment	Short-term risks associated with the selected groundwater corrective action during implementation are considered negligible and manageable given standard health and safety protocols regarding use of the treatment reagents. This technology poses little to no offsite risk to human health and the environment. Implementation of the *in situ* treatment system will occur within the site boundaries. The planned corrective actions do not include excavation, transportation, or re-disposal.	Short-term risks associated with the selected groundwater corrective action during implementation are considered negligible and manageable given standard health and safety protocols regarding use of the treatment reagents. This technology poses little to no offsite risk to human health and the environment. Implementation of the *in situ* treatment system will occur within the site boundaries. The planned corrective actions do not include excavation, transportation, or re-disposal.

Table 6-2 - TDEC Division of Solid Waste Management Regulatory Compliance for Groundwater Corrective Action
Kingston Fossil Plant

State Groundwater Corrective Action Requirements	Stilling Pond	Sluice Trench/Interim Ash Area
○ Time until full protection is achieved	As discussed in the CARA Plan, there are currently no unacceptable risks to human health and ecological receptors based on groundwater in the vicinity of the Stilling Pond. The time required to achieve a condition where GWPS have been attained and would be maintained without continued corrective action is uncertain due to a variety of factors, but routine groundwater monitoring at other TVA Plant CCR units has shown that implemented source control measures started to have a beneficial effect on groundwater quality within a five- to 10-year timeframe. This timeframe is based on TVA's current understanding of site conditions, groundwater and geochemical modeling, *in situ* treatment bench testing, analysis of recent trends in groundwater data, and professional judgement.	As discussed in the CARA Plan, there are currently no unacceptable risks to human health and ecological receptors based on groundwater in the vicinity of the Sluice Trench/Interim Ash Area. The time required to achieve a condition where GWPS have been attained and would be maintained without continued corrective action is uncertain due to a variety of factors, but routine groundwater monitoring at other TVA Plant CCR units has shown that implemented source control measures started to have a beneficial effect on groundwater quality within a five- to 10-year timeframe. This timeframe is based on TVA's current understanding of site conditions, groundwater and geochemical modeling, *in situ* treatment bench testing, analysis of recent trends in groundwater data, and professional judgement.
○ Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment	The remaining CCR material will be contained with a geosynthetic cover system that will prevent exposure to humans and the environment.	The remaining CCR material will be contained with a geosynthetic cover system that will prevent exposure to humans and the environment.
○ Long-term reliability of the engineering and institutional controls	As discussed in the CARA Plan, there are currently no unacceptable risks to human health and ecological receptors based on groundwater in the vicinity of the Stilling Pond. The engineered source control measures are designed to be appropriately durable, providing long-term reliability of source control. As an additionally long-term protective measure an institutional control prohibiting the use of groundwater may be implemented based on TVA's long-range planning considerations.	As discussed in the CARA Plan, there are currently no unacceptable risks to human health and ecological receptors based on groundwater in the vicinity of the Sluice Trench/Interim Ash Area. The engineered source control measures are designed to be appropriately durable, providing long-term reliability of source control. As an additionally long-term protective measure an institutional control prohibiting the use of groundwater may be implemented based on TVA's long-range planning considerations.
○ Potential need for replacement of the remedy	Because the existing source control actions coupled with *in situ* treatment is an established method to attain GWPS, the potential need for replacement of the corrective action is unlikely. If the implemented corrective actions progress and changing conditions are either not effective or groundwater concentrations are not decreasing commensurate with anticipated timelines, integration of additional treatment methods or modifications of the implemented corrective action would be completed within an adaptive management framework in coordination with TDEC and in accordance with applicable regulations.	Because the planned and existing source control actions coupled *with in situ* treatment is an established method to attain GWPS, the potential need for replacement of the corrective action is unlikely. If the implemented corrective actions progress and changing conditions are either not effective or groundwater concentrations are not decreasing commensurate with anticipated timelines, integration of additional treatment methods or modifications of the implemented corrective action would be completed within an adaptive management framework in coordination with TDEC and in accordance with applicable regulations.

Table 6-2 - TDEC Division of Solid Waste Management Regulatory Compliance for Groundwater Corrective Action
Kingston Fossil Plant

State Groundwater Corrective Action Requirements	Stilling Pond	Sluice Trench/Interim Ash Area
• The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of the following factors:	Evaluation criteria:	Evaluation criteria:
○ The extent to which containment practices will reduce further releases	Based on the current performance of the existing cover system, TVA is not planning modifications to the cover system or drainage at the Stilling Pond.	Additional source control measures will be implemented to reduce or eliminate releases of constituents into the environment. Planned additional unit closure actions include installation of a geosynthetic cover system and drainage modifications to promote site drainage. The proposed engineered geosynthetic cover system will extend beyond the existing limits of the soil cover system along the western and southern edges of the Interim Ash Staging Area The proposed geosynthetic cover system will tie into the existing limits of the cover system along the perimeter of Ditch 11 and the Sluice Trench and Area East of Sluice Trench. Stormwater drainage modifications will include replacement of existing stormwater culverts disturbed during construction and installation of new stormwater culverts as necessary. The stormwater ditch to the east of the railroad tracks will be regraded to improve drainage conditions.
○ The extent to which treatment technologies may be used	The *in situ* treatment system will be installed along portions of the southern and southeastern downgradient boundaries of the Stilling Pond such that the normal flow of groundwater in the uppermost aquifer is intercepted by the *in situ* treatment zone.	The *in situ* treatment system will be installed along portion of the southeastern downgradient boundary of the Sluice Trench/Interim Ash Area such that the normal flow of groundwater in the uppermost aquifer is intercepted by the *in situ* treatment zone.
• The ease or difficulty of implementing a potential remedy based on consideration of the following types of factors:	Evaluation criteria:	Evaluation criteria:
○ Degree of difficulty associated with constructing the technology	*In situ* treatment is an established technology that has been successfully planned and reliably implemented and monitored at many environmental sites. A preliminary evaluation of site-specific conditions at this unit did not reveal obstacles to implementation. The system design and performance can be modified to account for site-specific or changing conditions prior to implementation. Based on current information, limitations to implementation due to permitting, availability of equipment and specialists, and availability of disposal services were not identified.	Coupled with the additional unit source control actions, *in situ* treatment is an established technology that has been successfully planned and reliably implemented and monitored at many environmental sites. A preliminary evaluation of site-specific conditions at this unit did not reveal obstacles to implementation. The system design and performance can be modified to account for site-specific or changing conditions prior to implementation. Based on current information, limitations to implementation due to permitting, availability of equipment and specialists, and availability of disposal services were not identified.
○ Expected operational reliability of the technologies		
○ Need to coordinate with and obtain necessary approvals and permits from other agencies		
○ Availability of necessary equipment and specialists		
○ Available capacity and location of needed treatment, storage, and disposal services		

Table 6-2 - TDEC Division of Solid Waste Management Regulatory Compliance for Groundwater Corrective Action
Kingston Fossil Plant

State Groundwater Corrective Action Requirements	Stilling Pond	Sluice Trench/Interim Ash Area
• The degree to which community concerns are addressed by a potential remedy	*In situ* treatment is an established technology that pose little to no offsite risk to the community. Community concerns raised during the public comment period will be addressed in a subsequent revision of this CARA Plan.	Coupled with the comprehensive measures planned for the additional unit closure actions, *in situ* treatment is an established technology that pose little to no offsite risk to the community. Community concerns raised during the public comment period will be addressed in a subsequent revision of this CARA Plan.
The owner/operator shall specify as part of the selected remedy a schedule for initiating and completing remedial activities. Such a schedule must require the initiation of remedial activities within a reasonable period of time taking into consideration the following factors. The owner/operator must consider the following factors in determining the schedule of remedial activities:	Chapter 8 of this CARA Plan provides a schedule for the implementation of corrective action activities proposed. Exhibit 8-1 provides further details regarding the schedule for implementation activities.	Chapter 8 of this CARA Plan provides a schedule for the completion of the additional closure actions and implementation of corrective action activities proposed. Exhibit 8-1 provides further details regarding the schedule for implementation activities.
• Extent and nature of contamination	The extent and nature of contamination was considered when developing the selected corrective action schedule. The extent and nature of GWPS exceedances were evaluated in the Environmental Assessment Report and this CARA Plan	The extent and nature of contamination was considered when developing the selected corrective action schedule. The extent and nature of GWPS exceedances were evaluated in the Environmental Assessment Report and this CARA Plan
• Practical capabilities of remedial technologies in achieving compliance with GWPS and other objectives of the remedy	As discussed in the CARA Plan, there are currently no unacceptable risks to human health and ecological receptors based on groundwater in the vicinity of the Stilling Pond. It is anticipated that GWPS would be attained within a few years following *in situ* treatment implementation. The time required for *in situ* treatment to attain the GWPS is uncertain due to a variety of factors, but routine groundwater monitoring at other TVA Plant CCR units has shown that implemented source control measures started to have a beneficial effect on groundwater quality within a five- to 10-year timeframe. This timeframe is based on TVA's current understanding of site conditions, groundwater and geochemical modeling, *in situ* treatment bench testing, analysis of recent trends in groundwater data, and professional judgement.	As discussed in the CARA Plan, there are currently no unacceptable risks to human health and ecological receptors based on groundwater in the vicinity of the Sluice Trench/Interim Ash Area. It is anticipated that GWPS would be attained within a few years following *in situ* treatment implementation. The time required for *in situ* treatment to attain the GWPS is uncertain due to a variety of factors, but routine groundwater monitoring at other TVA Plant CCR units has shown that implemented source control measures started to have a beneficial effect on groundwater quality within a five- to 10-year timeframe. This timeframe is based on TVA's current understanding of site conditions, groundwater and geochemical modeling, *in situ* treatment bench testing, analysis of recent trends in groundwater data, and professional judgement.
• Availability of treatment or disposal capacity for wastes managed during implementation of the remedy	The availability of treatment or disposal capacity was deemed not to be a factor affecting the selected corrective action schedule.	The availability of treatment or disposal capacity was deemed not to be a factor affecting the selected corrective action schedule.
• Desirability of utilizing technologies that are not currently available, but which may offer significant advantages over already available technologies in terms of effectiveness, reliability, safety or ability to achieve remedial objectives	There are no known technologies in development that would be more desirable than *in situ* treatment. Technologies that are not currently available, but which may offer significant advantages over already available technologies in terms of effectiveness, reliability, safety or ability to attain remedial objectives, will be reviewed if they become available.	There are no known technologies in development that would be more desirable than *in situ* treatment. Technologies that are not currently available, but which may offer significant advantages over already available technologies in terms of effectiveness, reliability, safety or ability to attain remedial objectives, will be reviewed if they become available.

Table 6-2 - TDEC Division of Solid Waste Management Regulatory Compliance for Groundwater Corrective Action
Kingston Fossil Plant

State Groundwater Corrective Action Requirements	Stilling Pond	Sluice Trench/Interim Ash Area
• Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy	There are currently no identified unacceptable risks to human health or the environment based on the groundwater in the vicinity of the Stilling Pond, as documented in the CARA Plan, and there are no human receptors of onsite or offsite groundwater use. Therefore, potential risks to human health and the environment from exposure to contamination prior to completion of the corrective actions was not a factor in the selected corrective action implementation schedule.	There are currently no identified unacceptable risks to human health or the environment based on the groundwater in the vicinity of the Sluice Trench/Interim Ash Area, as documented in the CARA Plan, and there are no human receptors of onsite or offsite groundwater use. Therefore, potential risks to human health and the environment from exposure to contamination prior to completion of the corrective actions was not a factor in the selected corrective action implementation schedule.
• Resource value of the aquifer including:	Evaluation factors:	Evaluation factors:
○ Current and future uses	There are no onsite or downgradient offsite uses of groundwater as a drinking water source. TVA may consider additional institutional controls in the future if needed to address future use of groundwater.	There are no onsite or downgradient offsite uses of groundwater as a drinking water source. TVA may consider additional institutional controls in the future if needed to address future use of groundwater.
○ Proximity and withdrawal rate of users	There are no onsite or downgradient offsite uses of groundwater as a drinking water source.	There are no onsite or downgradient offsite uses of groundwater as a drinking water source.
○ Ground water quantity and quality	The uppermost aquifer at the KIF Plant is a minor water-bearing zone and cannot supply large quantities of water to wells.	The uppermost aquifer at the KIF Plant is a minor water-bearing zone and cannot supply large quantities of water to wells.
○ The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituent	Based on the human health and ecological risk assessment which concluded that no unacceptable risks exist at the KIF Plant as a result of CCR management, and potential risks to future onsite workers would be mitigated by implementing standard health and safety protocols. There is no expectation that damage to wildlife, crops, vegetation, or physical structures will occur. Therefore, these were not factors in developing the estimated remediation schedule.	Based on the human health and ecological risk assessment which concluded that no unacceptable risks exist at the KIF Plant as a result of CCR management, and potential risks to future onsite workers would be mitigated by implementing standard health and safety protocols. There is no expectation that damage to wildlife, crops, vegetation, or physical structures will occur. Therefore, these were not factors in developing the estimated remediation schedule.
○ The hydrogeologic characteristic of the facility and surrounding land	The uppermost aquifer at the KIF Plant and surrounding areas is a minor water-bearing zone and cannot supply large quantities of water to wells.	The uppermost aquifer at the KIF Plant and surrounding areas is a minor water-bearing zone and cannot supply large quantities of water to wells.
○ Ground water removal and treatment costs	Not applicable because groundwater removal and treatment is not required for *in situ* treatment or monitored natural attenuation.	Not applicable because groundwater removal and treatment is not required for *in situ* treatment or monitored natural attenuation.
○ The cost and availability of alternative water supplies	Alternate water supplies are available from public water suppliers in Roane County.	Alternate water supplies are available from public water suppliers in Roane County.
○ Other relevant factors	Not applicable.	Not applicable.

Acronyms:

CARA	Corrective Action/Risk Assessment	O&M	operation and maintenance
CCR	Coal Combustion Residuals	TDEC	Tennessee Department of Environment and Conservation
GWPS	Groundwater Protection Standards	TVA	Tennessee Valley Authority
KIF	Kingston	USEPA	United States Environmental Protection Agency

EXHIBITS

Exhibit No.
1-1

Title
Location Plan and Topographic Map

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by MB on 2024-07-25
Technical Review by EM on 2024-07-25

0 1,000 2,000 3,000 4,000 Feet
1:12,000 (At original document size of 22x34)

Legend

- Limit of Existing Cover System for TDEC Order CCR Units (Approximate – 2024)
- TDEC Order CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)
- CCR Unit Area (Approximate) Not Included in TDEC Order

DRAFT

CCR = Coal Combustion Residuals

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Topographic mapping corresponds to the Harriman Quadrangle (Edition of 2019, Scale 1:24,000) and the Elverton Quadrangle (Edition of 2019, Scale 1:24,000)
3. The KRP Ash Landfill and Peninsula Disposal Area are not included in the TDEC Order; the units are regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM).

Stantec TVA

Disclaimer: Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data. The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in any way from the content or provision of the data.

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Exhibit No.
1-2

Title
Perimeter Wall Stabilization

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2024-09-18
Technical Review by EM on 2024-09-18

0 250 500 750 1,000 Feet
1:3,000 (At original document size of 22x34)

Legend

- Limit of Existing Cover System for TDEC Order CCR Units (Approximate – 2024)

Perimeter Wall Stabilization

- Inboard/Outboard Wall
- Shear Wall
- Historic CCR Management Area (Approximate)
- TDEC Order CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

DRAFT

CCR = Coal Combustion Residuals

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA (2023)
3. The KRP Ash Landfill is not included in the TDEC Order; the unit is regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM).

Stantec TVA

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Exhibit No.

2-1

Title

KIF Plant Overview

Client/Project

Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location

Roane County, Tennessee

175668043
Prepared by MB on 2024-07-09
Technical Review by EM on 2024-07-09

0 500 1,000 1,500 2,000 Feet

1:6,000 (At original document size of 22x34)

Legend

- Limit of Existing Cover System for TDEC Order CCR Units (Approximate – 2024)
- Subsurface Wall (Approximate)
- TDEC Order CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)
- CCR Unit Area (Approximate) Not Included in TDEC Order

Perimeter Wall Stabilization (As Shown in Inset)

- Inboard/Outboard Wall
- Shear Wall

DRAFT

CCR = Coal Combustion Residuals

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA (2023)
3. The KRP Ash Landfill and Peninsula Disposal Area are not included in the TDEC Order; the units are regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM).

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Exhibit No.
2-2

Title
Geologic Map

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by TKR on 2024-08-13
Technical Review by EM on 2024-08-13

0 700 1,400 2,100 2,800 Feet
1:8,400 (At original document size of 22x34)

Legend

- Fault
- TDEC Order CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)
- CCR Unit Area (Approximate) Not Included in TDEC Order

Geologic Formations

- Ordovician/Cambrian Knox Group
- Cambrian Maynardville Limestone
- Cambrian Conasauga Shale
- Cambrian Rome Formation

DRAFT

CCR = Coal combustion residuals

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery courtesy of ESRI World Imagery basemap (Dated 2/22/2020)
3. Geologic map corresponds to the "East-Central Sheet Geologic Map of Tennessee" (1966); Moore, James L. et al (1993). "Geologic Map of The Harriman Quadrangle, Tennessee"; and the Site Geologic Map, Figure 2-1 included in the TVA (November 2004) "Kingston Fossil Plant Hydrogeologic Evaluation of Coal-Combustion Byproduct Disposal Facility Expansion".
4. The KRP Ash Landfill and Peninsula Disposal Area are not included in the TDEC Order; the units are regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM).

Stantec TVA

Disclaimer: Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data. The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in any way from the content or provision of the data.

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Exhibit No.
2-3

Title
Historical Stream Alignments

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2024-07-25
Technical Review by EM on 2024-07-25

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

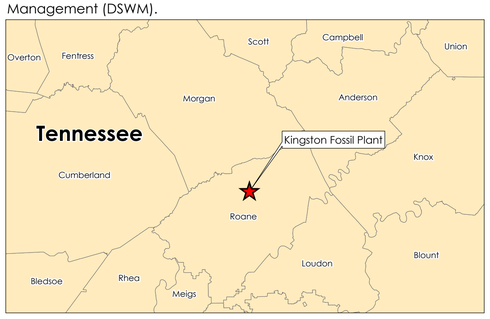
Legend

- Historical Stream Alignment
- Limit of Existing Cover System for TDEC Order CCR Units (Approximate – 2024)
- TDEC Order CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

DRAFT

CCR = Coal Combustion Residuals

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA (2023)
3. Historical stream locations obtained from Harriman Quadrangle Tennessee - Roane County 7.5 Minute Series Topographic Map (USGS 1935)
4. The KRP Ash Landfill is not included in the TDEC Order; the unit is regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM).



Stantec TVA

Disclaimer: Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data. The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in any way from the content or provision of the data.

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Exhibit No.
2-4

DRAFT

Title
Groundwater Elevation Contour Map, Event #3 (August 19, 2019)

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2024-07-25
Technical Review by EM on 2024-07-25

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Groundwater Investigation Monitoring Well
  groundwater elevation in feet above mean sea level (ft amsl)
- Other Monitoring Well
  groundwater elevation in ft amsl
- Piezometer
  groundwater elevation in ft amsl
- Emory River Gauging Station
  surface water elevation in ft amsl
- Groundwater Contour (5 ft interval; elevations are in ft amsl)
- Interpolated Groundwater Contour (5 ft interval; elevations are in ft amsl)
- Limit of Existing Cover System for TDEC Order CCR Units (Approximate – 2024)
- Subsurface Wall (Approximate)
- Surface Stream Flow
- TDEC Order CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Perimeter Wall Stabilization (As Shown in Inset)

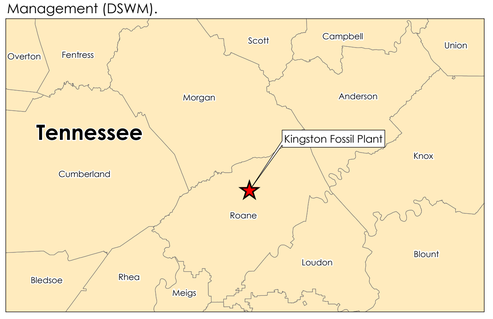
- Inboard/Outboard Wall
- Shear Wall

CCR = Coal combustion residuals

*Groundwater and pore water elevation displayed but not used as input for contouring due to factors such as well construction or being screened in a different hydrogeologic unit.

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA (2023)
3. Groundwater contours were created using Surfer Version 16.1.350 (December 13, 2018)
4. The KRP Ash Landfill is not included in the TDEC Order; the unit is regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM).



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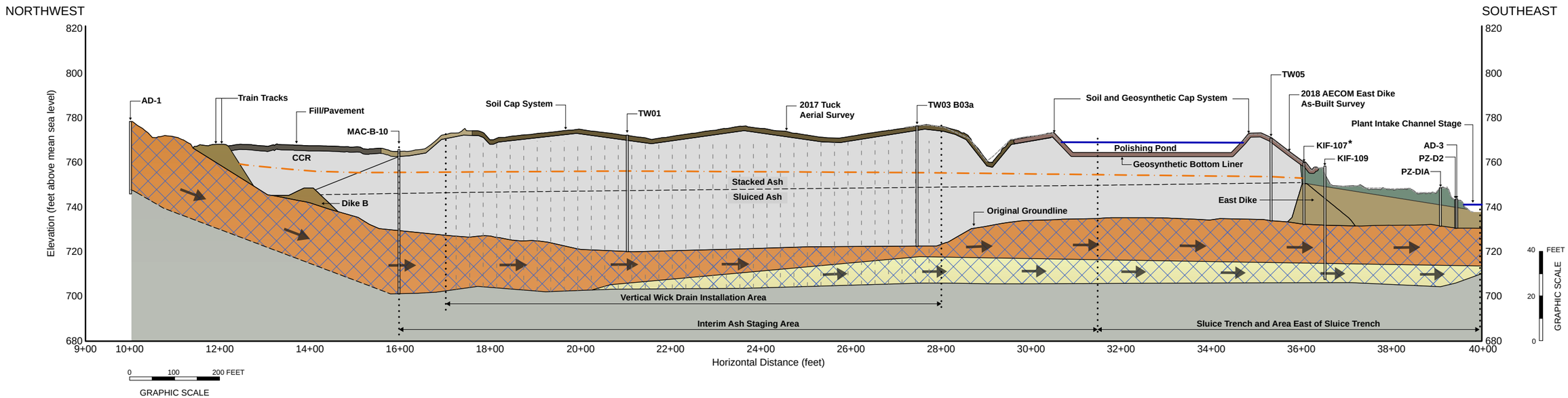
U:\TVA.EPI\175668043_KIF_Phase2\gis\mxd\CARA\MainText\KIF_MT_Exhibits\KIF_MT_Exhibits.aprx 2-4_GroundwaterContour_Event3 Revised: 2024-07-25 By: mbough

INTERIM ASH STAGING AREA / SLUICE TRENCH AND AREA EAST OF SLUICE TRENCH



1 CCR Material

- CCR material is stacked ash over sluiced ash, and the estimated total volume of CCR based on the EI is about 3.9 million cubic yards.
- For the Interim Ash Staging Area, global and veneer slope stability meet the established factor of safety criteria for the static and seismic load cases.
- For the Sluice Trench and Area East of Sluice Trench, global and veneer slope stability meet the established factor of safety criteria for the static load cases. For the seismic load cases, the veneer slope stability meets the established factor of safety criteria, but the pseudostatic global and post-earthquake global load cases do not meet the criteria. TVA is currently evaluating mitigation alternatives and it is anticipated that the mitigation design process will commence in parallel with the CARA phase of the TDEC Order program.
- The structural integrity of the CCR management unit is adequate and there is no evidence of voids/cavities in bedrock that could lead to loss of structural support and potential release of overlying CCR material.

2 Groundwater Quality

- The inferred groundwater and pore water elevations in the vicinity of the CCR units were similar. Pore water level fluctuations at most locations within the CCR units showed a similar, but subdued, correlation with the fluctuation pattern of the Emory River stage. Pore water level fluctuations were more subdued in comparison to groundwater level fluctuations, suggesting that foundation soils are impeding the flow of pore water.
- Most TDEC Appendix I and CCR Rule Appendix IV CCR constituent concentrations in onsite groundwater are below GWPS. Cobalt in wells AD-2 and KIF-105 was detected above the GWPS. This constituent will be further evaluated and addressed in the CARA Plan to determine if corrective actions are needed.

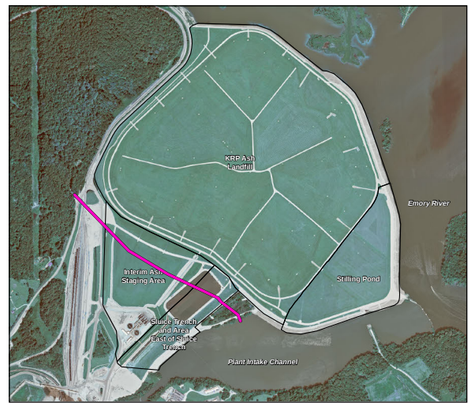
3 Potential Seep

- No seeps were identified during the EI**.

4 Surface Stream, Sediment and Ecology

- Based on the previous and ongoing extensive investigations conducted for the KRP, surface stream water, sediment and biota tissue concentrations are below remedial objectives and declining, and there are no adverse impacts to benthic macroinvertebrate communities or fish health.

TRANSECT LOCATION



Legend

- CCR / Stacked Ash / Sluiced Ash
- Primarily Silts and Clay
- Engineered Wetlands
- Fill
- Fill / Pavement
- Soil Cover
- Primarily Sand and Silty Sand
- Bedrock
- Phreatic Surface Groundwater / Pore Water Gauging (August 19, 2019)
- Generalized groundwater flow direction within the uppermost aquifer
- Uppermost aquifer
- Vertical Wick Drain Installation Area

Notes:

* The results of the polarized light microscopy analysis indicated that a 3-foot-thick interval consisting of 30% to 38% CCR material existed within the screened interval from approximately 9.0 to 12.0 feet below ground surface. The analytical results of water samples collected from well KIF-107 are thus found to be representative of pore water, not groundwater. See Chapter 5.1.3.1 of the EAR for additional details.

** Previously identified seepage is mitigated by a seepage collection system that discharges seep water to the Water Quality Channel and Polishing Pond for treatment prior to discharging to NPDES-permitted Outfall 001.

Stantec TVA

Exhibit No. 3-1

DRAFT

Title: INTERIM ASH STAGING AREA / SLUICE TRENCH AND AREA EAST OF SLUICE TRENCH CROSS-SECTION A–A′ CONCEPTUAL SITE MODEL

Client/Project: Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location: Roane County, Tennessee

175568043

Prepared by KB on 2024-08-21

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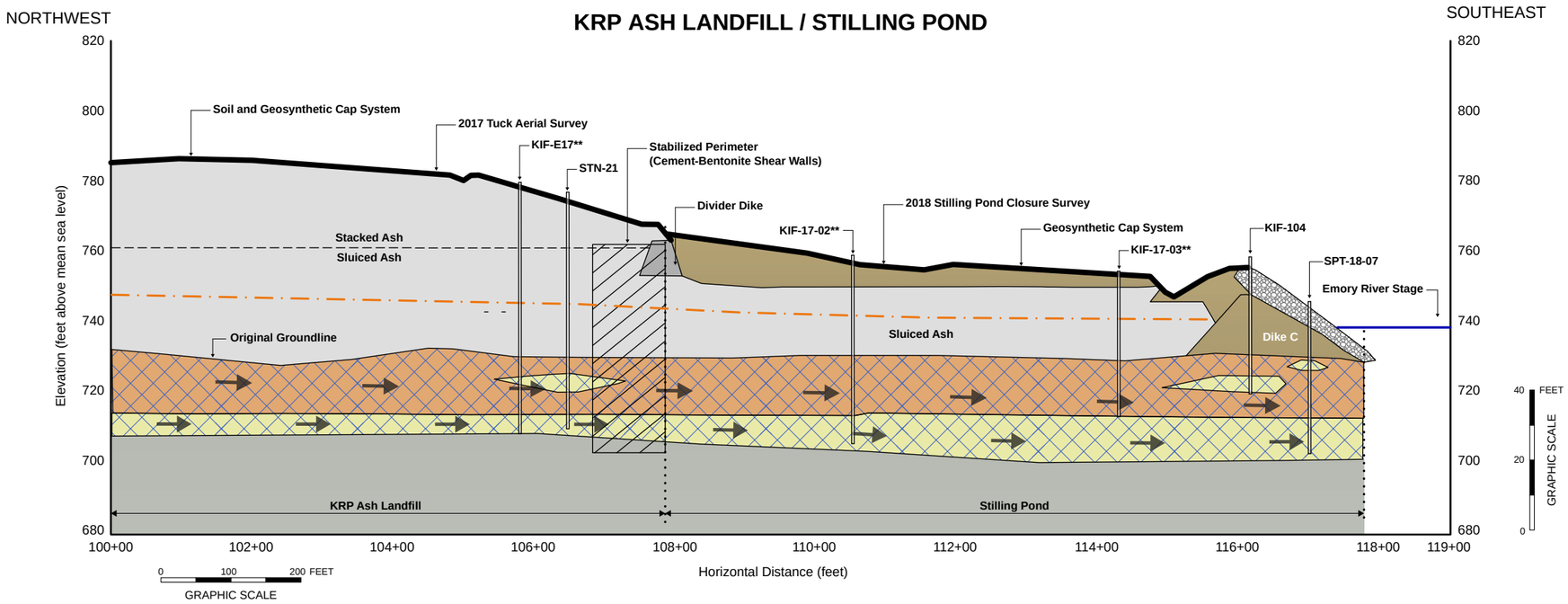
KRP ASH LANDFILL / STILLING POND



1 CCR Material

- CCR material in the Stilling Pond is sluiced ash and the estimated total volume of CCR based on the EI is about 804,000 cubic yards.
- Global and veneer slope stability meet the established factor of safety criteria for the static and seismic load cases.
- The structural integrity of the CCR management unit is adequate and there is no evidence of voids/cavities in bedrock that could lead to loss of structural support and potential release of overlying CCR material.

2 Groundwater Quality

- The inferred groundwater and pore water elevations in the vicinity of the CCR units were similar. The elevations of pore water levels within and groundwater levels in the vicinity of the Stilling Pond were generally within five feet of the Emory River stage. Pore water level fluctuations at most locations within the CCR units showed a similar, but subdued, correlation with the fluctuation pattern of the Emory River stage. Pore water level fluctuations were more subdued in comparison to groundwater level fluctuations, suggesting that foundation soils are impeding the flow of pore water.
- Most TDEC Appendix I and CCR Rule Appendix IV CCR constituent concentrations in onsite groundwater are below GWPS. Cobalt in wells 6AR, KIF-103 and KIF-104 was detected above the GWPS. This constituent will be further evaluated and addressed in the CARA Plan to determine if corrective actions are needed.

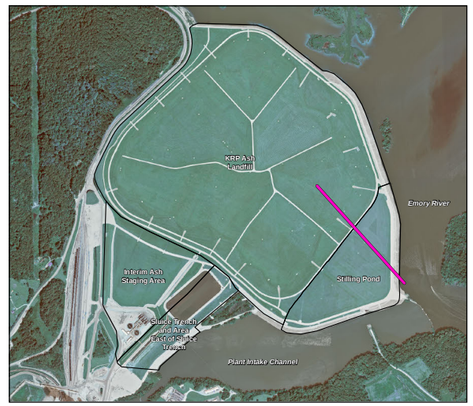
3 Potential Seep

- No seeps were identified during the EI*.

4 Surface Stream, Sediment and Ecology

- Based on the previous and ongoing extensive investigations conducted for the KRP, surface stream water, sediment and biota tissue concentrations are below remedial objectives and declining, and there are no adverse impacts to benthic macroinvertebrate communities or fish health.

TRANSECT LOCATION



Legend

- Stacked Ash / Sluiced Ash
- Compacted Ash
- Fill
- Rock Buttress
- Primarily Silts and Clay
- Primarily Sand and Silty Sand
- Bedrock
- Phreatic Surface Groundwater / Pore Water Gauging (April 2, 2019)
- Generalized groundwater flow direction within the uppermost aquifer
- Uppermost aquifer

Notes:

* Previously identified seepage is mitigated by a seepage collection system that discharges seep water to the Polishing Pond for treatment prior to discharging to NPDES-permitted Outfall 001.

**KIF-17-02, KIF-17-03, and KIF-E17 are projected laterally onto the cross section.

The KRP Ash Landfill is not included in the TDEC Order; it is regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM) - Class II Landfill Permit No. IDL 73-000-0094 (see Chapter 1.1 for more information).

Stantec TVA

Exhibit No. 3-2

DRAFT

Title
KRP ASH LANDFILL AND STILLING POND
CROSS-SECTION B–B' CONCEPTUAL SITE MODEL

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175568043

Prepared by KB on 2024-08-21

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Common EI Findings for CCR Management Units

Overall:
- More than 96% of the groundwater sample results from over 300 samples were below the approved levels.

CCR Material:
- The CCR management units have adequate stability and slopes are stable under current static conditions. There is no evidence of void/cavities in bedrock that could lead to a loss of structural support and release of overlying CCR material.

Groundwater Quality:
- Groundwater concentrations for most CCR Parameters are below groundwater protections standards for each of the CCR management units.
- Groundwater quality is affected by geochemical processes during flow of the groundwater through geological materials. Concentrations of CCR constituents in groundwater are generally lower, and in many cases much lower, than in pore water.

Seeps:
- No seeps were identified during the EI*.

Surface Stream, Sediment and Ecology:
- Based on the previous and ongoing extensive investigations conducted for the Kingston Recovery Project, surface stream water, sediment and biota tissue concentrations are below remedial objectives and declining, and there are no adverse impacts to benthic macroinvertebrate communities or fish health. TVA is continuing long-term monitoring activities to confirm these findings.

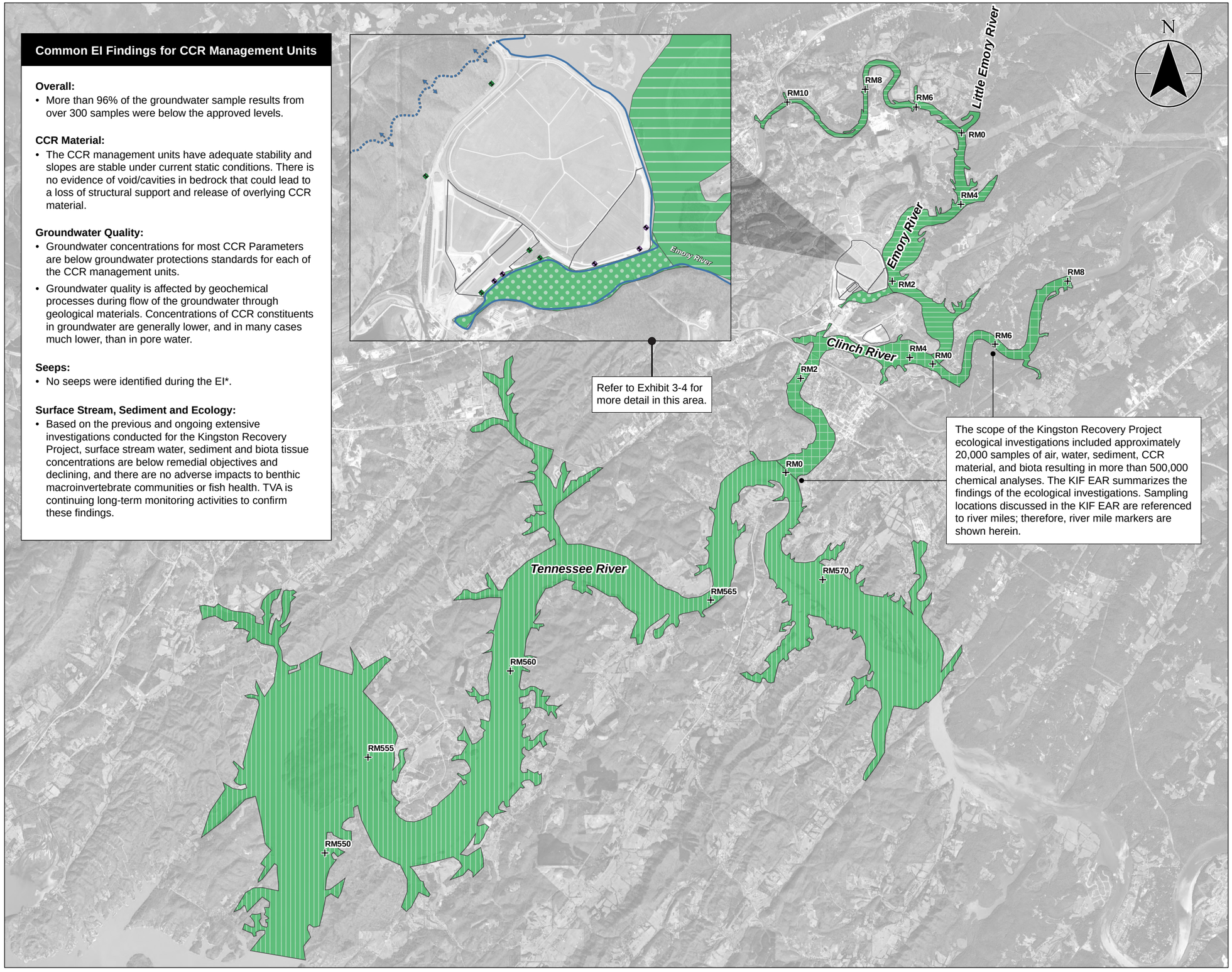

Exhibit No.
3-3

DRAFT

Title
Overall Study Area Findings

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by KB on 2024-09-17

0 4,000 8,000 12,000 16,000 Feet

Legend

- Groundwater results below Groundwater Protection Standards
- Groundwater results above Groundwater Protection Standards
- Surface Stream, Sediment, and Ecology Sampling Reach Location
- Clinch River
- Emory River
- Intake Channel/Impoundment
- Tennessee River
- Little Emory River
- RM River Mile
- Surface stream that bounds groundwater flow
- Hydrogeological Divide
- Generalized groundwater flow direction
- TDEC Order Study Area CCR Units (Approximate)

Abbreviations:

CCR: Coal combustion residuals
EAR: Environmental Assessment Report
EI: Environmental Investigation

Notes:

* Previously identified seepage is mitigated by a seepage collection system that discharges seep water to the Polishing Pond for treatment prior to discharging to NPDES-permitted Outfall 001.

The KRP Ash Landfill is not included in the TDEC Order; it is regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM) - Class II Landfill Permit No. IDL 73-000-0094 (see Chapter 1.1 for more information).

Imagery provided by ESRI.

Stantec TVA

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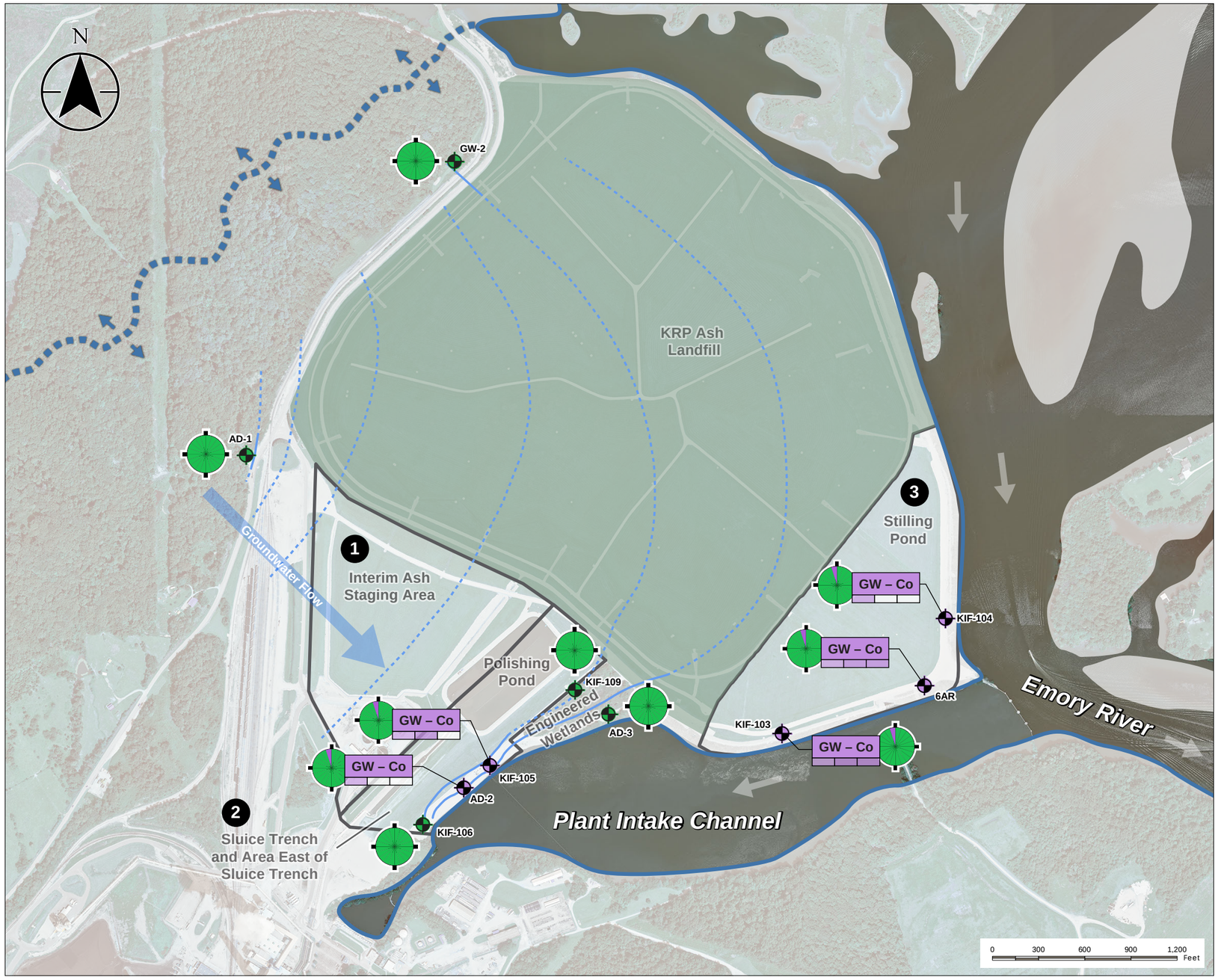

Potential groundwater impacts described below were further evaluated in the CARA Plan.

1 Interim Ash Staging Area

CCR Material:

- CCR material in this unit is stacked ash over sluiced ash, and the estimated total volume of CCR material is ~ 3.9 million cubic yards, which also includes the volume for the Sluice Trench and Area East of Sluice Trench.
- The global and veneer slope stability meet the established factor of safety criteria for the static and seismic load cases.

Groundwater Quality:

- Cobalt in wells AD-2 and KIF-105 was detected above the GWPS.

2 Sluice Trench and Area East of Sluice Trench

CCR Material:

- CCR material in this unit is stacked ash over sluiced ash, the volume of CCR material is included in the estimated total volume for the Interim Ash Staging Area.
- The global and veneer slope stability meet the established factor of safety criteria for the static load cases. For the seismic load cases, the evaluation indicates that veneer slope stability meets the established factor of safety criteria, but that the pseudostatic global and post-earthquake global load cases do not meet the criteria; TVA is currently evaluating mitigation alternatives to address these conditions.

Groundwater Quality:

- Cobalt in wells AD-2 and KIF-105 was detected above the GWPS.

3 Stilling Pond

CCR Material:

- CCR material is sluiced ash, with an estimated total volume of CCR of ~804,000 cubic yards.
- The global and veneer slope stability meet the established factor of safety criteria for the static and seismic load cases.

Groundwater Quality:

- Cobalt in wells 6AR, KIF-103 and KIF-104 was detected above the GWPS.

Overall

Surface Stream, Sediment and Ecology:

- As summarized on Exhibit 3-3, based on the previous and ongoing extensive investigations conducted for the Kingston Recovery Project, surface stream water, sediment and biota tissue concentrations are below remedial objectives and declining, and there are no adverse impacts to benthic macroinvertebrate communities or fish health. TVA is continuing long-term monitoring activities to confirm these findings.

Legend

- Groundwater results below Groundwater Protection Standards (GWPS)
- Groundwater results above Groundwater Protection Standards (GWPS)

Co – Cobalt

Sections colored in the chart indicate the number of constituents at a sampling location above GWPS

Number of constituents compared:

Groundwater: 20

Counts represent total metals sample results. Total metals sample results less than GWPS.

Surface stream flow direction

- Interpolated Groundwater Contour
- Groundwater Contour (5 ft interval; elevations are in ft amsl)
- Surface stream that bounds groundwater flow
- Hydrogeological Divide
- Generalized groundwater flow direction
- TDEC Order Study Area CCR Units (Approximate)

CCR: Coal combustion residuals

- 1–4 X above GWPS
- 5–9 X above GWPS
- >10 X above GWPS

Notes:

Groundwater contours included to illustrate general groundwater flow directions. See Exhibit 2-4, Groundwater Elevation Contour Map Event #3 (August 19, 2019), for actual groundwater elevations and groundwater contours.

The KRP Ash Landfill is not included in the TDEC Order; it is regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM) - Class II Landfill Permit No. IDL 73-000-0094.

Imagery provided by TVA (2023)

Stantec TVA

Exhibit No. 3-4

DRAFT

Title: Overall Findings Near KIF Plant TDEC Order CCR Units

Client/Project: Tennessee Valley Authority, Kingston Fossil (KIF) Plant TDEC Order

Project Location: Roane County, Tennessee

175668043

Prepared by KB on 2024-08-21

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Exhibit No.
5-1

DRAFT

Title
Planned KIF Plant TDEC Order CCR Unit Closure Actions

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2025-09-02
Technical Review by EM on 2025-09-02

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Groundwater Monitoring Well
- Limit of Existing Cover System for TDEC Order CCR Units (Approximate – 2024)
- Approximate East Dike Seismic Stability Mitigation Project Limits (Separate TVA Project)
- TDEC Order CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)
- Drainage Modifications
- Planned Geosynthetic Cover System Modification or Extension
- Existing Geosynthetic Cover System (Approximate)
- Existing Geosynthetic Liner System (Approximate)

CCR = Coal combustion residuals

For existing cover system see Appendix F.1

Closure actions depicted are based on design drawings in Appendix F.1

See Appendix E for Groundwater Monitoring Plan.

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA (2023)
3. The KRP Ash Landfill is not included in the TDEC Order; the unit is regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM).

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Exhibit No.
5-2

DRAFT

Title
Cross Section Transects of Modeled Long-Term Thickness of CCR Material Below Pore Water Phreatic Surface

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2025-09-02
Technical Review by JT on 2025-09-02

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Cross Section Transect Line
- Limit of Existing Cover System for TDEC Order CCR Units (Approximate – 2024)
- TDEC Order CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

Simulated Thickness of CCR Material beneath Pore Water Phreatic Surface (in feet)

- < 1 (transparent)
- 1 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 35
- 35 - 40

CCR = Coal combustion residuals

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA (2023)
3. The KRP Ash Landfill is not included in the TDEC Order; the unit is regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM).

Stantec TVA

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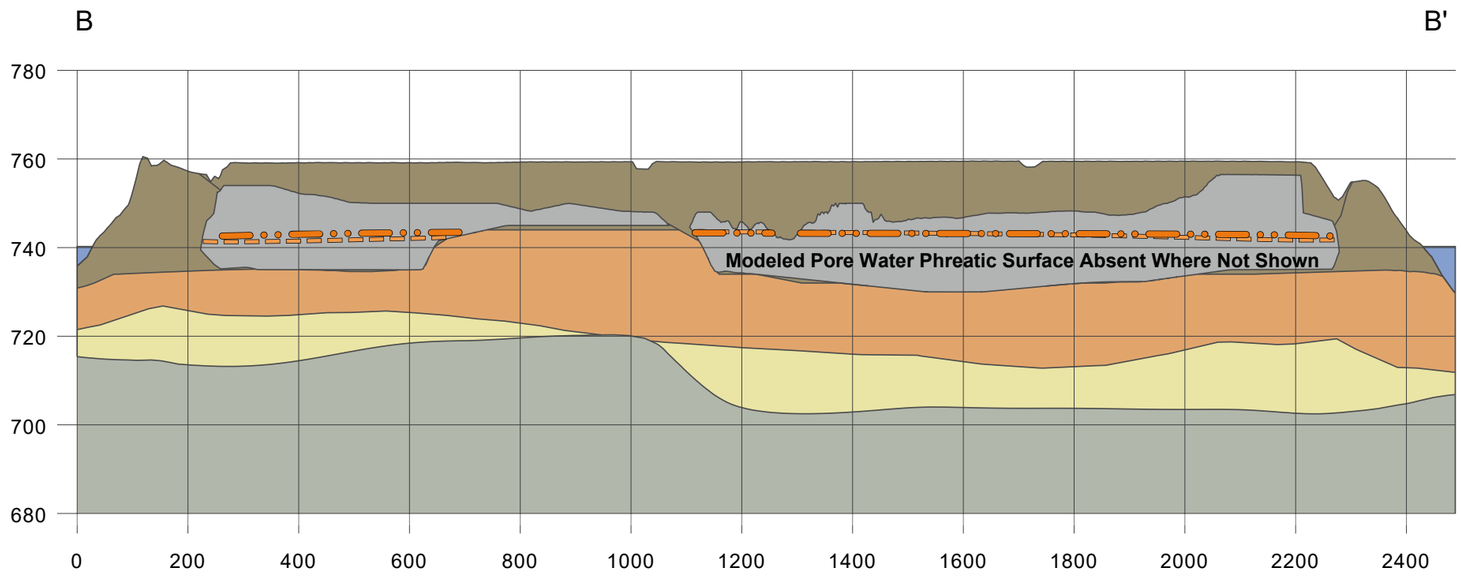
STILLING POND

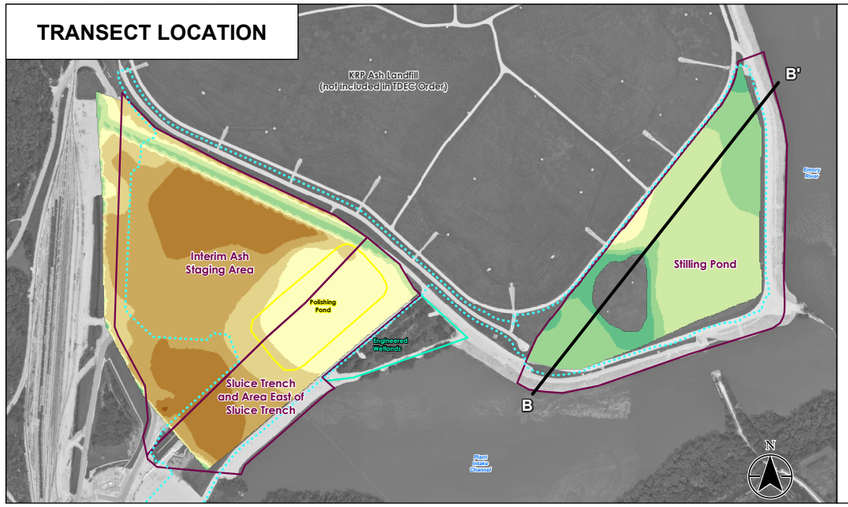


Scale: 1:3,600
Vertical exaggeration: 8x

0ft 400ft

Note: Existing or planned closure actions are not shown on these cross sections but were included in the modeling.

TRANSECT LOCATION



Modeled Long-Term Thickness of CCR Material Below Pore Water Phreatic Surface (in feet)*

- Absent (< 1)
- 1 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 35
- 35 - 40

*See Exhibit 5-2 for details.

Legend

- Fill
- CCR Material
- Primarily Silts and Clay
- Primarily Sand and Silty Sand
- Bedrock
- Observed Pore Water Phreatic Surface (August 19, 2019 (EAR Event 3))
- Modeled Long-term Pore Water Phreatic Surface (Modeled conditions of the Planned Closure and Corrective Actions) (see Appendix G)

DRAFT

Stantec TVA

Exhibit No.
5-3

Title
Measured and Modeled Long-Term Pore Water Phreatic Surface Levels at the Stilling Pond

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175568043

Prepared by KB on 2025-09-05

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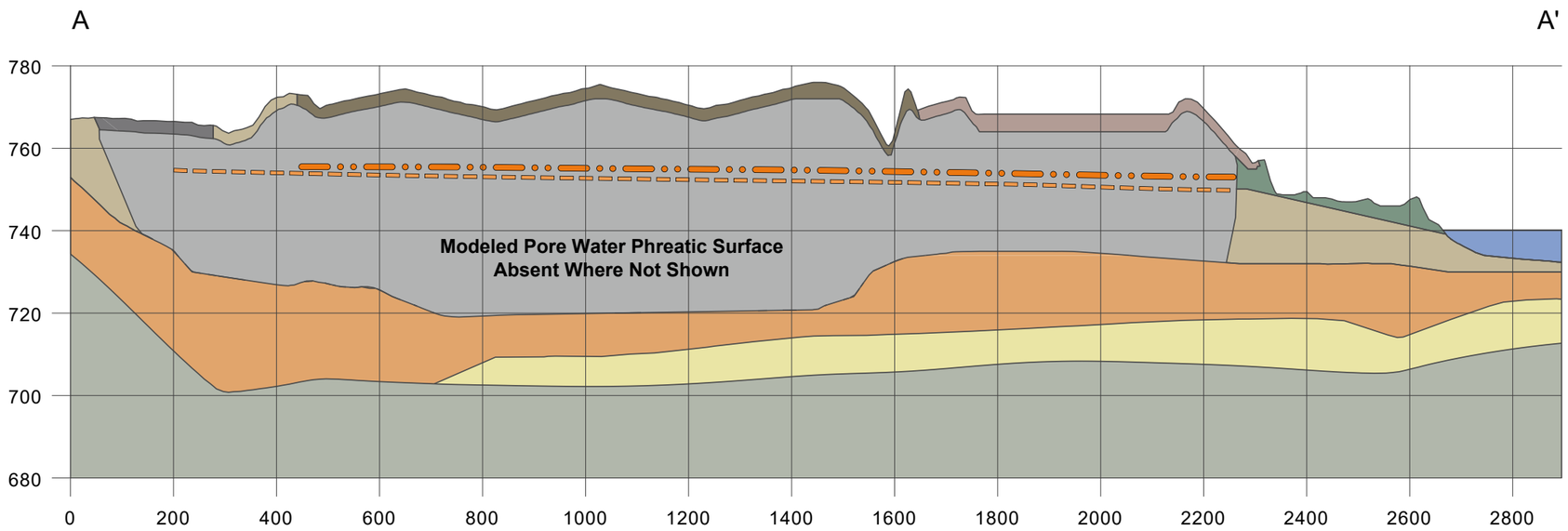
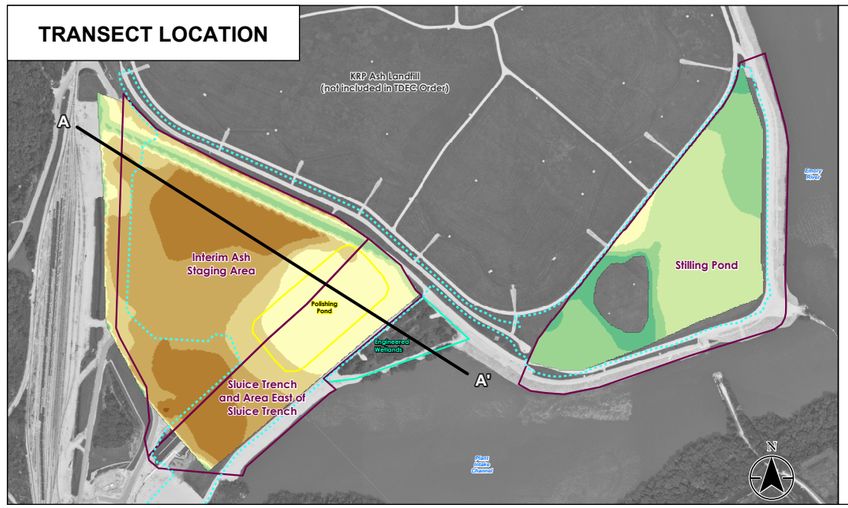
INTERIM ASH STAGING AREA / SLUICE TRENCH AND AREA EAST OF SLUICE TRENCH



Scale: 1:3,600
Vertical exaggeration: 8x

0ft 400ft

Note: Existing or planned closure actions are not shown on these cross sections but were included in the modeling.



Modeled Long-Term Thickness of CCR Material Below Pore Water Phreatic Surface (in feet)*

- Absent (< 1)
- 1 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 35
- 35 - 40

*See Exhibit 5-2 for details.

Legend

- Fill
- Fill / Pavement
- Soil Cap Systems
- Soil and Geosynthetic Cap System
- Engineered Wetlands
- CCR Material
- Primarily Silts and Clay
- Primarily Sand and Silty Sand
- Bedrock
- Observed Pore Water Phreatic Surface (August 19, 2019 (EAR Event 3))
- Modeled Long-term Pore Water Phreatic Surface (Modeled conditions of the Planned Closure and Corrective Actions) (see Appendix G)

DRAFT

Stantec TVA

Exhibit No.
5-4

Title
Measured and Modeled Long-Term Pore Water Phreatic Surface Levels at the Interim Ash Staging Area / Sluice Trench and Area East of Sluice Trench

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175568043
Prepared by KB on 2025-09-05

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Exhibit No.
6-1

DRAFT

Title
Planned KIF Plant TDEC Order CCR Unit Groundwater Corrective Actions

Client/Project
Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by DMB on 2025-09-08
Technical Review by EM on 2025-09-08

0 200 400 600 800 Feet
1:2,400 (At original document size of 22x34)

Legend

- Groundwater Monitoring Well
- Approximate Location of In Situ Treatment (Horizontal Well Injection)
- Limit of Existing Cover System for TDEC Order CCR Units (Approximate – 2024)
- Approximate East Dike Seismic Stability Mitigation Project Limits (Separate TVA Project)
- TDEC Order CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)
- Drainage Modifications
- Planned Geosynthetic Cover System Modification or Extension
- Existing Geosynthetic Cover System (Approximate)
- Existing Geosynthetic Liner System (Approximate)

CCR: Coal combustion residuals

Closure actions are depicted on this exhibit because they provide source control for the planned groundwater corrective action.

Closure actions and groundwater corrective actions are based on design drawings in Appendix F.1

See Appendix E for Groundwater Monitoring Plan.

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA (2023)
3. The KRP Ash Landfill is not included in the TDEC Order; the unit is regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM).

Stantec TVA

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Exhibit No.
7-1

Title

Planned Groundwater Monitoring System – TDEC Order CCR Units

Client/Project

Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location
Roane County, Tennessee

175668043
Prepared by MB on 2024-09-09
Technical Review by BS on 2024-09-09

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Compliance Monitoring Well
- Observation Well
- Other Wells and Piezometers
- Limit of Existing Cover System for TDEC Order CCR Units (Approximate – 2024)
- TDEC Order CCR Unit Area (Approximate)
- Engineered Wetlands (Approximate)
- Polishing Pond (Approximate)

CCR = Coal Combustion Residuals

DRAFT

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery provided by TVA (2023)
3. The KRP Ash Landfill is not included in the TDEC Order; the unit is regulated in accordance with TDEC Rule 0400-11-01-.04 Division of Solid Waste Management (DSWM).

Stantec TVA

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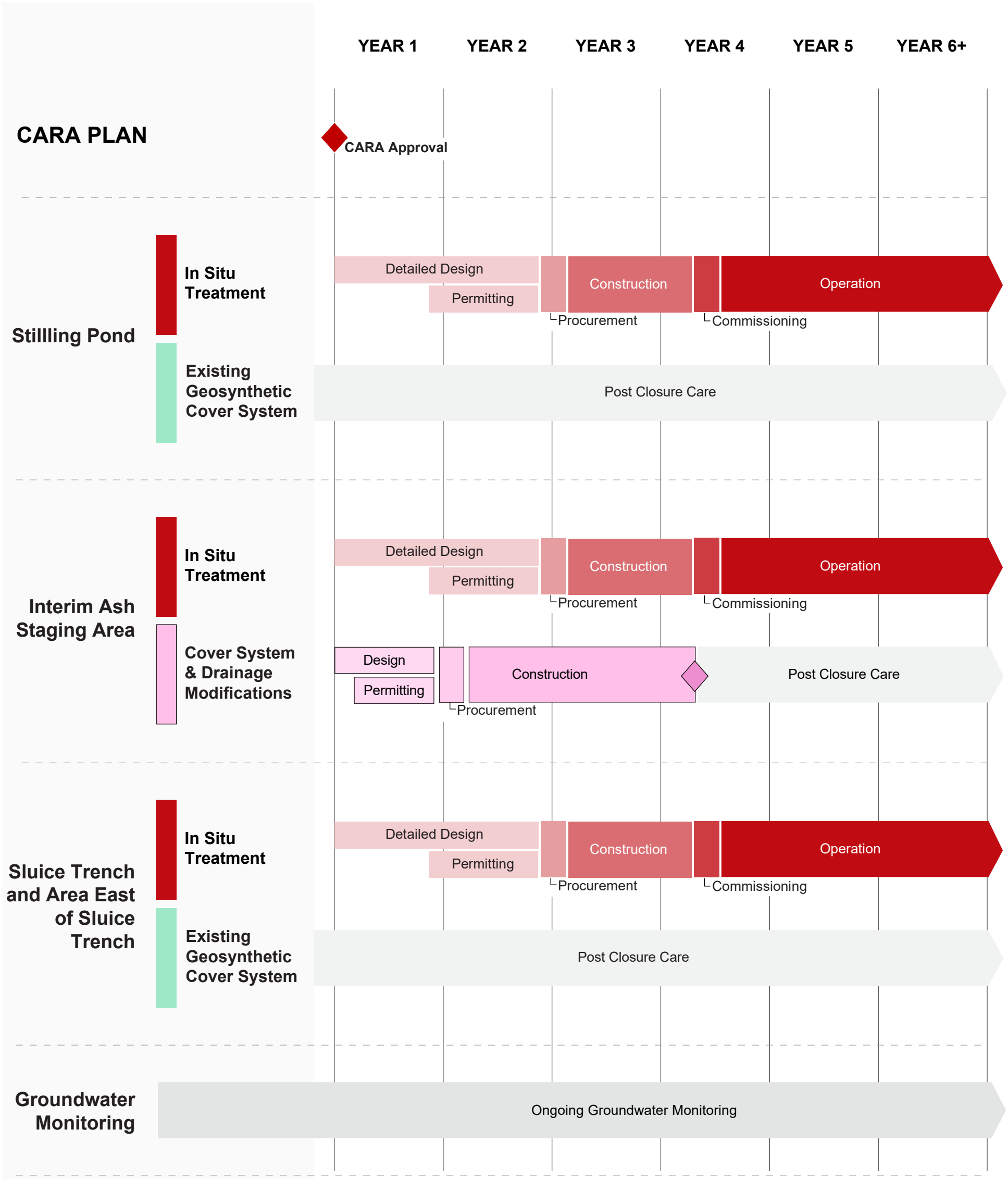
CARA Plan Implementation Schedule



Legend

Completion Milestone

Exhibit No. 8-1

DRAFT

Title: **CARA Plan Implementation Schedule**

Client/Project: Tennessee Valley Authority
Kingston Fossil (KIF) Plant TDEC Order

Project Location: Roane County, Tennessee

175668043

Prepared by KB on 2024-09-09

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