# Assessment of Corrective Measures TVA Cumberland Fossil Plant, Stewart County, Tennessee

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**ASSESSMENT OF CORRECTIVE MEASURES TVA CUMBERLAND FOSSIL PLANT, STEWART COUNTY, TENNESSEE**

This document entitled Assessment of Corrective Measures TVA Cumberland Fossil Plant, Stewart County, Tennessee was prepared by Stantec Consulting Services Inc. ("Stantec") for the account of Tennessee Valley Authority (TVA; the "Client").

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# Abbreviations

| | |
|---|---|
| ACM | Assessment of Corrective Measures |
| CCR | Coal Combustion Residuals |
| CFR | Title 40, Code of Federal Regulations |
| COI | Constituent of Interest |
| CSM | Conceptual site model |
| CUF | Cumberland Fossil Plant |
| CY | Cubic yards |
| EIS | Environmental Impact Statement |
| EIST | Enhanced In-Situ Treatment |
| ft | Feet |
| GWPS | Groundwater Protection Standard(s) |
| mg/L | Milligrams per liter |
| MSL | Main sea level |
| MNA | Monitored Natural Attenuation |
| NOI | Notice of Intent |
| NPDES | National Pollutant Discharge Elimination System |
| PWB | Process Water Basin |
| SSL | Statistically Significant Level |
| SSLs | Statistically Significant Levels |
| TDEC | Tennessee Department of Environmental Conservation |
| TDEC Order | TDEC Conservation Commissioner’s Order, OGC 15-0177 |
| TVA | Tennessee Valley Authority |
| U.S. EPA | United States Environmental Protection Agency |

# Executive Summary

On April 17, 2015, the United States Environmental Protection Agency (U.S. EPA) published a rule that sets forth national criteria for the management of coal combustion residuals (CCR) produced by electric utilities. The requirements can be found in Title 40, Code of Federal Regulations (CFR) Part 257. The rule includes requirements for monitoring groundwater and assessing corrective measures if constituents listed in Appendix IV of the rule are detected in groundwater samples collected from downgradient monitoring wells at statistically significant levels (SSLs) greater than established groundwater protection standards (GWPS).

In January 2019, the Tennessee Valley Authority (TVA) completed an evaluation of whether there were SSLs over GWPS established under 40 CFR § 257.95(h) for one or more Appendix IV constituents in accordance with 40 CFR § 257.95(g) at the Bottom Ash Pond, Dry Ash Stack, and the Gypsum Storage Area and the Stilling Pond (including Retention Pond at the Cumberland Fossil Plant (CUF). During assessment monitoring, three SSLs of Appendix IV constituents were reported above GWPS in downgradient monitoring wells at CUF. The Appendix IV constituents that were reported at SSLs above GWPS were arsenic at CUF-206, cobalt at CUF-212, and lithium at 93-3. As of the date of this report, TVA has not completed a demonstration that a source other than the CCR units has caused the Appendix IV constituent detections above GWPS, as allowed under 40 CFR § 257.95(g)(3)(ii).

In accordance with 40 CFR § 257.96(a), TVA prepared this 2019 Assessment of Corrective Measures (ACM) Report for the Bottom Ash Pond, Dry Ash Stack, and the Gypsum Storage Area (the CCR Multiunit) and the Stilling Pond (including Retention Pond) (the CCR Unit) at CUF. This ACM Report provides an assessment of the effectiveness of potential corrective measures by addressing the criteria provided in 40 CFR § 257.96(c). The CCR Multiunit is monitored by a CCR Rule multiunit groundwater monitoring well network of two upgradient wells and five downgradient wells. The Stilling Pond (including Retention Pond) is monitored by a CCR Rule groundwater monitoring well network of two upgradient wells and four downgradient wells.

Three primary strategies have been evaluated to address groundwater exhibiting concentrations of arsenic, cobalt, and lithium above the GWPS. These strategies include Monitored Natural Attenuation (MNA), Hydraulic Containment and Treatment, and Enhanced In-Situ Treatment (EIST).

Following preparation of this ACM Report, the remedy selection process will begin to select a remedy that meets the requirements of 40 CFR § 257.97(b) and § 257.97(c). At least 30 days prior to when the final remedy is selected, a public meeting will be held with interested and affected parties to discuss the results of the corrective measures assessment in accordance with 40 CFR § 257.96(e). Semi-annual reports will be prepared pursuant to 40 CFR § 257.97(a) to document progress toward remedy selection and design. TVA will continue to review new data as it becomes available and implement changes to the groundwater monitoring and corrective action program as necessary to maintain compliance with 40 CFR § 257.90 through § 257.98.

# 1.0 INTRODUCTION

This Assessment of Corrective Measures (ACM) Report has been prepared to meet the requirements in the United States Environmental Protection Agency (U.S. EPA) Coal Combustion Residuals (CCR) Rule, 40 CFR § 257.96. During assessment monitoring when at least one constituent listed in Appendix IV of the CCR Rule is detected at a statistically significantly level (SSL) above a site-specific groundwater protection standard (GWPS) established pursuant to 40 CFR § 257.95(h), and the owner/operator has been unable to demonstrate that a source other than the CCR unit or an error caused the SSL, the owner/operator must initiate an ACM.

At the Tennessee Valley Authority (TVA) Cumberland Fossil Plant (CUF) the Bottom Ash Pond, Dry Ash Stack, and the Gypsum Storage Area (hereinafter collectively referred to as CCR Multiunit) are monitored by a multiunit groundwater monitoring well system, and the Stilling Pond (including Retention Pond) (hereinafter referred to as CCR Unit) is monitored by its own groundwater monitoring well network. Assessment monitoring detected SSLs for three Appendix IV constituents above GWPS in downgradient monitoring wells at CUF. The Appendix IV constituents that were reported at SSLs above GWPS were:

**CCR Multiunit**

- Cobalt at CUF-212 and lithium at 93-3.

**CCR Unit**

- Arsenic at CUF-206.

CUF-212 and 93-3 are part of the groundwater monitoring well system for the CCR Multiunit, and CUF-206 is part of the groundwater monitoring well system for the CCR Unit. As a result of these detections, TVA initiated an ACM on April 15, 2019, for both the CCR Multiunit and the CCR Unit. This report documents the completion of the required ACM and discusses potential corrective measures as required under the CCR Rule. For purposes of this report, any SSL of Appendix IV listed constituents over GWPS will be defined as a constituent of interest (COI).

## 1.1 OVERVIEW OF CCR RULE REQUIREMENTS FOR ACM IN 40 CFR § 257.96

Section 257.96(a) of the CCR Rule requires that, within 90 days of determining an SSL exceeds a GWPS of an Appendix IV constituent, the owner/operator must initiate an ACM to prevent further releases, to remediate any releases, and to restore the affected area to original conditions. The ACM report must be completed within 90 days of initiating the ACM unless the owner/operator demonstrates that an extension of no longer than 60 days is needed due to site-specific conditions or circumstances. A qualified professional engineer must certify the accuracy of the extension demonstration. The certified demonstration must be included in the annual groundwater monitoring and corrective action report required by 40 CFR § 257.90(e). TVA did not seek an extension for completing the ACM.

The CCR Rule requires that the ACM report under 40 CFR § 257.96(a) must include an analysis of the effectiveness of potential corrective measures in meeting the requirements and objectives of the remedy. More specifically, 40 CFR § 257.96(c) provides that:

*The assessment under paragraph (a) of this section must include an analysis of the effectiveness of potential corrective measures in meeting all of the requirements and objectives of the remedy as described under 40 CFR § 257.97 addressing at least the following:*

*(1) 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;*

*(2) The time required to begin and complete the remedy; and*

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

Potential corrective measures to be considered for the CCR units are generally discussed in Section 4.0, **Appendix A**, and **Appendix B** of this report.

## 1.2 OVERVIEW OF CCR RULE REQUIREMENTS FOR REMEDY SELECTION IN 40 CFR § 257.97

Once the ACM report is complete, the process for selecting a remedy will commence. The owner/operator must select a remedy that, at a minimum, meets the requirements of 40 CFR § 257.97(b) and must consider the evaluation factors set forth in 40 CFR § 257.97(c). In addition, at least 30 days prior to the selection of the remedy, the owner/operator must discuss the results of the corrective measures assessment in a public meeting required by 40 CFR § 257.96(e). The owner/operator must also provide a schedule for implementing the selected remedy that takes into account the factors set forth in 40 CFR § 257.97(d).

After the ACM report is completed and before the remedy is selected, 40 CFR § 257.97(a) requires semi-annual reports to be prepared describing the progress in selecting and designing the remedy. The CCR Rule contemplates that more investigation and consideration may be needed to evaluate and design the remedy before making the final selection. Once a final remedy is chosen, a final report describing the remedy and how it meets the standards set forth in 40 CFR § 257.97(b) will be prepared.

# 2.0 BACKGROUND

CUF is located in Cumberland City, Stewart County, Tennessee. The facility lies on the south bank of the Cumberland River and adjacent to Wells Creek. The coal combustion process at CUF results in the production of by-products that include gypsum, fly ash, and bottom ash. The plant currently manages these CCR materials in the CCR Multiunit and CCR Unit. **Figure 2-1** shows an overview map of CUF including its facilities and CCR units. CUF was constructed between 1968 and 1973 and began operations in 1972.

## 2.1 CCR UNIT DESCRIPTIONS

The Bottom Ash Pond, Dry Ash Stack, and the Gypsum Storage Area are referred to as the CCR Multiunit for purposes of this report. The current area of the Bottom Ash Pond encompasses approximately 5.3 acres, the Dry Ash Stack encompasses approximately 115 acres, and the Gypsum Storage Area encompasses approximately 155 acres. These units are surrounded with perimeter dike systems.

Bottom ash is sluiced to the Bottom Ash Pond, reclaimed, and then spread and compacted within the Dry Ash Stack. The Bottom Ash Pond also receives effluent from lined settling channels and a nearby plant that processes gypsum slurry. Effluent from the Bottom Ash Pond is then conveyed to the Stilling Pond.

The current footprint of the Gypsum Storage Area is approximately 155 acres. Surplus gypsum material is stored at the gypsum stack for later use by the wallboard plant. Smaller particles from a gypsum dewatering process are pumped to TVA's fines dipping area in the corner of the bottom ash pond where they are dipped, allowed to decant and eventually hauled and placed on the gypsum stack in a specified area.

For compliance with the CCR Rule, TVA certified a multiunit groundwater monitoring well network for the CCR Multiunit.

The Stilling Pond (including Retention Pond) is referred to as the CCR Unit in this report. The CCR Unit encompasses approximately 56 acres in size and impounds approximately 819,000 cubic yards (CY) of water with 1,077,000 CY of storage remaining (Stantec, 2016a; Stantec 2018a). The constructed height of the perimeter dike that forms the Stilling Pond is approximately 30 to 35 feet (Stantec, 2016a).

The Stilling Pond is used for: (1) detention for stormwater runoff from the Gypsum Storage Area and Dry Ash Stack, process water from the Bottom Ash Pond, and effluent from various other plant operations and sumps, and (2) discharge of flow to the Cumberland River via the Condensing Cooling Water Discharge Channel.

The Retention Pond receives process water from the Bottom Ash Pond that discharges into the Stilling Pond where treatment of CCR-containing-effluent occurs.

For compliance with the CCR Rule, TVA certified a single groundwater monitoring well network for the CCR Unit.

## 2.2 PLANS FOR CLOSURE

TVA is currently conducting an environmental investigation of the CCR disposal areas at CUF under the oversight of the Tennessee Department of Environment and Conservation (TDEC) through the TDEC Commissioner's Order, OGC 15-0177 (TDEC Order), issued on August 6, 2015. The CCR Multiunit and CCR Unit at CUF are being studied under the TDEC Order. The method of closure for the units at CUF will be determined when the TDEC Order requirements have been met. Closure at CUF will be completed in accordance with the TDEC Order and 40 CFR § 257.102.

## 2.3 CONCEPTUAL SITE MODEL SUMMARY

The geologic and hydrogeologic conceptual site model (CSM) is one of the primary tools that can be used to support decisions on corrective measures.

### 2.3.1 Geology and Hydrogeology

The following sections provide a summary of the geologic and hydrogeologic CSM. CUF is located within the Wells Creek Basin, which is the result of a meteor impact that occurred approximately 200 million years ago. Bedrock was uplifted 2,500 feet in the center of the impact, tilting the mostly horizontal limestone and shale strata outward from the central uplift (Stantec, 2018b). Over time, the area affected by the meteor crater has been more susceptible to weathering. Due to the orientation of the bedding planes and faults, the Wells Creek Basin was formed. Circular faults surround the basin, with grabens (valleys) and horsts (ridges). The bedrock elevation in the basin ranges from 360 ft MSL to 449 ft MSL, with the highest elevation located on the central hill near the western boundary of the Gypsum Storage Area (TVA, 1998). A cross-section view of the Stilling Pond (including Retention Pond) is shown on **Figure 2-2a** and a cross-section view of a general ash stack at CUF is shown on **Figure 2-2b**.

#### 2.3.1.1 Alluvium

The regional overburden geologic units consist of Quaternary-aged flood plain, deposits of the Cumberland River, and larger creeks including Wells Creek (Wilson and Sterns, 1968). Flood plain deposits consist of alluvial lenticular beds of clays and silts grading to coarser grained sands and gravels with depth (TVA, 2010).

Prior to the construction of CUF in 1968, the channel for Wells Creek was located beneath the Dry Ash Stack and the Stilling Pond (including Retention Pond) areas. The creek's channel was relocated and placed along the southwestern edge of the Dry Ash Stack and the Stilling Pond (adjacent to the perimeter dike) during the construction of the plant. Alluvial deposits are located within the historic floodplain found below an elevation of 360 ft MSL. The alluvial deposits from Wells Creek are highly variable in thickness and are not consistently present beneath the CCR units (Wilson and Sterns, 1968). Alluvial deposits are not present at higher preconstruction elevations, including the eastern parts of the Stilling Pond, Retention Pond, and Dry Ash Stack; the northwest part of the Bottom Ash Pond; and east and west portions of the Gypsum Storage Area.

The alluvium beneath CUF may be differentiated between alluvial silts and clays and alluvial sands and gravels. Generally, in the vicinity of the CCR units, the shallow alluvium is silt and clay with minor intervals of silty sand. The fine-grained alluvium has relatively low permeability, and although it may be saturated in certain intervals it is not considered a usable aquifer.

Underlying the silt and clay, coarser grained alluvium consists of sand and gravel deposits that are discontinuous and pinch out with distance away from the former Wells Creek channel along the eastern and northeastern edges of the CCR units. The coarser grained alluvium is generally saturated and confined beneath the finer grained alluvial deposits. Where present, this coarse-grained alluvium is the uppermost aquifer beneath the CCR units. In areas where coarse-grained alluvium is not present, the upper most aquifer is within the bedrock. The complexity of the hydrogeological formations beneath the CCR Unit prevents the upper most aquifer from being represented by a simple surface.

#### 2.3.1.2 Bedrock

The CCR units overlie eight mapped bedrock formations ranging from the Ordovician Hermitage Formation to the Mississippian Fort Payne Formation. With the exception of the Chattanooga Shale, bedrock primarily consists of various limestone formations. A geologic map of the region shows the variability of strikes and dips for the bedrock across the basin. Most notably, the bedrock formations along the northern side of the CCR units strike generally to the east with steeply dipping beds to the south (Wilson and Sterns, 1968).

### 2.3.2 Groundwater Flow Direction

Groundwater flow directions at CUF are generally north toward the Cumberland River or west-southwest toward Wells Creek depending on which surface water body is more proximal. The predominant groundwater flow direction in the vicinity to the Dry Ash Stack and Gypsum Storage Area is to the south/southwest**.** The predominant groundwater flow direction in the vicinity of the Stilling Pond is to the west**. Figure 2-3** shows the general groundwater flow direction at CUF that was generated based on groundwater levels from both CCR monitoring wells and non-CCR monitoring wells.

### 2.3.3 Potential Receptor Review

The two largest public water suppliers in Stewart County are the Dover Water Department and the North Stewart Utility District (CDC, 2019). The Dover Water Department withdrawals its drinking water from the Cumberland River. The Dover Water Treatment plant is located approximately 14.4 miles downstream of CUF. The North Stewart Utility District withdraws its water from the Brandon Spring, which is within the Cumberland River watershed, is located approximately 20 miles downstream of CUF. The City of Erin Water Department provides potable water to Cumberland City and the Survey Area. The City of Erin water supply is sourced from the Cumberland River at its confluence with Yellow Creek (approximately 3.7 miles northeast (upstream) of CUF Plant.

# 3.0 GROUNDWATER ASSESSMENT MONITORING PROGRAM

Groundwater assessment monitoring has been conducted at CUF in accordance with 40 CFR § 257.95.

## 3.1 GROUNDWATER MONITORING NETWORK

In compliance with 40 CFR § 257.91, two background wells (CUF-201 and CUF-202) were established upgradient and serve as background wells for both the CCR Multiunit and CCR Unit. A total of nine monitoring wells were installed downgradient of the CCR units.

**CCR Multiunit**

- Monitoring wells 93-2R, 93-3, CUF-209, CUF-211, and CUF-212 serve as downgradient wells for the CCR Multiunit; and

**CCR Unit**

- Monitoring wells CUF-205, CUF-206, CUF-207, and CUF-208 serve as downgradient wells for the CCR Unit.

The locations of these monitoring wells are presented on **Figure 2-1**.

## 3.2 GROUNDWATER ASSESSMENT

Groundwater assessment monitoring was conducted in 2018. The following Appendix IV constituents had SSLs above the GWPS:

**CCR Multiunit**

- An SSL for cobalt was identified at monitoring well CUF-212.
    - The maximum concentration of cobalt detected in 2018 was 0.027 mg/L; and
    - The GWPS for cobalt is 0.006 mg/L.
- An SSL for lithium was identified at monitoring well 93-3.
    - The maximum concentration of lithium detected in 2018 was 0.079 mg/L; and
    - The GWPS for lithium is 0.040 mg/L.

**CCR Unit**

- An SSL for arsenic was identified at monitoring well CUF-206.

- The maximum concentration of arsenic detected in 2018 was 0.013 milligrams per liter (mg/L); and
- The GWPS for arsenic is 0.010 mg/L.

## 3.3 GROUNDWATER CHARACTERIZATION

The groundwater was characterized for the CCR Multiunit and the CCR Unit. This section summarizes the results of the groundwater characterization.

Groundwater data obtained from CUF-212 and 93-3 identified cobalt and lithium impacts at the CCR Multiunit. Based on the location of the CCR monitoring wells with Appendix IV SSLs, available data from existing CCR monitoring wells are currently considered for CCR characterization. Cobalt concentrations at monitoring well CUF-212 are delineated horizontally by monitoring wells 93-2R to the west and 93-3 to the east. Lithium concentrations at monitoring well 93-3 are delineated by monitoring well CUF-212 to the west.

Groundwater data obtained from CUF-206 identified arsenic impacts at the CCR Unit. Based on the location of the CCR monitoring well with an Appendix IV SSL, available data from existing CCR monitoring wells are currently considered for CCR characterization. Arsenic concentrations at monitoring well CUF-206 are delineated horizontally by monitoring wells CUF-205 to the east and CUF-207 to the west.

The potential treatment zones to address the extents of arsenic, cobalt, and lithium above the GWPS around the CCR Multiunit and CCR Unit perimeter are illustrated on **Figure 3-1**.TVA is currently conducting environmental investigations of CCR disposal sites at its coal-fired sites in Tennessee under the TDEC Order. Once the environmental investigations are complete, TVA must submit environmental assessment reports (EARs) that provide an analysis of the extent of CCR contamination, including groundwater contamination, at each site to TDEC for approval. Then, as part of the TDEC Order process, TVA must submit Corrective Action/Risk Assessment (CARA) Plans that specify all actions that TVA plans to take at a site, including corrective measures for groundwater remediation. TDEC must approve the CARA Plans, including the selected remedy(s) and corrective measures for groundwater remediation, before TVA may commence implementation. The work being performed under the TDEC Order process will further inform the evaluation and selection of the remedy(s) under 40 CFR § 257.97 of the CCR Rule.

As part of the environmental investigation being conducted at CUF, three additional groundwater monitoring wells were installed immediately north of the CCR Multiunit and one additional well was installed immediately east of the CCR Multiunit. These additional wells will help to further refine the characterization of the extent of arsenic, cobalt and lithium impacts.

Supplemental site characterization (including data collected under the TDEC Order) will be used to refine the nature and extent of the Appendix IV constituents exhibiting an SSL above GWPS and to support selection and design of a remedy. Specifically, supplemental characterization will include the following, some of which will be performed as part of the environmental assessment work being completed as part of the TDEC Order process:

- Additional data will be generated from the installation of four monitoring wells as part of the TDEC Order process to further refine the delineation of the horizontal extent of groundwater impacts to the east and north of the CCR units;
- Installation of additional monitoring wells as needed to further define the extent of Appendix IV constituents greater than the GWPS;
- Evaluation of the nature and estimated quantity of material released including concentrations of Appendix IV constituents in the material released; and
- Continued sampling of wells for the purpose of evaluating and designing a remedy.

## 3.4 SUMMARY OF ALTERNATE SOURCE DEMONSTRATION

At this time, an alternate source demonstration has not been completed for the SSL exceedances over the GWPS in wells CUF-206, CUF-212, and 93-3 at CUF.

# 4.0 ASSESSMENT OF CORRECTIVE MEASURES

Section 257.96(a) of the CCR Rule requires that, within 90 days of determining an SSL exceeding a GWPS of an Appendix IV constituent, the owner/operator must initiate an ACM to prevent further releases, to remediate any releases, and to restore the affected area to original conditions.

Groundwater assessment monitoring conducted for the CCR Multiunit and CCR Unit has indicated that arsenic, cobalt, and lithium were present at SSLs above the GWPS established under 40 CFR § 257.95 (h) at monitoring wells CUF-206, CUF-212, and 93-3, respectively. As discussed in Section 3.3, additional groundwater characterization will be conducted during the remedy selection process.

This section of the report provides an ACM to address groundwater exhibiting arsenic, cobalt and lithium concentrations above the GWPS.

## 4.1 ANALYSIS OF CORRECTIVE MEASURES

The objective of the ACM is defined in 40 CFR § 257.96(a) and consists of preventing further releases, remediating any releases, and restoring the affected area to original conditions.

An assessment of corrective measures to address Appendix IV SSLs has been initiated in accordance with 40 CFR § 257.96(a), and an analysis of potential corrective measures is being conducted in accordance with 40 CFR § 257.96(c).

## 4.2 PLAN FOR CLOSING CCR UNITS

The objectives of corrective measures under 40 CFR § 257.96(a) are to “prevent further releases [from the CCR units], to remediate any releases, and to restore affected areas to original conditions.” Ultimately, in accordance with 40 CFR § 257.97(b)(3), the selected corrective measure must at a minimum [c]ontrol the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents of Appendix IV to this part into the environment.” The Preamble (80 Fed. Reg. 21302, 21406) to the CCR Rule discusses that source control measures may include modifying operational procedures. To achieve TVA’s commitment to convert from wet to dry handling of CCR and to comply with regulatory requirements and timeframes under the CCR Rule, TVA will close the Bottom Ash Pond and the Stilling Pond (including Retention Pond). The Bottom Ash Pond and Stilling Pond (including Retention Pond) will be closed in accordance with 40 CFR § 257.102. Closing of the Bottom Ash Pond and Stilling Pond (including Retention Pond) will limit water infiltration through the CCR and reduce further releases since rainwater will not come into contact with the CCR.

Closure of the Bottom Ash Pond and the Stilling Pond (including Retention Pond) CCR Unit cannot be completed until a temporary, lined process water basin (PWB) is installed. A temporary lined PWB will be constructed within a portion of the CCR Unit, so that flows can be rerouted to the temporary PWB and a portion of the unit will be closed by removal. The temporary PWB will be removed and the remaining

portion of the Retention Pond (over which the temporary PWB was constructed) and the Bottom Ash Pond will be closed by removal or closed in place depending upon the outcome of the TDEC Order process. The Dry Ash Stack and the Gypsum Storage Area, which is a CCR landfill, may continue to operate if TVA continues to comply with groundwater monitoring and corrective action requirements under the CCR Rule and state regulations. TVA has plans to initiate intermediate cover over portions of the landfill that are not open for current use.

These measures will reduce the potential for migration of CCR constituents to groundwater and prevent releases to groundwater. Subsequent groundwater assessment monitoring will be conducted to track changes in groundwater conditions as a result of these closures and operational changes. These data will also be considered in the selection and design of a remedy in accordance with 40 CFR § 257.97.

Annual reports will be generated to summarize the results of the groundwater assessment monitoring. Interim groundwater corrective measures will be considered if the results of the groundwater assessment monitoring indicate that off-site receptors could be impacted by the release of COIs from the CCR Multiunit or CCR Unit.

## 4.3 POTENTIAL REMEDIAL TECHNOLOGIES

This ACM provides an evaluation of potential remedial technologies to address the SSLs observed at monitoring wells CUF-206, CUF-212, and 93-3. As discussed in Section 4.2, closure of the Bottom Ash Pond and the Stilling Pond (including Retention Pond) will serve as the primary source control measure. In addition to this source control measure, three primary strategies have been evaluated to address groundwater exhibiting concentrations above the GWPS including the following:

- Monitored Natural Attenuation (MNA);
- Hydraulic Containment and Treatment; and
- Enhanced In-Situ Treatment (EIST).

**Appendix A** provides a detailed summary of each of these corrective measures.

The hydraulic containment and treatment and the EIST corrective measures both require treatment of groundwater (either in-situ or ex-situ). **Table 1** presents a summary of technologies evaluated to treat arsenic, cobalt, and lithium in groundwater.

## 4.4 EFFECTIVENESS OF PROPOSED CORRECTIVE MEASURES

The effectiveness of each corrective measure discussed in Section 4.3 was analyzed in accordance with 40 CFR § 257.96(c). A qualitative approach was used to compare the effectiveness of the proposed corrective measures. The following qualitative scoring system was used:

- *Performance, Reliability, and Ease of Implementation*: These criteria were scored as High, Medium or Low. A High ranking indicates a corrective measure performs comparatively well in that evaluation category;
- *Potential Impacts of Potential Remedies to Safety, Cross-Media Impacts, and Exposure to residual COIs*: These criteria were scored as Low Risk, Medium Risk, or High Risk. A Low Risk ranking indicates a corrective measure performs comparatively well in that evaluation category.
- *The Time Required to Begin and Completed the Remedy*: An estimate of the time frame required to begin and complete the remedy is discussed in **Appendix B**; and
- *Institutional Requirements:* State and local permit requirements and other public health requirements that may substantially affect implementation of the remedy are also discussed in **Appendix B**.

The results of the qualitative evaluation of corrective measures completed for the CCR Multiunit and CCR Unit are presented in **Appendix B** and **Table B-1**.

# 5.0 SELECTION OF GROUNDWATER REMEDY

A remedy to address SSLs in groundwater will be selected in accordance with 40 CFR § 257.97. This section of the report summarizes additional information that is expected to be obtained and reviewed prior to selection of a groundwater remedy.

## 5.1 DATA REQUIREMENTS FOR DESIGN OF GROUNDWATER REMEDY

The groundwater remedy selection process will include the collection of supplemental data to fill data gaps. In addition, groundwater modeling, as appropriate, will be conducted to further evaluate the applicability of groundwater containment and treatment alternatives. The following discussion provides an overview of additional data collection and analysis to be conducted to support remedy selection.

The extent of arsenic, cobalt and lithium above GWPS has been initially characterized in accordance with 40 CFR § 257.95(g)(1) and will be further refined as additional data is obtained. The results of this characterization will assist in the selection of a groundwater remedy in accordance with 40 CFR § 257.97 (b) and 40 CFR § 257.91(c).

Groundwater assessment monitoring will be conducted in accordance with 40 CFR § 257.96(b) until the remedy is selected and the corrective action groundwater monitoring program is initiated under 40 CFR § 257.98(a)(1). Continued assessment monitoring will generate data to evaluate the effect of operational changes and closure of the Bottom Ash Pond and Stilling Pond (including Retention Pond) on groundwater concentrations and trends. These data will inform evaluation of the effectiveness of source control measures in controlling the source and preventing further releases. The scope and necessity of potential interim actions will be determined based upon analysis of data collected as part of the groundwater assessment monitoring program and supplemental activities.

Groundwater modeling, as appropriate, will be conducted to support the basis of design for any potential remedy that involves groundwater containment and treatment. A groundwater model will be developed to define basis of design requirements for potential groundwater remedies. The basis of design parameters defined through groundwater modeling, as appropriate, can include:

- Groundwater flow velocities and flow direction;
- Groundwater extraction rates for containment remedies;
- Groundwater mounding potential resultant from installation of EIST;
- Changes in groundwater flow directions resulting from EIST installation;
- Lengths of EIST to contain release; and
- Estimated time frame to reduce concentrations of COIs to levels necessary to achieve GWPS.

Groundwater modeling can also be useful for estimating the time frame for restoring groundwater to concentration levels less than the GWPS.

As shown in **Table 1**, treatment technologies that are effective for arsenic, cobalt, and lithium can include:

- Advanced Filtration;
- Chemical Precipitation;
- Co-Precipitation;
- Redox Manipulation – Oxidation/Reduction Treatment;
- Absorption (Chemical Fixation); and
- Ion Exchange.

The groundwater chemistry is site-specific and therefore bench-scale treatability testing can be used to identify the best methodology to immobilize arsenic, cobalt and lithium at CUF. Bench-scale treatability studies may be conducted on groundwater samples collected from monitoring wells CUF-206, CUF-212 and 93-3 prior to selecting a groundwater corrective measure for implementation.

## 5.2 SEMI-ANNUAL REPORTING, PUBLIC MEETING, REMEDY SELECTION, AND FINAL REPORT

Following completion of this ACM, the owner/operator must select a remedy as soon as feasible to comply with 40 CFR § 257.97(a). Progress toward the selection and design of the remedy will be documented in semi-annual reports in accordance with 40 CFR § 257.97(a).

At least 30-days prior to selecting a remedy, a public meeting to discuss the results of the corrective measures assessment will be conducted as required by 40 CFR § 257.96(e).

A final report will be generated after the remedy is selected. This final report will describe the remedy and how it meets the standards specified in 40 CFR § 257.97(b) and 257.97(c).

Recordkeeping requirements specified in 40 CFR § 257.105(h), notification requirements specified in 40 CFR § 257.106(h), and internet requirements specified in 40 CFR § 257.107(h) will be complied with as required by 40 CFR § 257.96(f).

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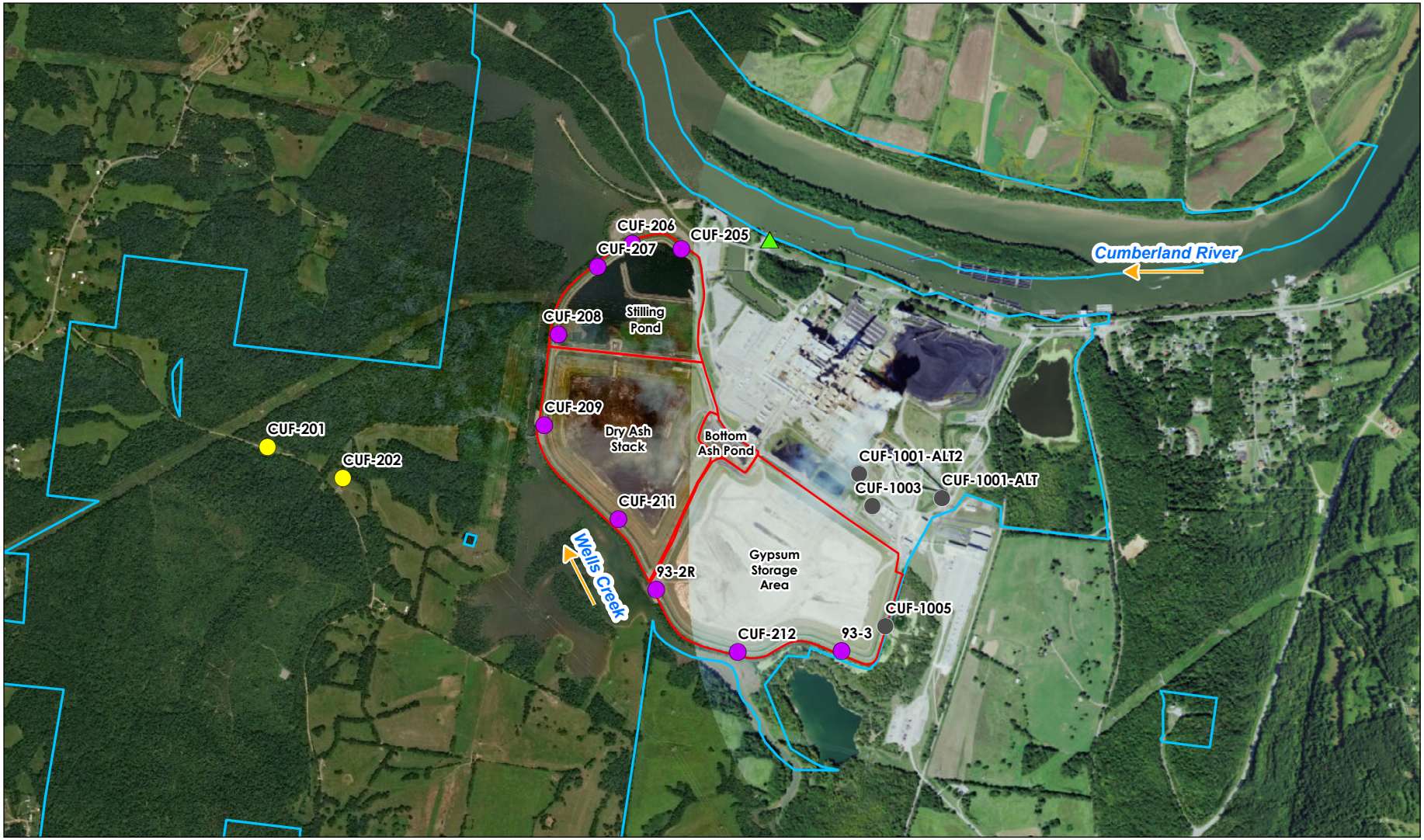
# TABLES

| TABLE 1. | | | |
|---|---|---|---|
| WATER TREATMENT TECHNOLOGIES FOR CONSTITUENTS<br>TENNESSEE VALLEY AUTHORITY - CUMBERLAND FOSSIL PLANT<br>CCR UNITS | | | |
| **Water Treatment Technology** | **COI*** | | |
| | **Arsenic** | **Cobalt** | **Lithium** |
| Advanced Filtration | X | X | X |
| Chemical Precipitation | X | X | X |
| Co-Precipitation | X | X | X |
| Redox Manipulation | X | X | X |
| Absorption (Chemical Fixation) | X | X | X |
| Ion Exchange | X | X | X |

* Constituent of Interest

# Figures



Legend

- Staff Gauge
- Background Well
- Downgradient Well
- Investigation Well
- TVA Property Boundary
- CCR Unit Subject to CCR Rule

N

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**Notes**

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Background: TVA 2017 Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

*Project Location*
Cumberland City
Stewart County, Tennessee

Prepared by LMB on 2019-07-15
Technical Review by EP on 2019-07-15
Independent Review by JB on 2019-07-15

*Client/Project*
Tennessee Valley Authority
Cumberland Fossil Plant
CCR Rule

182603472

*Figure No.*
**Figure 2-1**

*Title*
**CCR Units with Background and Downgradient Wells**

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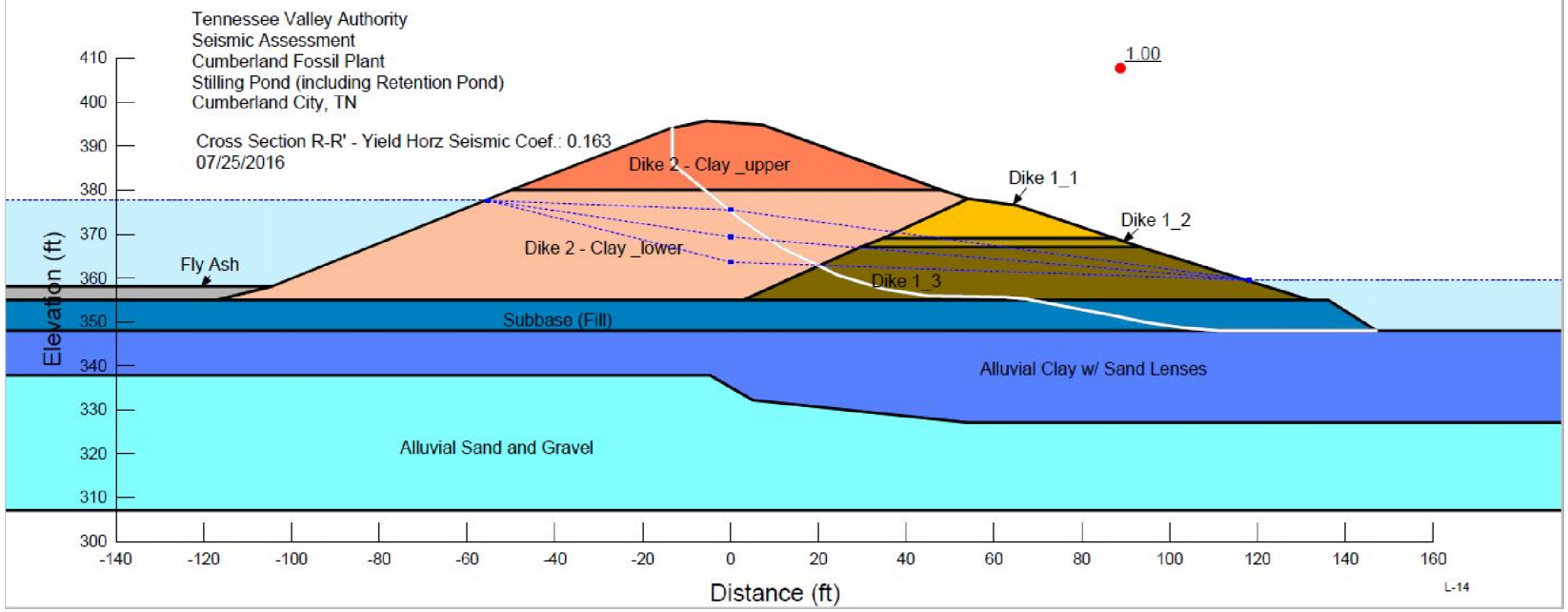
## FIGURE L.3

Name: Dike 2 - Clay _upper Unit Weight: 120 pcf Cohesion': 550 psf
Name: Alluvial Sand and Gravel Unit Weight: 125 pcf Cohesion': 455 psf Phi': 30 °
Name: Fly Ash Unit Weight: 100 pcf Cohesion': 0 psf Phi': 28 °
Name: Dike 2 - Clay _lower Unit Weight: 120 pcf Cohesion': 1,000 psf
Name: Subbase (Fill) Unit Weight: 120 pcf Cohesion': 0 psf Phi': 32 °
Name: Alluvial Clay w/ Sand Lenses Unit Weight: 118 pcf Cohesion': 1,500 psf
Name: Dike 1_1 Unit Weight: 120 pcf Cohesion': 1,750 psf
Name: Dike 1_2 Unit Weight: 120 pcf Cohesion': 1,250 psf
Name: Dike 1_3 Unit Weight: 120 pcf Cohesion': 1,000 psf



*Project Location*
Cumberland City
Stewart County, Tennessee

Prepared by LMB on 2019-07-11
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Independent Review by JB on 2019-07-11

*Client/Project* 182603472
Tennessee Valley Authority
Cumberland Fossil Plant
CCR Rule

*Figure No.*
**Figure 2-2a**

*Title*
**Geologic Cross-Section (Stilling Pond (including Retention Pond))**

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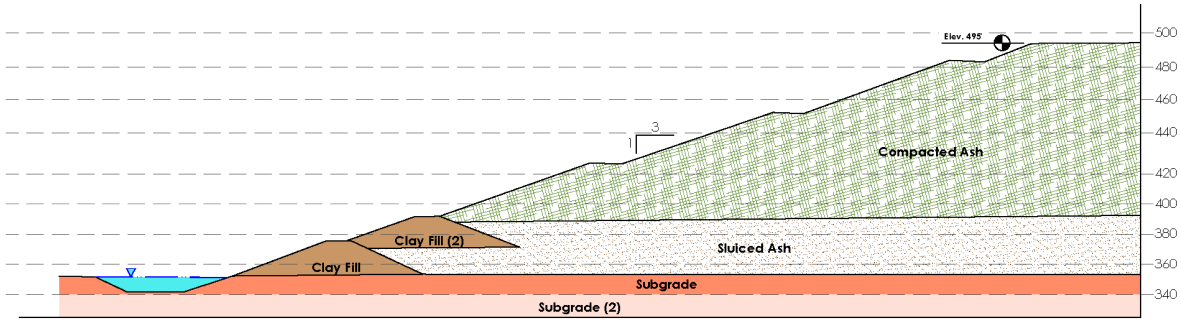


**Figure 2-2b: Geologic Cross-Section (General Dry Ash Stack)**

*Project Location*
Cumberland City
Stewart County, Tennessee

Prepared by LMB on 2019-07-15
Technical Review by EP on 2019-07-15
Independent Review by JB on 2019-07-15

*Client/Project*
Tennessee Valley Authority
Cumberland Fossil Plant
CCR Rule

182603472

*Figure No.*
**Figure 2-2b**

*Title*
**Geologic Cross-Section (General Dry Ash Stack)**

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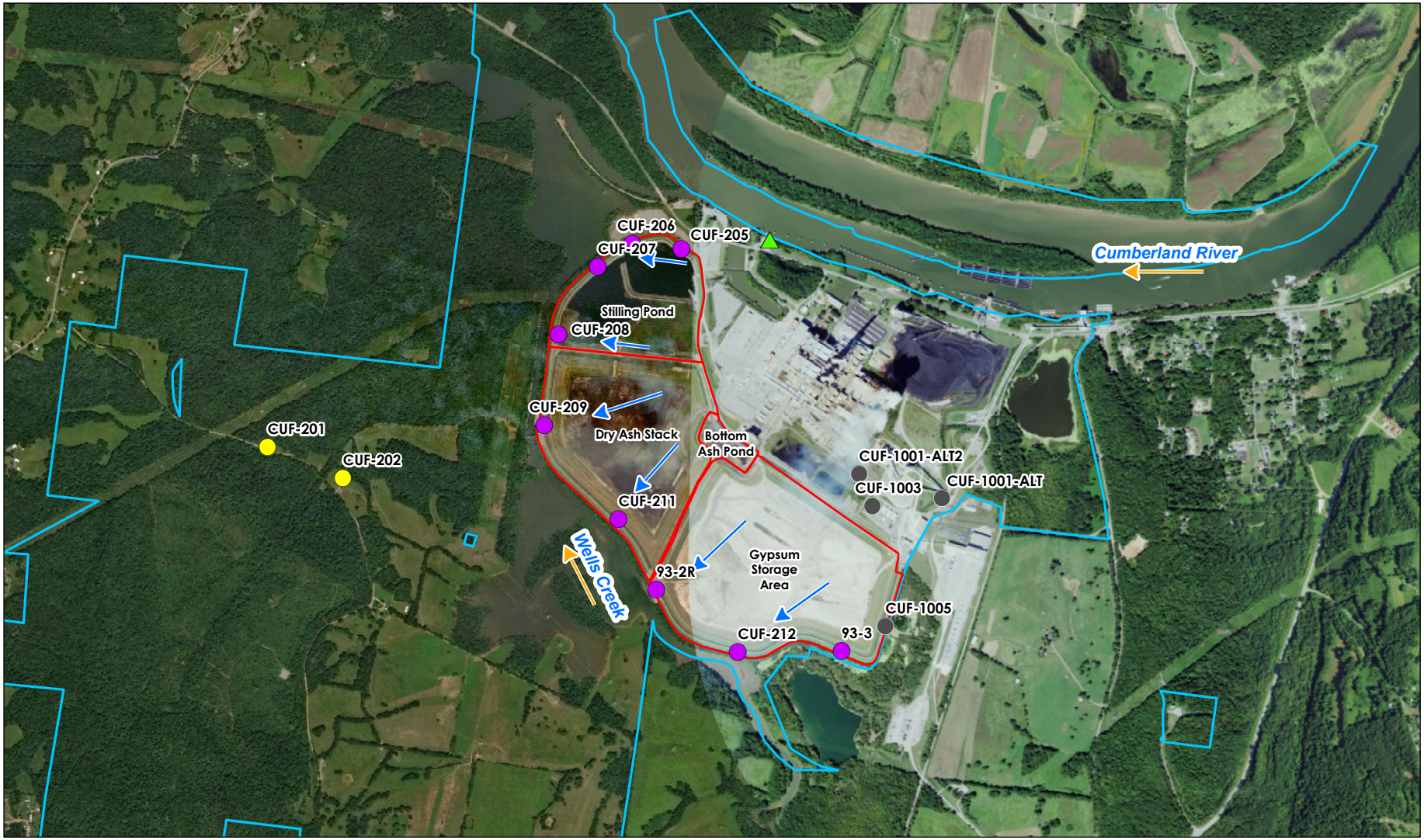

Legend

- Staff Gauge
- Background Well
- Downgradient Well
- Investigation Well
- Groundwater Flow Direction
- TVA Property Boundary
- CCR Unit Subject to CCR Rule

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***Notes***

**1.** Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet

**2.** Background: TVA 2017 Imagery Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

*Project Location*
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Stewart County, Tennessee

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Independent Review by JB on 2019-07-15

*Client/Project*
Tennessee Valley Authority
Cumberland Fossil Plant
CCR Rule

182603472

*Figure No.*
**Figure 2-3**

*Title*
**Groundwater Flow Direction**

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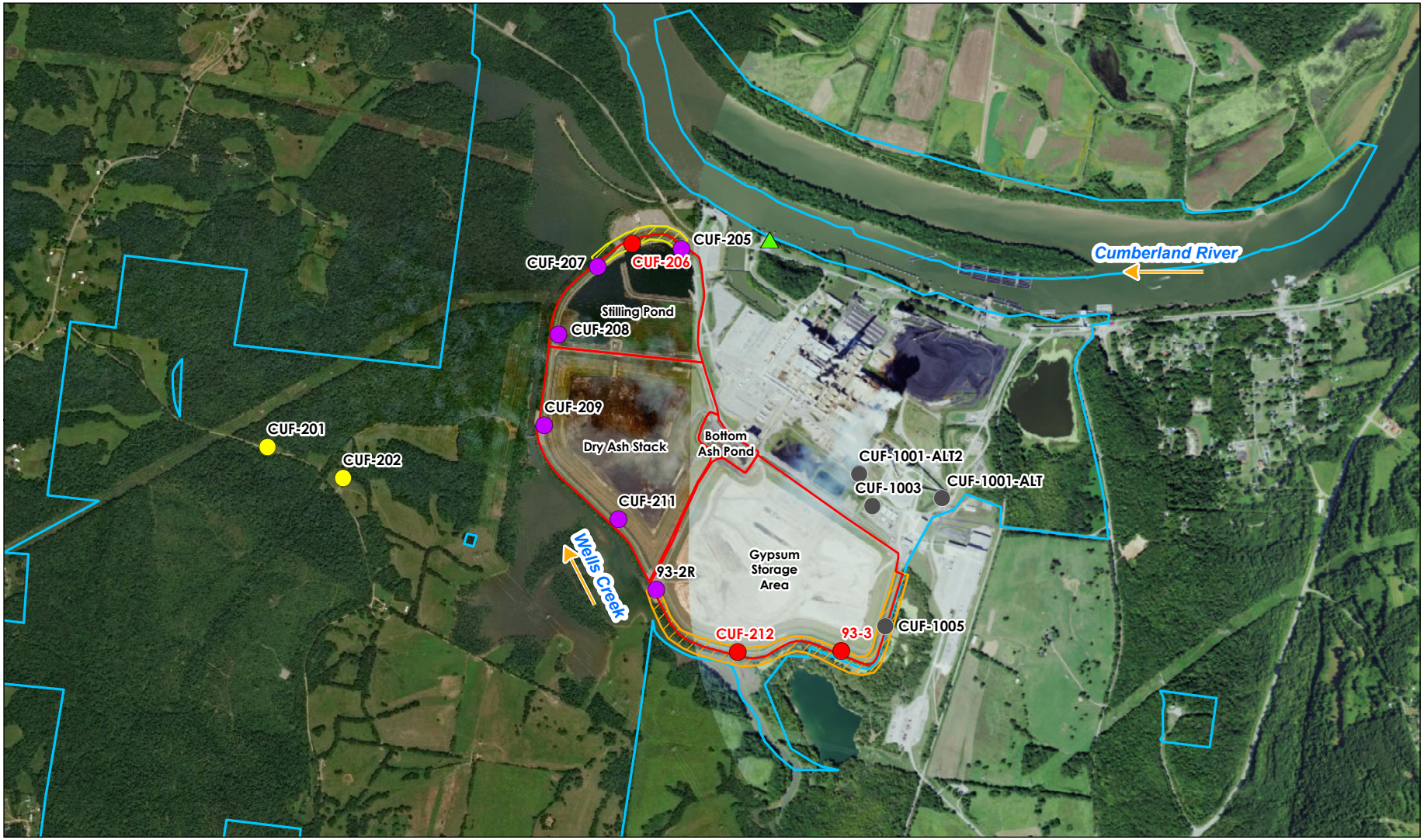

Legend

- Staff Gauge
- Background Well
- Downgradient Well
- GWPS Exceedance Well
- Investigation Well
- TVA Property Boundary
- CCR Unit Subject to CCR Rule
- Potential Arsenic Treatment Zone
- Potential Cobalt & Lithium Treatment Zone

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(At original document size of 8.5x11)
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**Notes**

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
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CCR Rule

182603472

*Figure No.*
**Figure 3-1**

*Title*
**Monitoring Wells and Limits of COI Impacts**

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# APPENDIX A

## Potential Remedies

# 1.0 GROUNDWATER CORRECTIVE MEASURES STRATEGIES

Three strategies to address impacted groundwater have been developed to assess corrective measures. Each strategy is detailed in this appendix. For purposes of this report any SSL detections of Appendix IV constituents over GWPS will be defined as a constituent of interest (COI).

## 1.1 MONITORED NATURAL ATTENUATION

Monitored Natural Attenuation (MNA) is a remedial strategy that involves establishing a program to monitor the physical, chemical, or biological processes that currently exist at a site. These processes can often work to reduce the toxicity, concentration, and mobility of site COIs in a time frame that is acceptable and that at times can be comparable to other technologies. MNA is increasingly employed at sites where COI concentrations are near threshold levels, do not have an immediate pathway to sensitive receptors, and are not resultant from an on-going source.

MNA implementation would consist of establishing a monitoring and assessment program to determine if the COI concentrations present in the groundwater were being reduced as a result of operational changes and/or closure of the Bottom Ash Pond and Stilling Pond (including Retention Pond). Existing and potentially new monitoring wells at the facility would be used to characterize reduction in COI concentrations over time.

At wells CUF-206, CUF-209 and 93-3 of the CCR Multiunit and CCR Unit at CUF, there is a statistically significant level (SSL) above the groundwater protection standard (GWPS) for arsenic, cobalt, and lithium. A portion of the Stilling Pond will be closed and CCR will be removed for purposes of building a new process water basin (PWB). A temporary lined PWB will be constructed so that flows can be rerouted while the permanent PWB is being constructed. These operational changes will help control the source until the TDEC Order process determines the closure method for the remaining portion of the CCR Unit after the temporary PWB is no longer needed. The following conditions at CUF make MNA a viable strategy:

- Limited impacts to groundwater: Currently, an SSL above GWPS established under 40 CFR § 257.95(h) for arsenic, cobalt, and lithium are observed along isolated portions of the CCR Multiunit and CCR Unit. There are no drinking water supply wells on site, including between the CCR units and the adjacent surface water. A limited extent of impact and no drinking water receptors increase the likelihood that natural systems can attenuate COIs in an acceptable time frame.

- Naturally-occurring reactions in native soils: COIs are susceptible to a variety of filtering and oxidation/reduction (redox) reactions that can separate or precipitate dissolved concentrations to remove them from aqueous solution. COIs can be present in multiple valance states and their chemical reactivity is affected by groundwater pH, redox potential, the presence of iron and sulfur, and other subsurface variations. The effectiveness of geochemical processes can be evaluated by collecting native soil and groundwater samples and conducting bench-scale testing to evaluate the effectiveness of MNA.

Continued monitoring, in accordance with the groundwater monitoring program, would be necessary to validate that COI concentrations continue to decrease at an acceptable rate.

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

## 1.2 HYDRAULIC CONTAINMENT AND GROUNDWATER TREATMENT

Hydraulic containment is a technology that has been employed for decades to control impacted groundwater. Containment is typically achieved through the use of low-permeability barriers, high-permeability collection galleries, submersible pumps, or a combination of these features. The applicability and orientation of a hydraulic containment system is largely based on site-specific conditions including aquifer dimensions and conductivity, presence of confining layers, depth, gradient, characteristics of the COIs, and presence of receiving water bodies or wells.

Hydraulic containment systems can be very effective at controlling the migration of constituents in groundwater, particularly when there are sensitive systems nearby or a continuing source of contamination.

Hydraulic containment systems include physical barriers and pumping systems as summarized below:

- Physical Barriers:
    - Slurry Walls: Soil/bentonite slurries placed inside a 3-foot wide trench keyed into an impermeable soil layer (clay) serves as a physical barrier that prohibits the movement of groundwater and contains COI migration.
    - Sheet Pile Walls: Steel panels driven through the soil column to key into an impermeable zone serves as a physical barrier that prohibits movement of groundwater and contains COI migration.
    - Soil/Bentonite Walls: Dry soil/bentonite mixtures placed inside a 3-foot wide trench keyed into an impermeable soil layer (clay) serves as a physical barrier that prohibits the movement of groundwater and contains COI migration.
- Pumping Systems:
    - Vertical Wells: The use of vertical wells is a proven technology that can be used in unconsolidated soils and bedrock. The number of wells, spacing between wells and well depths are a function of aquifer characteristics.
    - Horizontal Wells: The use of horizontal wells potentially allows for the installation of more well screen along a zone of COI impacts, in comparison with vertical wells, thus improving the overall efficiency of the extraction system. The use of horizontal wells is not

recommended for aquifers where there is large differential between high and low groundwater elevations as it may be difficult to pinpoint the COI recovery zone. Deep horizontal wells not be as practical as vertical wells due to Site-specific conditions.

- Trenching Systems: Trenches function in a manner similar to horizontal wells but are installed with conventional excavation techniques. The use of trenches is cost-effective when COIs are present at shallow depths and high groundwater flow rates.
- Phytoremediation: This technique is feasible when COIs are present at concentrations less than those levels that are toxic to plant life. Trees with deep root zones can extract groundwater containing COIs above GWPS and assimilate the COIs within their cell structure. This removes the COI from the groundwater and can result in obtaining the GWPS in an accelerated time frame. For closed in-place CCR Units, it is important to promote vertical growth of the tree root structure as opposed to lateral growth. Lateral growth of the plant roots can damage the liner system covering the CCR. Damages to the liner system would allow rainwater to come into contact with the CCR which could extend the time required to achieve GWPS.

The basis of design for a hydraulic containment system is typically generated by developing a detailed hydrogeologic CSM and a numerical groundwater model. The CSM serves as the basis for developing a numerical groundwater flow and solute transport model that is calibrated and verified against actual site conditions. The calibrated groundwater model is then used to evaluate a variety of approaches (e.g., vertical wells, horizontal wells, physical barriers) and to estimate the groundwater extraction rates necessary to contain the target zone. Understanding extraction rate requirements is important for developing an effective means of treating extracted groundwater.

Extracted groundwater often requires treatment to remove or reduce the concentration of the COIs prior to discharge to a receiving water body, publicly owned treatment works, land application, or re-injection through a well system.

Treatment of the impacted groundwater can be completed on or off-site using one of the following treatment methodologies:

- pH Adjustment: In cases where low pH is the primary COI, the groundwater can be treated by simple pH adjustment. Increasing the pH of the groundwater is accomplished by the addition of caustic solution (e.g., sodium hydroxide) at a rate that can be determined through bench-scale testing. Similarly, high pH groundwater can be treated through the addition of an acidic solution at a rate that can be determined through bench-scale testing. Other treatment methods discussed below may also require some pH adjustment to facilitate treatment.
- Chemical Precipitation: COIs can be removed from groundwater by raising the pH, using sodium hydroxide, calcium carbonate, or sulfides to convert the soluble COI to an insoluble form that precipitates out from the water stream. Bench-scale testing can be used to determine the addition rates of chemical precipitates and the percent COI removal that can be achieved through this process.

- Adsorption: COIs can be removed from groundwater by passing groundwater through an adsorption media such as bentonite, activated alumina, granular activated carbon, or iron-impregnated silica sands. COIs are adsorbed onto the surface of the media and removed from the groundwater. The adsorption material has a limited service life due to the amount of available treatment surfaces on the media. This adsorption material must be periodically replaced when the available surfaces are consumed with the COI. Bench-scale testing can be used to define the groundwater/media contact time for COI removal and estimate the active life of the adsorption media before it requires replacement.
- Ion Exchange: In this process an ion on the surface of the treatment media is exchanged with the ion that is removed from the impacted groundwater. Ion exchange is a proven technology with different media performing better for different COIs. This technology can be expensive depending on the cost of the ion exchange media. Advances in the beneficial reuse of high calcium content biomaterials has made the use of this technology attractive for some COIs. Bench-scale testing may be completed to determine if ion exchange is a viable technology for consideration. Bench-scale testing can also determine the necessary contact time between the impacted groundwater and ion exchange media, and the service life of the ion exchange media.
- Hydraulic containment and groundwater treatment are applicable remedial alternatives due to several conditions at CUF, including:
    - *Precludes migration to potential receptors*: Operation of a hydraulic containment system would demonstrably capture COI-containing groundwater and prevent migration;
    - *Localized area of impacts*: COIs have been detected above GWPS within assessment monitoring wells around the perimeters of the CCR Multiunit and CCR Unit. The COI impacts are estimated to have a localized extent of impacts and could be managed with a limited number of extraction points; and
    - *Established treatment technologies*: Treatment of COIs in industrial wastewaters is accomplished through multiple proven technologies. Potential treatment alternatives include advanced filtration, chemical precipitation, redox manipulation, adsorption and ion exchange. The most effective alternative(s) would be selected based on the geochemistry of the groundwater and bench-scale treatability testing.

A hydrogeologic model would be required to design the hydraulic containment system orientation and bench-scale testing would could assist in selecting the preferred treatment technology.

A Groundwater Monitoring Program is typically an integral part of any hydraulic containment system. It is anticipated that after selection of the remedy, a corrective action groundwater monitoring program will be implemented in accordance with 40 CFR § 257.98(a)(1). This monitoring program will track changes in COI concentrations and the extent and effectiveness of the containment system.

The time frame to achieve GWPS with a hydraulic containment system is strongly dependent on the site's hydrogeologic conditions, the degree and extent of COI impact, and the chemical behavior of COIs in the

subsurface. These inherent site conditions often function as rate limiting characteristics and should be considered when considering the schedule for achieving GWPS.

## 1.3 Enhanced In-Situ Treatment (EIST)

In-situ treatment of groundwater using EIST is an established technology for a variety of site conditions and contaminants. This alternative includes measures implemented in-situ to immobilize or reduce the concentration of COIs. In-situ technologies can be deployed in a variety of configurations depending on the extent of COIs and their proximity to potential receptors. Examples of EIST approaches include:

- Infiltration galleries: Regularly spaced injection wells would be installed in the target area to allow for delivery of a reagent to stabilize or transform COIs in-place. An injection gallery allows for repeated treatments as needed to meet remedy goals.
- Direct injection: Regularly spaced injection points can be advanced into the target area to allow for one-time delivery of a reagent to stabilize or transform COIs in-place.
- Permeable reactive barrier: Excavation of a trench perpendicular to groundwater flow direction can be backfilled with a permeable treatment media that allows groundwater to flow through it while reducing concentrations of COIs through chemical, physical, and/or biological processes.

Evaluation of these technologies will require development of a detailed hydrogeologic CSM and a groundwater model. The CSM serves as the basis for developing a numerical groundwater flow and solute transport model that is calibrated and verified against actual site conditions. The hydrogeologic model can then be used to determine the basis of design for deploying an EIST remedy and evaluating contact time and groundwater flow requirements.

Bench-scale testing will can be used to evaluate potential reagents to be used in-situ. The bench-scale testing will be designed to develop an understanding of the geochemistry and assess the effectiveness of prospective reagents. Bench-scale testing can also be used to determine the scope and necessity of field-scale pilot testing.

EIST is an applicable remedial alternative based on several conditions at sites, including:

- Localized area of impacts: COIs have been detected above GWPS within a limited number of wells around the perimeters of the CCR Multiunit and CCR Unit. This indicates that in-situ stabilization or an EIST barrier would be limited to only a portion of the perimeter. Additional investigations would be conducted to define the area of treatment or required length of the barrier; and
- Metals treatment technologies: Removal of COIs with multiple treatment technologies have been demonstrated in industrial wastewater applications. Potential treatment alternatives include advanced filtration, co-precipitation, redox manipulation, adsorption, and ion exchange. The most effective alternative(s) would be selected based on the geochemistry of the groundwater and potential bench-scale treatability testing. Bench-scale testing can help determine the preferred

treatment media, groundwater/treatment media contact time, and effectiveness of an EIST barrier application in achieving GWPS.

A groundwater monitoring program is typically an integral part of any EIST system. It is anticipated that after selection of the remedy, a corrective action groundwater monitoring program will be implemented in accordance with 40 CFR § 257.98(a)(1). This monitoring program will track changes in COI concentrations and the extent and effectiveness of the EIST system.

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

- Site Access: EIST barriers can require access for heavy equipment and a working platform to excavate the trench. Uneven or wooded terrain would complicate site preparation activities and may make installation infeasible.
- Dike Stability: The installation of an EIST could require the use of trenches. The location of the trenches in relationship to the dikes of the CCR Multiunit and CCR Unit require careful evaluation to make sure that stability of the dike structures is maintained.
- Depth: Installation of EIST barriers can be limited by the design depth and soil types present. Depending on depth and soil characteristics, specialized installation techniques may be required. For example, single-pass trenching machines can install EIST barriers in sandy materials without obstructions but are limited to a maximum depth of approximately 50 feet below ground surface. Slurry trenching techniques can be used to reach deeper impacts, but additional site infrastructure is required to support the installation.
- Geochemistry: The valence state of COIs, pH and redox potential of groundwater, and chemical makeup of the subsurface must be evaluated to determine the applicability of an EIST barrier.

# APPENDIX B

## Assessment of Potential Remedies

# 1.0 INTRODUCTION

The evaluation of appropriate remedies to meet the requirements of 40 CFR § 257.96(c) is provided in the subsections below and is summarized in **Table B-1**. The qualitative assessments in **Table B-1** (low, medium, high) are based on experience, professional judgement, and known Site conditions. This document provides evaluation in compliance with 40 CFR § 257.96(c).

Five remedial alternatives classified under three technology types, hydraulic containment, monitored natural attenuation, and in-situ treatment, will be evaluated as groundwater corrective measures:

- Hydraulic Containment:
    - Conventional Vertical Well System;
    - Horizontal/ Angular Well System; and
    - Trenching System.
- Monitored Natural Attenuation; and
- Enhanced In-Situ Treatment.

# 2.0 PERFORMANCE

The performance criteria described in the following section focuses on the specified technology's goal of corrective measures to prevent further releases, remediate any current releases, and restore the affected area to original conditions.

## 2.1 SOURCE CONTROL TECHNOLOGIES

Source control will be achieved by ceasing discharge of CCR to the CCR Unit and initiating dewatering operations to remove process water from above the CCR. Section 4.2 discusses the operational changes and partial closure plans for the Stilling Pond (including Retention Pond). The Bottom Ash Pond and Stilling Pond (including Retention Pond) will ultimately be closed in accordance with 40 CFR § 257.102. Source control technologies are not further evaluated in this report since this assessment of corrective measures focuses only on groundwater corrective actions.

## 2.2 GROUNDWATER CORRECTIVE MEASURES

The groundwater corrective measures evaluated include:

- Monitored Natural Attenuation (MNA);
- Hydraulic Containment; and
- Enhanced In-Situ Treatment.

This section describes these technologies in more detail.

### 2.2.1 Monitored Natural Attenuation

Additional groundwater assessment monitoring is conducted once source control has been implemented for the CCR Multiunit and CCR Unit to determine if the arsenic, cobalt, and lithium concentrations are stable or decreasing. Once the source is controlled, natural groundwater flux should result in reduced concentrations of arsenic, cobalt, and lithium after a period of time. The groundwater assessment monitoring will determine if the source control measures are reducing or stabilizing arsenic, cobalt, and lithium concentrations in the groundwater to levels necessary to achieve the GWPS. Trend analyses will be completed to predict the time that it will take for the groundwater to reach GWPS. MNA is a proven technology that has been effectively used at groundwater remediation sites. MNA is considered a **high** performing alternative based on project experience on similar sites and professional judgement.

### 2.2.2 Hydraulic Containment

If source control technologies do not reduce COI concentrations to below the GWPS, then additional groundwater remediation corrective measures may be required.

Several site-specific conditions contribute to the effective performance of the hydraulic containment system. These site-specific conditions include:

- Depth to impacted groundwater at CUF;
- Length of impacts along the perimeters of the CCR Multiunit and CCR Unit;
- Thickness of alluvium at CUF;
- Groundwater capture zones; and
- Arsenic, cobalt, and lithium to be removed from the groundwater.

Hydraulic containment systems can be designed based upon data obtained through additional site characterization assessments, groundwater modeling, and potential bench-scale treatability tests. These additional studies are focused on the arsenic, cobalt, and lithium present at the CCR units that exceed GWPS. Data from these studies will help develop a basis of design for the hydraulic containment system which includes:

- Number and depth of the extraction wells installed within the alluvium;
- Groundwater extraction rate from the alluvium;
- Optimum above ground groundwater treatment approach for arsenic, cobalt, and lithium;
- Treated groundwater discharge location; and
- Estimated time frame to achieve GWPS.

Groundwater extraction and treatment is a feasible technology at CUF with a **high** or **medium-rated** performance depending on site-specific issues such as groundwater use restrictions.

### 2.2.3 Enhanced In-Situ Technologies

Several site-specific conditions contribute to the effective performance of the enhanced in-situ technologies (EISTs). These site-specific conditions include:

- Depth to impacted groundwater within the alluvium;
- Length of arsenic, cobalt, and lithium impacts along the perimeter of the CCR units;
- Groundwater flow rate within the alluvium; and,
- Arsenic, cobalt, and lithium to be removed from the groundwater.

EISTs can be designed based upon data obtained through additional Site characterization assessments, groundwater modeling and potential bench-scale treatability testing. These additional studies are focused on the arsenic, cobalt, and lithium present at the CCR units that exceed SSLs. Data from these studies will help develop a basis of design for the EIST which includes:

- Location and depth of the EIST to intercept arsenic, cobalt, and lithium present in the alluvium;

- Optimum EIST media for treatment of arsenic, cobalt, and lithium;
- EIST detention times for effective treatment;
- Service life for the EIST media;
- Provisions for media replacement; and,
- EIST quantities.

EISTs would generally be considered **high to medium** performing alternatives based on project experience on similar sites and professional judgement. Bench-scale testing of multiple reagents or modelled site conditions can be used to evaluate retention times, reaction rates, media selection, quantities and delivery methods for treatment using EIST.

# 3.0 RELIABILITY

The reliability criterion is based on the degree of certainty that the technology will consistently work toward and attain the specified goal(s) of corrective measures over time.

## 3.1 GROUNDWATER CORRECTIVE MEASURES

The reliability of the following groundwater corrective measures will be evaluated in this section:

- MNA;
- Hydraulic Containment; and
- EIST.

### 3.1.1 Monitored Natural Attenuation

MNA is a commonly applied corrective measure that can, under appropriate conditions, reliably reduce arsenic, cobalt, and lithium concentrations after source control measures are completed. The process of determining the effectiveness and reliability of MNA involves regular monitoring and analysis of groundwater data following closure. This monitoring process and the related data analysis is central to determining whether appropriate conditions exist to support MNA and will serve as the primary means of determining and confirming reliability. MNA may not result in the arsenic, cobalt, and lithium levels in groundwater returning to levels below the GWPS. In these instances, arsenic, cobalt, and lithium concentration reduction is achieved through a variety of geochemical and hydrogeologic processes that affect the solubility, sorption, and concentration of the constituents. Therefore, the reliability of MNA is considered to be **high to medium** depending on site conditions.

### 3.1.2 Hydraulic Containment

Hydraulic containment alternatives are generally considered to be **highly** reliable for containing the arsenic, cobalt, and lithium contamination and preventing migration. This technology may not be as reliable when considering the reduction of arsenic, cobalt, and lithium concentrations within the aquifer. Reduction of arsenic, cobalt, and lithium concentrations is highly dependent on the success of source control steps and the ability of the arsenic, cobalt, and lithium to be adsorbed within the soil column. Conventional vertical wells are installed within the alluvium in a line or series with overlapping radii of influence to effectively capture groundwater. Modifications can be made during startup and as site conditions change to optimize the system's performance. If needed, extraction well systems can be expanded with additional wells, after the initial installation. Horizontal well reliability and extraction trench reliability is generally comparable to that of vertical wells, although the application is less common. Site-specific issues could restrict the extraction of groundwater and as a result could lower the reliability of this approach to **medium**.

### 3.1.3 Enhanced In-Situ Technologies

EIST is a commonly applied corrective measure that can, under appropriate conditions, reliably reduce arsenic, cobalt, and lithium concentrations after source control measures are completed. The EIST processes can include one or more of the following treatment mechanisms:

- Advanced Filtration;
- Chemical Precipitation; and
- Adsorption.

The process of determining the effectiveness and reliability of EIST involves regular monitoring and analysis of groundwater data following closure. Groundwater monitoring will be conducted to determine the effectiveness of EIST and to determine the time frame required to achieve GWPS for arsenic, cobalt, and lithium. Bench testing allows for the development of a site-specific approach to treat arsenic, cobalt, and lithium to achieve GWPS.

The reliability of EIST is considered to be **high to medium** depending on the COI being treated and site-specific considerations.

# 4.0 EASE OF IMPLEMENTATION

This criterion requires evaluation of the alternatives based on the ease of implementation for each of the technologies at the site.

## 4.1 GROUNDWATER CORRECTIVE MEASURES

The ease of implementation criterion is based on the degree of certainty that the technology can be installed and reduce the concentrations of COIs over time to achieve the GWPS for arsenic, cobalt, and lithium.

### 4.1.1 Monitored Natural Attenuation

MNA can be readily implemented and existing monitoring wells (potentially supplemented with additional wells) could be used for groundwater monitoring purposes. MNA does not require significant infrastructure and instead relies on natural processes to attenuate arsenic, cobalt, and lithium concentrations over time. Standard techniques for obtaining and analyzing groundwater data for arsenic, cobalt, and lithium are readily available. Therefore, an MNA corrective measure is evaluated as **highly** implementable.

### 4.1.2 Hydraulic Containment

Hydraulic containment systems are widely implemented and are a proven technology for capture of arsenic, cobalt, and lithium contamination and are applicable for groundwater treatment at CUF. The ease of implementation varies across the range of available hydraulic containment systems from **medium to high**. Implementation issues associated with each of these techniques is discussed below:

Vertical Wells:

- The number of extraction wells and their spacing distance is dependent upon the horizontal and vertical extent of arsenic, cobalt, and lithium impacts within the alluvium, the hydrogeologic characteristics of the alluvium, the groundwater extraction rate from the alluvium and the groundwater capture zone within the alluvium;
- Specialized drilling equipment may be required to install the wells within the alluvium depending on the depth of arsenic, cobalt, and lithium impacts; and
- Limited space may be available on the top of the dikes adjacent to CUF-206, CUF-212, and 93-3 to install the hydraulic containment system.

Horizontal Wells:

- The length of horizontal wells and their installation depth is dependent upon the horizontal and vertical extent of arsenic, cobalt, and lithium impacts, the hydrogeologic characteristics of the alluvium, the groundwater extraction rate from the alluvium and the groundwater capture zone within the alluvium;

- Specialized drilling equipment will be required to install the horizontal wells in the alluvium; and
- It may be difficult to place the horizontal wells at the desired depths due to surface constraints associated with the CCR units.

Trenches:

- Specialized drilling equipment will be required to install the trenches within the alluvium;
- Trench stabilization techniques (sheet pile, bio-degradable slurry) are required to prevent collapse of the sidewalls during installation; and
- It may be difficult to place the arsenic, cobalt, and lithium treatment media at depth in narrow trenches.

The number of wells required for effective capture is based upon the horizontal and vertical extent of the arsenic, cobalt, and lithium impacts within the alluvium and groundwater flow characteristics in the alluvium. Vertical extraction wells could be executed relatively easily with existing site conditions and result in a **high** ease of implementation. Horizontal extraction wells suggest a **medium** ease of implementation due to additional clearances necessary to install wells. Trenching systems suggest a **medium** ease of implementation due to trench stability concerns and potential impacts on sensitive ecosystems.

### 4.1.3 Enhanced in-situ treatment

EIST would require extensive time, infrastructure, additional design and up-front monitoring for implementation. EISTs could be permeable reactive barriers (PRBs), infiltration galleries or through direct injections specifically designed for arsenic, cobalt, and lithium removal from groundwater. Implementation issues associated with each of these techniques is discussed below:

PRBs:

- Construction of a PRB for arsenic, cobalt, and lithium removal may require specialized equipment and construction techniques that could impact the ease of implementation; and
- Following installation, a PRB typically requires minimal maintenance and periodic monitoring.

Infiltration Galleries:

- Injection galleries can be installed for arsenic, cobalt, and lithium treatment with standard drilling equipment;
- Access can be limited, so the location of slopes, existing infrastructure, and other obstructions must be factored into the design; and
- Injection galleries are subject to fouling that can inhibit the injection of reagents particularly if multiple injection events are required.

Direct Injection:

- Direct injection for arsenic, cobalt, and lithium treatment can be accomplished with standard drilling equipment;
- Access can be limited, so the location of slopes, existing infrastructure, and other obstructions must be factored into the design; and
- Multiple direct injection events may be required to achieve the GWPS for arsenic, cobalt, and lithium.

Once the EIST barriers are installed the remedial alternative is passive and would require only periodic monitoring and maintenance. The overall ease of implementation for an EIST alternative would be **medium**.

# 5.0 POTENTIAL SAFETY IMPACTS

This criterion evaluates the alternatives based on potential safety impacts that may occur as a result from the implementation of the technologies on site.

## 5.1 GROUNDWATER CORRECTIVE MEASURES

Safety impacts that may occur as a result from the implementation of groundwater corrective measures for arsenic, cobalt, and lithium are discussed in this section.

### 5.1.1 Monitored Natural Attenuation

MNA safety impacts are minimal due to the inherent passive nature of the system. The primary safety concerns would be associated with the installation of any additional wells to monitor arsenic, cobalt, and lithium trends in the groundwater should they be required to supplement the existing well network. Additional opportunities for safety impacts would be during groundwater monitoring activities. These impacts are common to any technology that may be deployed, because groundwater monitoring will be required regardless of which remedial technology is implemented. For these reasons, MNA has a **low risk** of safety concerns.

### 5.1.2 Hydraulic Containment

Groundwater extraction well construction or trenching activities for capturing arsenic, cobalt, and lithium impacted groundwater would require construction activities and consequently pose a **medium risk** of safety impacts. Construction equipment involved in the installation of extraction wells, drilling, electrical work and piping would be a main area for safety impact concern. Operations and maintenance, repair, and replacement activities may also present safety hazards, but are generally lower risk than construction-related safety impacts.

### 5.1.3 Enhanced In-Situ Technologies

EISTs for arsenic, cobalt, and lithium treatment would require a more complex construction plan and therefore a **medium risk** for safety impacts. Construction equipment would be the main concern because construction projects are inherently more dangerous than other site work due to the presence of heavy machinery. Once installed, EISTs are passive and would result in minimal safety impact potential. EISTs implementation has a **medium risk** for safety concerns.

# 6.0 POTENTIAL CROSS-MEDIA IMPACTS

This criterion evaluates the alternatives based on potential cross-media impacts that may occur as a result from the implementation of the technologies on site.

## 6.1 GROUNDWATER CORRECTIVE MEASURES

Potential cross-media impacts that may occur as a result from the implementation of groundwater corrective measures for arsenic, cobalt, and lithium treatment is discussed in this section.

### 6.1.1 Monitored Natural Attenuation

Monitored natural attenuation poses minimal risk of cross-media impacts as the systems, when installed are passive and primarily interact with existing groundwater flow. MNA is considered **low risk** for cross-media impacts.

### 6.1.2 Hydraulic Containment

Extracted groundwater containing arsenic, cobalt, and lithium is transported from the recovery well to the treatment system using enclosed piping. The main potential for cross-media impacts would occur if the piping failed and untreated extracted groundwater is released to the environment. This risk is mitigated through periodic monitoring of the secondary containment. Hydraulic containment technologies are considered to have a **medium** risk.

### 6.1.3 Enhanced In-Situ Technologies

There is a potential for the accidental release of diesel fuel during the installation of subsurface barrier walls for arsenic, cobalt, and lithium treatment. In addition, if the barrier wall is installed within CCR materials there is the potential that CCR materials can be exposed and then released to the environment. Also, injected treatment reagents for arsenic, cobalt, and lithium would have the potential for being released to the environment. The potential for these types of releases are mitigated through the development of spill prevention control and countermeasure plans. Due to the minimal potential for spills of fuel or treatment reagents during construction activities, EIST is considered a **medium risk**.

# 7.0 CONTROL OF EXPOSURE TO RESIDUAL CONTAMINATION

This criterion evaluates the alternatives based on exposure to residual arsenic, cobalt, and lithium contamination to receptors such as humans and the environment that may occur as a result from the implementation of the technologies on site.

## 7.1 GROUNDWATER CORRECTIVE MEASURES

Each groundwater corrective measure discussed in this report has a **low risk** of residual contamination. This is the result of arsenic, cobalt, and lithium being present in the groundwater at concentrations general less than a part per million. In addition, the groundwater impacts are present below the ground surface, and when groundwater is brought above the ground surface, it is transported through double walled piping to the treatment system. Therefore, the risk of exposure to residual contamination is **low**.

# 8.0 TIME REQUIRED TO BEGIN REMEDY

This criterion evaluates the alternatives based on time required for completion of design, planning, bench-scale testing, permitting, installation and startup of the remedial technologies.

## 8.1 GROUNDWATER CORRECTIVE ACTION

Due to the fact that MNA does not involve the introduction of an additional chemical or physical remedial tools, the process would likely require one to one and one-half years prior to implementation of the alternative to obtain groundwater trending data for arsenic, cobalt, and lithium. This lead time would be necessary to complete required additional monitoring, determine if additional monitoring wells are required and construct wells, if needed.

Hydraulic containment systems or EISTs would be expected to require between three to five years after remedy selection to implement due to the following reasons:

- Design, bench- and pilot-scale testing, reporting and state approval is anticipated to require multiple years.
- State, local, or other environmental permit requirements are anticipated to affect implementation of hydraulic containment or EISTs.
- Closure of the CCR units will take two to twenty years to complete depending on the remedy deployed;
- Interim measures for groundwater remediation for arsenic, cobalt, and lithium, if instituted prior to closure of the Stilling Pond (including Retention Pond) CCR Unit, will take one to three years to complete;
- Groundwater assessment monitoring will determine the need for additional groundwater corrective measures beyond MNA and interim measures; and
- Obtaining enough groundwater data to evaluate the performance of the Stilling Pond (including Retention Pond) CCR Unit closure method requires time.

# 9.0 TIME REQUIRED TO COMPLETE REMEDY

This criterion evaluates the alternatives based on time required to achieve the necessary goals of the corrective measures and restore groundwater in the affected area to achieve GWPS.

## 9.1 GROUNDWATER CORRECTIVE MEASURES

Since MNA does not introduce a reagent or barrier, the time to reach the GWPS for arsenic, cobalt, and lithium is currently unknown. The duration is directly dependent on the concentrations of arsenic, cobalt, and lithium present in the groundwater and the effectiveness of the engineered cap to prevent further releases. It is possible that several decades of monitoring may be required before necessary groundwater conditions are achieved. Groundwater modeling can be used to predict remediation time frames once enough post-closure monitoring data is obtained.

The time frame to achieve GWPS for arsenic, cobalt, and lithium with hydraulic containment remedies are also subject to concentrations of COIs in the groundwater. Groundwater modeling can be used to predict remediation time frames once enough post-closure monitoring data is obtained. The alternatives of vertical or horizontal extraction wells would remove arsenic, cobalt, and lithium mass from the subsurface, thereby reducing the volume still present in the subsurface. Therefore, the extraction alternatives may restore groundwater in a shorter time frame if source control efforts are effective.

The time frame to achieve GWPS with a EIST system is strongly dependent on the site's hydrogeologic conditions within the alluvium, the degree and extent of arsenic, cobalt, and lithium impact within the alluvium, and the chemical behavior of arsenic, cobalt, and lithium in the subsurface, These inherent site conditions often function as rate limiting characteristics and should be considered when considering the schedule for achieving GWPS for arsenic, cobalt, and lithium. Groundwater fate and transport modeling can be used to provide an estimated range of time frames to achieve GWPS.

# 10.0 INSTITUTIONAL REQUIREMENTS: STATE, LOCAL OR OTHER ENVIRONMENTAL PERMIT REQUIREMENTS THAT MAY SUBSTANTIALLY AFFECT IMPLEMENTATION

This criterion evaluates the alternatives based on state, local or other permitting requirements that may substantially affect the implementation of the technologies on site.

## 10.1 GROUNDWATER CORRECTIVE MEASURES

A groundwater assessment monitoring program will be developed to monitor the effectiveness of the CCR unit closure method and groundwater in-situ treatment or groundwater extraction and treatment technologies for arsenic, cobalt, and lithium. State and local approval may be necessary to execute the construction work plan for additional groundwater corrective measures. The following permits would likely be required:

- Stormwater Permit for Construction Activities – applies for all corrective measures (Hydraulic Containment and EIST) where greater than one acre of land is disturbed as a result of construction activities; and
- Tennessee NPDES Permit Modification – modifications to the existing Tennessee NPDES permit may be required for the hydraulic containment options since an additional source of impacted water is routed to the on-site treatment plant that discharges through the permitted outfall.

# TABLES

**Table B-1**
**CORRECTIVE MEASURES QUALITATIVE EVALUATION - 257.96(c) Analysis Criteria**
**CUF CCR Units**

| | *Groundwater Corrective Action* | | *Hydraulic Containment* | | |
|---|---|---|---|---|---|
| | **Monitored Natural Attenuation** | **Enhanced In-Situ Treatment** | **Conventional Vertical Well System** | **Horizontal/ Angular Well System** | **Trenching System** |
| **257.96(c)(1)** | | | | | |
| **Performance** | **High**<br>Soil column will filter particulate that contains As, Co and Li/dissolved As, Co and Li. Loading will be reduced by source control approaches. | **High**<br>Enhanced in-situ treatment technologies are evaluated based upon bench-scale testing of impacted groundwater. | **High**<br>Technology is feasible and will be further evaluated in accordance with 257.97, prior to remedy selection. | **High**<br>Technology is feasible and will be further evaluated in accordance with 257.97, prior to remedy selection. | **High**<br>Technology is feasible and will be further evaluated in accordance with 257.97, prior to remedy selection. |
| **Reliability** | **High**<br>Soil column will filter particulate that contains As, Co and Li/dissolved As, Co and Li. Loading will be reduced by source control approaches. | **High**<br>Enhanced in-situ treatment technologies are evaluated based upon bench-scale testing of impacted groundwater. | **High**<br>Technology is reliable due to narrow GW extraction window and the downward vertical flow component of groundwater. | **High**<br>Technology is reliable due to narrow GW extraction window and the downward vertical flow component of groundwater. | **High**<br>Technology is reliable due to narrow GW extraction window and the downward vertical flow component of groundwater. |
| **Ease of implementation** | **High**<br>Corrective Action Groundwater Monitoring will be conducted in accordance with 257.98 (a) (1). | **Medium**<br>The treatment zone has a narrow window. Installation of technology may require specialized construction equipment. Depth of installation makes use of technology more difficult. | **High**<br>Proven technology can be executed from top of berm/small hydraulic containment zone. This limits the number of extraction wells. | **Medium**<br>Proven technology can be executed from top of berm but requires greater clearance zone/small hydraulic containment zone. This limits the length of horizontal wells. Surface constraints may limit ability for placement. | **Medium**<br>Proven technology can be executed from top of berm but requires greater clearance zone/small hydraulic containment zone. This limits the length of recovery trenches. Potential stability concerns during installation. |
| **Potential impacts of appropriate potential remedies: safety impacts** | **Low Risk**<br>All work activities are conducted in accordance with a site-specific health and safety plan for safe execution of groundwater monitoring activities | **Medium Risk**<br>More advanced worker training is required to operate specialized equipment. | **Medium Risk**<br>More advanced worker training is required to operate specialized equipment. | **Medium Risk**<br>More advanced worker training is required to operate specialized equipment. | **Medium Risk**<br>More advanced worker training is required to operate specialized equipment. |
| **Potential impacts of appropriate potential remedies: cross-media impacts** | **Low Risk**<br>All work activities occur in-situ. | **Medium Risk**<br>All work activities occur in-situ with some potential to release COC's to the environment through spills. | **Medium Risk**<br>All work activities bring soils and groundwater to ground surface with some potential to release COC's to the environment through spills. | **Medium Risk**<br>All work activities bring soils and groundwater to ground surface with some potential to release COC's to the environment through spills. | **Medium Risk**<br>All work activities bring soils and groundwater to ground surface with some potential to release COC's to the environment through spills. |
| **Potential impacts of appropriate potential remedies: control of exposure to residual COIs** | **Low Risk**<br>All work activities occur in-situ/groundwater impacts previously identified. | **Low Risk**<br>All work activities occur in-situ with some potential to release COC's to the environment through spills. | **Low Risk**<br>All work activities bring soils to ground surface with some potential to release COC's to the environment through spills. | **Low Risk**<br>All work activities bring soils to ground surface with some potential to release COC's to the environment through spills. | **Low Risk**<br>All work activities bring soils to ground surface with some potential to release COC's to the environment through spills. |
| **257.96(c)(2)** | | | | | |
| **Time required to begin remedy** | 1 to 1.5 years | 3 to 5 years after a corrective measure is selected | 3 to 5 years after a corrective measure is selected | 3 to 5 years after a corrective measure is selected | 3 to 5 years after a corrective measure is selected |
| **Time required to complete remedy** | Varies dependent on groundwater fate, transport modeling and concentrations of As, Co and Li in CCR pore water. | Varies dependent on groundwater fate, transport modeling and concentrations of As, Co and Li in CCR pore water. | Varies dependent on groundwater fate, transport modeling and concentrations of As, Co and Li in CCR pore water. | Varies dependent on groundwater fate, transport modeling and concentrations of As, Co and Li in CCR pore water. | Varies dependent on groundwater fate, transport modeling and concentrations of As, Co and Li in CCR pore water. |
| **257.96(c)(3)** | | | | | |
| **State, local or other environmental permit requirements that may substantially affect implementation** | TDEC input required on Groundwater Corrective Action Monitoring Program. | TDEC input required on Groundwater Corrective Action Monitoring Program. | TDEC input required on Groundwater Corrective Action Monitoring Program. A TNPDES permit is required. | TDEC input required on Groundwater Corrective Action Monitoring Program. A TNPDES permit is required. | TDEC input required on Groundwater Corrective Action Monitoring Program. A TNPDES permit is required. |
| **Comments** | No timeframe specified to comply with 257.98 (c). Long term groundwater monitoring may be required. | No timeframe specified to comply with 257.98 (c). Corrective Action Groundwater Monitoring terminates if 3 years of data below the GWPS is obtained. | No timeframe specified to comply with 257.98 (c). Corrective Action Groundwater Monitoring terminates if 3 years of data below the GWPS is obtained. | No timeframe specified to comply with 257.98 (c). Corrective Action Groundwater Monitoring terminates if 3 years of data below the GWPS is obtained. | No timeframe specified to comply with 257.98 (c). Corrective Action Groundwater Monitoring terminates if 3 years of data below the GWPS is obtained. |