Third Semiannual Report on the Progress of Remedy Selection

TVA Cumberland Fossil Plant, Stilling Pond (Including Retention Pond) CCR Unit, Cumberland City, Stewart County, Tennessee

January 15, 2021

Prepared for:

Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:

Stantec Consulting Services Inc.

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1.0 Introduction

In accordance with 40 CFR § 257.97(a), the Tennessee Valley Authority (TVA) has prepared this third semiannual report to document progress toward remedy selection and design at the Stilling Pond (including Retention Pond) (also referred to herein as the coal combustion residuals (CCR) Unit) at the Cumberland Fossil Plant (CUF) in Cumberland City, Stewart County, Tennessee.

1.1 Regulatory Background

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 CCR produced by electric utilities. The requirements can be found in Title 40, Code of Federal Regulations (CFR) Part 257, Subpart D. 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, TVA completed an evaluation of whether there were SSLs over established GWPS as defined in 40 CFR § 257.95(h) for one or more Appendix IV constituents in accordance with 40 CFR § 257.95(g). At the CUF CCR Unit, assessment monitoring in 2018 detected SSLs greater than the GWPS for arsenic at monitoring well CUF-206. Since this time, TVA has updated the statistical analysis:

- In mid and late 2019, TVA updated the statistical analysis after incorporating additional groundwater monitoring data from the 2019 assessment monitoring events.
- In mid and late 2020, TVA updated the statistical analysis after incorporating results from the assessment monitoring events in 2020.

In accordance with 40 CFR § 257.96(a), TVA prepared the 2019 Assessment of Corrective Measures (ACM) Report for the CCR Unit at CUF, placed it in the facility operating record on July 15, 2019 and uploaded it to the TVA CCR Rule Compliance Data and Information website on August 14, 2019. The ACM Report provided an assessment of the effectiveness of potential corrective measures in achieving the criteria provided in 40 CFR § 257.96(c). Three primary strategies were evaluated to address groundwater exhibiting concentrations of arsenic above the GWPS:

- Monitored Natural Attenuation (MNA)
- Hydraulic Containment and Treatment
    - Physical Barriers
    - Pumping Systems
- Enhanced In-Situ Treatment (EIST)
    - Infiltration Galleries
    - Direct Injection
    - Permeable Reactive Barrier (PRB)

Following preparation of the ACM Report, TVA began the remedy selection process. Semiannual reports are required pursuant to 40 CFR § 257.97(a) to document progress toward remedy selection and design. The CCR Rule contemplates that more investigation and consideration may be needed to evaluate and design the remedy before making the final selection. TVA placed the first and second Semiannual Reports on the Progress of Remedy Selection into the facility operating record on January 15, and July 15, 2020, respectively, pursuant to 40 CFR § 257.97(a) and § 257.105(h)(12). TVA provided notification of the availability of the semiannual reports describing the progress in selecting and designing the remedy and placed them on the TVA CCR Rule Compliance Data and Information website on February 14, and August 14, 2020, respectively, in accordance with 40 CFR § 257.106(h)(9) and § 257.107(h)(9). 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.

At least 30 days prior to final groundwater remedy selection pursuant to the CCR Rule, 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). The selected remedy must meet the requirements of 40 CFR § 257.97(b) and must consider the evaluation factors set forth in 40 CFR § 257.97(c). 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. The owner/operator must provide a schedule for implementing the selected remedy that considers the factors set forth in 40 CFR § 257.97(d).

1.2 Summary of State Required Investigation and Remedy Selection Process

With oversight from the Tennessee Department of Environment and Conservation (TDEC), TVA is currently conducting environmental investigations of the CCR disposal areas at CUF, including the CCR Unit, in accordance with TDEC Commissioner's Order, OGC, 15-0177 (TDEC Order). The TDEC Order sets forth the process by which TVA is investigating the site, will provide an assessment of the data to TDEC, and will present proposed corrective measures and remedies, including for groundwater, to TDEC for approval. More specifically, once TDEC determines that the environmental investigations are complete, TVA will submit an environmental assessment report (EAR) that provides an analysis of the extent of CCR contamination, including groundwater contamination, at CUF to TDEC for approval. Then, as part of the TDEC Order process, TVA will submit a Corrective Action/Risk Assessment (CARA) Plan that specifies actions that TVA plans to take at the site, including corrective measures for groundwater remediation, to TDEC for approval. TDEC must approve the CARA Plan, including the CCR Unit closure methodologies, selected final remedy(s) and corrective measures for groundwater remediation. The TDEC Order process includes a public comment period for the public to provide comments on the CARA Plan.

1.3 Report Contents

This third semiannual progress report provides a summary of CUF site characteristics, the groundwater assessment monitoring program, the findings of the ACM process, and the current progress of selecting and designing a final remedy for statistically significant GWPS exceedances.

2.0 Site Background and Characteristics

CUF is located in Cumberland City, Stewart County, Tennessee. The facility lies on the south bank of Cumberland River and adjacent to Wells Creek. **Figure 1** shows an overview map of CUF including the CCR Unit. Construction of CUF began in 1968 and operations commenced in 1972. CUF currently continues to operate as a coal-fired power generation facility. The coal combustion process at CUF has resulted in the production of fly ash, bottom ash, and gypsum.

The Stilling Pond (including Retention Pond) 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.

2.1 Conceptual Site Model Summary

The hydrogeologic conceptual site model (CSM) is one of the primary tools that can be used to support decisions on corrective measures. This section of the report provides a summary of the hydrogeologic CSM. The geology and hydrogeology of the CUF site have been characterized during implementation of multiple investigations. These investigations provide an understanding of site geology and the presence of water-bearing zones in which groundwater and potential contaminants would be present and potentially migrating.

CUF is located within the Wells Creek Basin, which is a meteor impact structure. The subsurface geology at CUF is characterized by two hydro-stratigraphic units which includes the alluvium and bedrock. The alluvium can be further differentiated into alluvial silts and clays and alluvial sands and gravels. The CUF site overlies eight bedrock formations that primarily consist of limestone, dolomite and shale. The alluvial sand and gravel is considered the upper-most aquifer and groundwater from this hydro-stratigraphic unit is monitored in accordance with 40 CFR § 257.91. A typical cross-section view of the subsurface geology is shown on **Figure 2**. Groundwater flow direction at the CCR Unit is generally toward Wells Creek. **Figure 3** presents a groundwater flow direction map for CUF for September 8, 2020.

2.2 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), and the City of Erin Water Department provides water to Cumberland City. The Dover Water Department withdraws its water from the Cumberland River. The Dover water treatment plant intake 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 and is located approximately 20 miles downstream of CUF. The City of Erin Water Department 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 for the CCR Unit is conducted at CUF in accordance with 40 CFR § 257.95.

3.1 Groundwater Monitoring System

In compliance with 40 CFR § 257.91, two background (CUF-201 and CUF-202) and four downgradient monitoring wells (CUF-205, CUF-206, CUF-207 and CUF-208) were installed and comprise the well network for the CCR Unit. The locations of these monitoring wells are presented on **Figure 1**.

3.2 Groundwater Characterization

Groundwater assessment monitoring was conducted during 2018, 2019, and 2020, and at the time of this report, the second semiannual assessment monitoring event and retest event in 2020 had been conducted. The following Appendix IV constituent was detected at SSLs above the GWPS in 2018, 2019, and 2020.

- Arsenic
    - SSLs for arsenic were identified at monitoring well CUF-206
    - The GWPS for arsenic is 10 µg/L

Data from existing CCR network wells has been used to characterize the nature and extent of releases from the CCR Unit as required by 40 CFR § 257.95(g)(1). The potential treatment zone to address the extent of arsenic above GWPS along the unit perimeter is illustrated on **Figure 4**. Under the CCR Rule, work is being performed and additional wells are being installed that will further inform the evaluation and selection of the remedy(s) under 40 CFR § 257.97 of the CCR Rule (reference **Figure 4**).

4.0 Assessment of Corrective Measures

TVA prepared the 2019 ACM Report for the CCR Unit and placed it in the operating record on July 15, 2019. The report was posted to the TVA CCR Rule Compliance Data and Information website on August 14, 2019. The ACM Report provided an assessment of the effectiveness of potential corrective measures in achieving the criteria provided in 40 CFR § 257.96(c).

4.1 Planned Source Control Measures

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 CCR Unit. The final closure method for the CCR Unit at CUF will be determined based on the outcome the TDEC Order process and will be in accordance with 40 CFR § 257.102. Closing of the CCR Unit will limit water infiltration through the CCR and reduce further releases.

Flows to the Main Ash Pond (i.e., Stilling Pond (Including Retention Pond)) have been redirected to a temporary lined basin (TLB) and flows to the Main Ash Pond will cease in accordance with the requirements of 40 CFR § 257.101(a)(1). Construction of the Main Ash Pond Repurposing Project, including dewatering of the Main Ash Pond, began in November 2020. The TLB will facilitate dewatering and closure of the Main Ash Pond. Dewatering is expected to be completed in 2021 and then CCR removal from a portion of the unit will commence. Upon completion of the repurposing project and construction of the process water basis, the TLB will be removed and the remaining portion of the CCR Unit will be closed by removal or closed in place depending upon the outcome of the TDEC Order process.

Section 4.2 of the ACM Report describes the plan for closing the CCR Unit at CUF. The methods described above will reduce the potential for releases and migration of CCR constituents. Subsequent groundwater assessment monitoring will be conducted to track changes in groundwater conditions resulting from 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.

Groundwater assessment monitoring as required by 40 CFR § 257.96(b) will continue until a final remedy is selected. Long-term groundwater assessment monitoring is a component of the corrective measures implementation.

4.2 Potential Remedial Technologies

Subject to necessary environmental reviews, the CCR Unit will be closed in accordance with the requirements set forth in 40 CFR § 257.102.

In addition to source control measures, three primary strategies were evaluated to address groundwater exhibiting concentrations of arsenic above the GWPS including:

- MNA
- Hydraulic Containment and Treatment
    - Physical Barriers
    - Pumping Systems
- EIST
    - Infiltration Galleries
    - Direct Injection
    - PRB

The ACM Report provides a more detailed description of these corrective measures. The effectiveness of each potential corrective measure was assessed in accordance with 40 CFR § 257.96(c) and all are currently considered feasible for remediating the groundwater at the CCR Unit.

5.0 Selection of Remedy: Current Progress

A remedy to address the SSL in groundwater will be selected in accordance with 40 CFR § 257.97. Upon selection of a remedy, the owner or operator must prepare a final report (i.e., Remedy Selection Report) describing the selected remedy and how it meets the standards specified below pursuant to 40 CFR § 257.97(a). Remedies must:

- (1) Be protective of human health and the environment
- (2) Attain the groundwater protection standard as specified pursuant to §257.95(h)
- (3) Control the source(s) of releases to reduce or eliminate, to the maximum extent feasible, further releases of constituents in appendix IV to this part into the environment
- (4) Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems
- (5) Comply with standards for management of wastes as specified in §257.98(d).

In support of the remedy selection process, additional investigation is being conducted and is described below.

5.1 Data Requirements for Design of Groundwater Corrective Action

To further refine the targeted area for corrective measures, and finalize the alternative for the CCR Unit, additional data may be required to address potential data gaps. The characterization of the horizontal extent of arsenic downgradient of the CCR Unit is being further refined by the investigation required under the ongoing TDEC Order work and CCR Rule.

The following activities have been completed to date:

- One additional monitoring well was installed northwest of well CUF-206 to delineate dissolved arsenic concentrations in groundwater and characterize conditions closer to the facility boundary (reference **Figure 4**).

Activities planned to further evaluate site conditions:

- Slug testing will be performed at the new well location northwest of the CCR Unit to further characterize hydraulic conductivity.
- Additional groundwater sampling will be conducted on the newly installed facility boundary well in 2021 and 2022 to obtain baseline groundwater analytical results for statistical analysis.

Potential future activities to further evaluate MNA:

- A geochemical investigation is being conducted to evaluate groundwater and aquifer solids in areas downgradient of the CCR Unit.

- TVA has initiated geochemical modeling at the CCR Unit to evaluate the influence of native soils on groundwater chemistry. Furthermore, the geochemical modeling will aid in evaluating corrective measures identified. Geochemical processes operating in groundwater influence migration of arsenic through adsorption, ion exchange, and potential mineral formation. The time frame of effectiveness and capacity of the native soil system to attenuate arsenic would be evaluated using geochemical modeling.

- Groundwater Flow Modeling – Numerical modeling of groundwater flow based on expanded groundwater elevation data gained from the ongoing environmental investigation and additional hydrogeologic characterization efforts may be used to further refine the understanding of groundwater flow direction and velocity.

- Groundwater Fate and Transport Modeling – The groundwater flow model may be linked to a fate and transport model to further evaluate the estimated time for natural attenuation mechanisms to reduce the arsenic concentrations to below GWPS.

Potential future activities to further evaluate hydraulic containment and treatment:

- Groundwater Flow Modeling – The numerical groundwater flow model may be used to evaluate hydraulic containment. A calibrated groundwater model may be 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 an identified target zone. The objective of hydraulic containment modeling would be to incorporate groundwater extraction scenarios to optimize hydraulic containment of arsenic-impacted groundwater while balancing extracted groundwater treatment requirements.

- Groundwater Treatability Study - For ex-situ treatment of extracted groundwater, treatability studies would be needed to evaluate technologies for the treatment of arsenic.

- Supplemental Hydraulic Properties Evaluation – This evaluation could be necessary if the existing understanding of the hydraulic characteristics of the subsurface is insufficient to evaluate hydraulic capture geometry and potential groundwater recovery rates. If needed, installation of new wells and performance of pumping tests to evaluate hydraulic capture geometry and potential groundwater recovery rates would be used in the groundwater flow modeling simulations for groundwater extraction evaluation. These data would inform the feasibility, design, and implementation of groundwater recovery systems.

Potential future activities to evaluate EIST:

- A geochemical investigation would be conducted to evaluate groundwater and aquifer solids associated with the CCR Units.

- Groundwater Treatability Study – For in-situ treatment of groundwater, bench-scale treatability studies may be conducted on representative groundwater samples prior to selecting a groundwater corrective measure for implementation to address arsenic concentrations.

5.2 Semiannual Reporting, Public Meeting, Remedy Selection and Final Report

Progress toward the selection and design of the remedy will be documented in semiannual reports in accordance with 40 CFR § 257.97(a). Semiannual reports will be placed into the facility operating record pursuant to 40 CFR § 257.105(h)(12). TVA will provide notifications of the availability of the semiannual reports describing the progress in selecting and designing the remedy and will place the reports on the TVA CCR Rule Compliance Data and Information website in accordance with 40 CFR § 257.106(h)(9) and § 257.107(h)(9), respectively, 30 days after placement in the facility operating record. 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 prepared upon selection of the remedy. 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).

References:

Stantec. (2016a). Initial Structural Stability Assessment. Cumberland Fossil Plant – Stilling Pond (including Retention Pond) Stewart County, Tennessee. October 12.

Stantec. (2018a). Wetland Demonstration. Stilling Pond (Including Retention Pond). Cumberland Fossil Plant Cumberland City, Stewart County, Tennessee. October 12.

Stantec. (2018b). Placement Above the Uppermost Aquifer Demonstration Bottom Ash Pond Cumberland Fossil Plant Stewart County, Tennessee. October 12.

Attachments:

Figures

Figure 1 – Map with CCR Unit Background and Downgradient Monitoring Wells

Figure 2 – Conceptual Cross-Section of Stilling Pond (including Retention Pond)

Figure 3 – CCR Groundwater Potentiometric Surface September 8th, 2020

Figure 4 – Monitoring Wells and Limits of Appendix IV Constituent Impacts

FIGURES

Legend

- Background Well
- Downgradient Well
- Facility Boundary Monitoring Well
- Conceptual Cross-Section Location TVA
- Property Boundary
- CCR Unit Area (Approximate)

The Stilling Pond and Retention Pond are also known as the Main Ash Pond

0 600 1,200 Feet

(At original document size of 11x17)
1:7,200

N

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Background: TVA Imagery flown by Tuck Mapping (c. 2017)

Project Location
Stewart County, Tennessee

Prepared by MB on 2020-12-15
Technical Review by MD on 2020-12-15

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

182603597

Figure No.
1

Title
Map with CCR Unit Background and Downgradient Monitoring Wells

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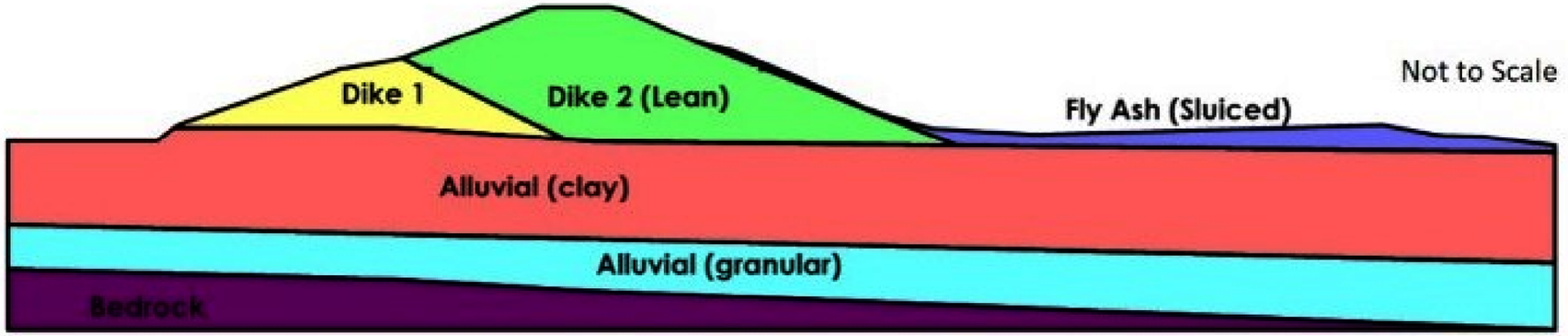
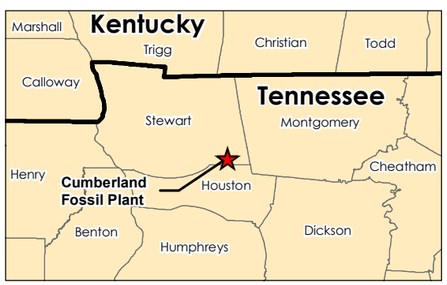
Characterization of subsurface at Stilling Pond:

Material Type	Unit Weight	Cohesion	Friction Angle
Dike 1 (Lean Clay)	123 pcf	200 psf	22 °
Dike 2 (Lean Clay)	123 pcf	200 psf	32 °
Fly Ash (Sluiced)	100 pcf	0 psf	22 °
Alluvial Clay	124 pcf	200 psf	33 °
Alluvial Granular	130 pcf	0 psf	32 °
Bedrock			



Typical section through NW dike
Source: Report of Geotechnical Exploration and Slope Stability Evaluation – Ash Pond, Stantec 2010



Legend

(At original document size of 11x17)
Image Not To Scale

N

TVA

Project Location
Stewart County, Tennessee

Prepared by MB on 2020-11-30
Technical Review by MD on 2020-11-30

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

182603597

Figure No.
2

Title
Conceptual Cross-Section of Stilling Pond (including Retention Pond)

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Figure 3

CCR GROUNDWATER POTENTIOMETRIC SURFACE SEPTEMBER 8TH, 2020

REVISION NUMBER:	DRAWN BY:	REVIEWED BY:
REV. 0	TERESA.WATTERS	DENNIS.CONNAIR

ENVIRONMENTAL COMPLIANCE & OPERATIONS

CUMBERLAND FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

DATE APPROVED:	APPROVED BY:
12/17/2020	DENNIS.CONNAIR

Legend

- Montitoring Well
- Piezometer
- 390 — Potentiometric contours (ft-msl) (dashed where inferred)
- TVA Property Boundary

TENNESSEE
DENNIS P. CONNAIR
#3750
LICENSED PROFESSIONAL GEOLOGIST

N

0 412.5 825 1,650 2,475
Feet

Cumberland River elevation was 355.88 ft-amsl on September 8th, 2020

373.53* = value not used in contouring,

AECOM TVA

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Downgradient Well
- Facility Boundary Monitoring Well
- TVA Property Boundary
- CCR Unit Area (Approximate)
- Potential Arsenic Treatment Zone

0 200 400 Feet

(At original document size of 11x17)
1:2,400

N

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Background: TVA Imagery flown by Tuck Mapping (c. 2017)

Project Location
Stewart County, Tennessee

Prepared by MB on 2020-12-15
Technical Review by MD on 2020-12-15

Client/Project
Tennessee Valley Authority
Cumberland Fossil Plant

182603597

Figure No.
4

Title
Monitoring Wells and Limits of Appendix IV Constituent Impacts

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