Semiannual Report on the Progress of Remedy Selection
TVA Colbert Fossil Plant
Tuscumbia, Colbert County, Alabama

January 15, 2020

Prepared for:

Tennessee Valley Authority
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1.0 INTRODUCTION

In accordance with 40 CFR § 257.97(a),) and ADEM Admin. Code r. 335-13-15, the Tennessee Valley Authority (TVA) has prepared this semiannual report to document progress toward final remedy selection and design at the Ash Disposal Area 4 CCR Unit (CCR Unit), also known as Ash Pond 4, at the Colbert Fossil Plant (COF) in Tuscumbia, Colbert County, Alabama.

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 coal combustion residuals (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).

The Alabama Department of Environmental Protection (ADEM) has promulgated a state CCR Rule (ADEM Land Division – Solid Waste Program, Division 13 (ADEM Admin. Code r. 335-13-15)). As the ADEM CCR Rule has not been approved by the U.S. EPA to operate in lieu of the U.S. EPA CCR Rule, TVA must comply with both the ADEM and U.S. EPA CCR Rules. This semiannual report is also intended to comply with the requirements of the ADEM CCR Rule.

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 CCR Unit, assessment monitoring detected SSLs greater than the GWPS for cobalt and arsenic at monitoring wells COF-102 and COF-105, respectively. TVA recalculated the statistical analysis in mid-2019 after incorporating additional groundwater monitoring data from the first assessment monitoring event and retest event in 2019. In late-2019, TVA updated the statistical analysis after incorporating results from the second semiannual groundwater monitoring event. The same SSLs were observed at the same monitoring wells as previously identified. As of the date of this report, TVA has not demonstrated that a source other than the CCR Unit associated with wells COF-102 and COF-105 caused the SSLs, as allowed under 40 CFR § 257.95(g)(3)(ii).

In accordance with 40 CFR § 257.96(a), TVA prepared the 2019 Assessment of Corrective Measures (ACM) Report for the CCR Unit at COF, placed it in the facility operating record on July 15, 2019 and uploaded it to the TVA CCR 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 and cobalt above the GWPS:

- Monitored Natural Attenuation (MNA);
- Hydraulic Containment and Treatment; and,

- Enhanced In-Situ Treatment (EIST).

Following preparation of the ACM Report, TVA began the remedy selection process. Semi-annual 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 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 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). 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

TVA is currently conducting environmental investigations at COF under the oversight of ADEM pursuant to the First Amended Consent Decree, entered by the Circuit Court of Colbert County, Alabama, in Case No. 20-CV-2013-900123 (ADEM Consent Decree). In May 2019, TVA submitted a Comprehensive Groundwater Investigation (CGWI) Report (May 17, 2019) to ADEM that described the hydrogeologic setting and provided an evaluation of the extent of CCR constituents in groundwater, including in the vicinity of the CCR Unit. Additional investigation activities were performed at COF in late 2019 to supplement the CGWI in combination with an ACM, which was submitted to ADEM in July 2019 pursuant to the requirements of the ADEM Consent Decree. As determined to be necessary, corrective measures at COF will be completed following remedy selection in accordance with the ADEM Consent Decree and the requirements set forth in the U.S. EPA and ADEM CCR Rules.

1.3 REPORT CONTENTS

This first semiannual report on the progress of remedy selection provides brief summaries of COF site characteristics, the groundwater assessment monitoring program, findings of the ACM process, and the current progress of selecting and designing a remedy for the groundwater associated with the CCR Unit.

2.0 SITE BACKGROUND AND CHARACTERISTICS

COF is located at 900 Colbert Steam Plant Road in Tuscumbia, Colbert County, Alabama. The facility occupies 1,354 acres between the south shore of the Tennessee River / Pickwick Reservoir and U.S. Highway 72, approximately 12 miles west of the center of Tuscumbia, Alabama. The COF property boundaries are shown in **Figure 1**. Construction of COF began in October 1951 and commercial operations began in January 1955. Coal-fired generation ceased on March 23, 2016. The retired COF powerhouse is in the northwest portion of the property adjacent to the Tennessee River/Pickwick Reservoir (**Figure 1**).

Now closed and capped, the CCR Unit was originally constructed in 1972 and received both sluiced bottom ash and, for a limited time, fly ash from plant operations until 2016 when the coal burning operations were terminated at COF. The CCR Unit is subject to the U.S. EPA and ADEM CCR Rules. Closure of the CCR Unit was completed in accordance with an ADEM-approved closure plan and the U.S. EPA CCR Rule. Elements of closure included dewatering, grading, and constructing an engineered cap system to prevent infiltration of rainwater. Surface water management infrastructure and erosion and sediment control were also provided. Construction was primarily finished by December 2017, with closure deemed complete on March 6, 2018. The engineered cap includes a low-density polyethylene flexible membrane liner, a drainage layer consisting of a geocomposite material, cover soil, and permanent vegetative cover. The final cap and cover system design complies with the relevant standards under the U.S. EPA CCR Rule.

2.1 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.

2.1.1 Geology and Hydrogeology

The following sections provide a summary of the geologic and hydrogeologic CSM. The subsurface geology at COF is characterized into three hydro-stratigraphic units including the Alluvial sand and gravel aquifer (Alluvium), Residuum water-bearing unit (Residuum), and the Tuscumbia-Fort Payne bedrock aquifer. The Alluvium is the upper-most aquifer at the CCR Unit being monitored in accordance with 40 CFR § 257.91, and the ADEM CCR Rule. A typical cross-section view of the subsurface geology is shown on **Figure 2**.

2.1.1.1 Alluvial Aquifer

The Alluvial aquifer is considered the uppermost aquifer in the area around the CCR Unit. It is composed of Pleistocene-age alluvium deposits that overlie bedrock. The Alluvial aquifer has a limited areal extent, and at COF, it is located adjacent to Cane Creek. Alluvium is a general term for clay, silt, sand, gravel or similar unconsolidated detrital material, deposited during comparatively recent geologic time by a stream or other body of running water, as a sorted or semi-sorted sediment. The alluvium near the CCR Unit that was deposited in the incised paleochannel of Cane Creek has been observed to be as much as 45 to 50 feet thick. Groundwater flow is to the northeast in the area of the CCR Unit as illustrated in **Figure 3**.

A chert-rich clay residuum derived from the weathering of underlying limestone bedrock overlies the Tuscumbia Limestone. The thickness of the residuum at COF is highly variable, ranging from zero thickness (where bedrock is exposed at the surface) to 60 to 70 feet thick. The residuum unit does not yield a significant quantity of groundwater and is not used as a source of drinking water or for other general purposes.

2.1.1.2 Tuscumbia-Fort Payne Bedrock Aquifer

The Tuscumbia Fort-Payne Bedrock aquifer at COF is composed of the Tuscumbia Limestone and Fort Payne Chert. These units are light to medium gray, fine to medium-grained fossiliferous, cherty limestone and the contact between the two units is often undistinguishable. The Tuscumbia limestone contains two types of fractures: (1) horizontal fractures that occur along bedding planes, and (2) a conjugate set of high angle fractures that trend approximately N50°E and N50°W. Dissolution of the Tuscumbia limestone has resulted in the development of karst that is characterized by high secondary porosity. The dissolution features are generally oriented in the same directions as the fracture networks. Dissolution along these features results in a well-developed system of interconnected secondary porosity features Wells that penetrate enlarged joint/fracture sets and bedding planes yield large quantities of water, and typically respond quickly to recharge events (i.e., rain). Wells that do not intersect with these features have lower yields and slower recharge response times.

2.2 POTENTIAL RECEPTOR REVIEW

Although private groundwater wells have been identified in the area of COF, the area is served by municipal water supply. Water use surveys conducted in 1993 and 2003 indicated that private wells near COF were used generally as backup water supplies and/or for purposes other than drinking water, such as lawn/garden irrigation and car washing. Depths of private wells identified by the 2003 survey range from 136 to 265 feet, suggesting that the wells were completed in the Tuscumbia-Fort Payne aquifer. No industrial or commercial groundwater production wells were identified within five miles of COF.

Groundwater monitoring wells have been installed around the perimeter of the COF facility as part of additional environmental investigations recently conducted. Data from these wells indicate that COIs are not migrating off site to adjacent properties.

Three public water supply utilities are present within a five-mile radius of COF including the Colbert County Rural Water System, the Cherokee Water Department and the Hawk Pride Mountain Water System. The Colbert County Rural Water System treats up to 2.5 million gallons per day (MGD) of raw Tennessee River water to serve approximately 3,600 customers. The river water intake pipe for the filtration plant is located within the COF property boundary. The Cherokee Water Department treats up to 0.5 MGD of raw Tennessee River water to serve approximately 800 customers. The intake for the Cherokee Water Department is approximately six miles downstream of COF. The Hawk Pride Mountain Water System supplies approximately 1,350 customers with groundwater supplied by two wells completed in the Tuscumbia-Fort Payne bedrock aquifer. These three facilities are interconnected so that one system can supply treated water to another during emergencies.

3.0 GROUNDWATER ASSESSMENT MONITORING PROGRAM

Groundwater assessment monitoring for the CCR Unit is conducted at COF in accordance with 40 CFR § 257.95 and with ADEM Admin. Code r. 335-13-15.06(6).

3.1 GROUNDWATER MONITORING WELL NETWORK

In compliance with 40 CFR § 257.91, one background well (CA5) was established upgradient and four monitoring wells (COF-102, COF-104, COF-105 and COF-106) were installed downgradient of 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 and 2019. The following Appendix IV constituents were detected at SSLs above a GWPS:

- SSLs for arsenic and cobalt were identified at monitoring wells COF-105 and COF-102, respectively; and,
- The GWPS for arsenic is 10 µg/L and the GWPS for cobalt is 6 µg/L.

Additional monitoring wells have been installed and the monitoring data will aid in further refining the characterization of the nature and extent of groundwater release at the site, as required by 40 CFR 257.95(g)(1). The potential treatment areas along the unit perimeter to address the extent of arsenic and cobalt above the GWPS is illustrated on **Figure 4**. The work being performed under the ADEM Consent Decree will further inform the evaluation and selection of the remedy(s) under 40 CFR § 257.97 of the CCR Rule.

4.0 ASSESSMENT OF CORRECTIVE MEASURES

The 2019 ACM Report for the CCR Unit was added to 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. The CCR Unit was closed in-place and capped in accordance with 40 CFR § 257.102. Closing and capping of the CCR Unit limits water infiltration through the CCR and reduces the potential for further releases. The completed closure and capping of the CCR Unit serve as source control measures as required under 40 CFR § 257.97(b)(2).

Closure of the 4 CCR Unit serves as a source control measure; however, remedial technologies are being considered to address the area of groundwater exhibiting continued arsenic and cobalt concentrations above the GWPS. TVA addressed source control in 2018 when the CCR unit was closed and capped using engineered designs consistent with the relevant standards under the U.S. EPA CCR Rule. For the CCR Unit, the engineered cap includes a low-density polyethylene flexible membrane liner, a drainage layer consisting of a geocomposite material, cover soil, and permanent vegetative cover. Surface water management infrastructure and erosion/sediment control were also provided. The purpose of these engineered elements is to prevent infiltration of rainwater and to control surface water runoff, thus controlling the source of the release. Current post-closure care of the CCR units includes inspections and maintenance of the engineered cap. Stability of the CCR materials and potential seeps are also monitored.

The process for selecting a remedy includes continued evaluation of groundwater assessment monitoring data, as required by 40 CFR § 257.96(b). Groundwater assessment monitoring will continue until a remedy is selected. In addition, information that is being collected as part of the ADEM Consent Decree will inform decision making related to timing, scope, and necessity of potential interim actions as well as the final selection and design of a final remedy in accordance with 40 CFR § 257.97. Groundwater monitoring data collected after closure of the CCR Unit has exhibited a decreasing trend for cobalt in COF-102. This trend suggests that unit closure is supporting improved groundwater conditions for dissolved cobalt.

4.2 POTENTIAL REMEDIAL TECHNOLOGIES

The CCR Unit was 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 and cobalt above the GWPS including:

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

The ACM Report prepared pursuant to the U.S. EPA CCR Rule 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.

The separate ACM prepared pursuant to the requirements of the ADEM Consent Decree divided Monitored Natural Attenuation into the following three options:

1. Monitored Natural Attenuation via Continued Groundwater Monitoring
2. Monitored Natural Attenuation and Institutional Controls
3. Monitored Natural Attenuation, Institutional Controls, Interim Responses, and Adaptive Management

All three options include Monitored Natural Attenuation, which would be implemented to document groundwater quality improvement and trends, to confirm that offsite migration of CCR constituents to surrounding properties is not occurring, and to better understand the estimated time to achieve compliance with groundwater protection standards (GWPS). Institutional controls may be used to limit future property and groundwater use. Interim responses would be established through Target Levels for groundwater that are protective of surface water. In addition, Option 3 would establish certain conditions (e.g., increasing concentration trends) that will trigger further adaptive management activities. These activities may include further investigations and/or active groundwater remedies.

5.0 SELECTION OF REMEDY: CURRENT PROGRESS

A remedy to address SSLs in groundwater will be selected in accordance with 40 CFR § 257.97[1] and the requirements of the ADEM Consent Decree.

5.1 DATA REQUIREMENTS FOR DESIGN OF GROUNDWATER CORRECTIVE ACTION

In order to further refine the targeted area for corrective measures, develop remedial cost estimates and finalize the alternative for the CCR Unit, the currently available site-specific data may require additional refinement to address potential data gaps. It is noted that additional data collection requirements will include ongoing ADEM Consent Order work that is reported separately.

Current and future activities to further evaluate site conditions:

- Two additional monitoring wells were installed around former the CCR Unit. Monitoring well COF-116 is a background well situated south of the CCR unit and well COF-111 is a downgradient well on the northeast side of the CCR Unit. Monitoring well locations are illustrated in **Figure 1**.
- TVA will continue monitoring groundwater on a semiannual basis (with retest events) resulting in four sampling events per year and will include the newly installed monitoring wells (COF-111 and COF-116).
- The surface water evaluation of Cane Creek and the Tennessee River will continue with additional upstream surface water sampling, surface water elevation gauging, flow measurements and RM-2 modeling.
- Slug testing has been performed at multiple well locations surrounding the CCR Unit to further characterize hydraulic conductivity including at newly installed monitoring wells COF-111 and COF-116.
- A geochemical investigation is being conducted to evaluate groundwater and aquifer solids in the former chemical pond area upgradient (west) and downgradient (east) of the CCR Unit.
- TVA has started development of a groundwater model for the alluvial aquifer and will continue to develop the model.

[1] The Alabama Department of Environmental Management (ADEM) has adopted a state CCR rule. As the state rule has not been approved by EPA to operate in lieu of the federal CCR Rule, TVA must comply with both the state and federal CCR regulations. This report also complies with ADEM Admin. Code r. 335-13-15-.06 (6)(g).

Current activities to further evaluate MNA:

- Sampling of groundwater for MNA parameters (including alkalinity, nitrate, nitrate + nitrite, dissolved sulfide, total organic carbon and dissolved organic carbon) has commenced to aid in the evaluation of one of the proposed corrective measures strategies.

Potential future activities to further evaluate hydraulic containment and treatment:

- Supplemental Groundwater Flow Modeling Simulations – A groundwater flow model is currently being developed based on expanded groundwater elevation data gained from the additional hydrogeologic characterization efforts and will be used for future modeling of hydraulic containment scenarios.

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

- Supplemental Hydraulic Properties Evaluation – This evaluation could be necessary if the existing understanding of the hydraulic characteristics of the subsurface are not sufficient 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 feed back into the groundwater flow modeling simulations for groundwater extraction. These data would inform the feasibility, design, and implementation of any groundwater recovery systems.

Current activities to evaluate Enhanced In-situ Treatment:

- A geochemical investigation is being conducted to evaluate groundwater and aquifer solids in the former chemical pond area upgradient (west) and downgradient (east) of the CCR Unit.

Potential future activities to evaluate Enhanced In-situ Treatment:

- 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 and cobalt 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). 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 produced 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), in addition to the requirements for recordkeeping, notification and internet postings under the ADEM CCR Rule.

Attachments:

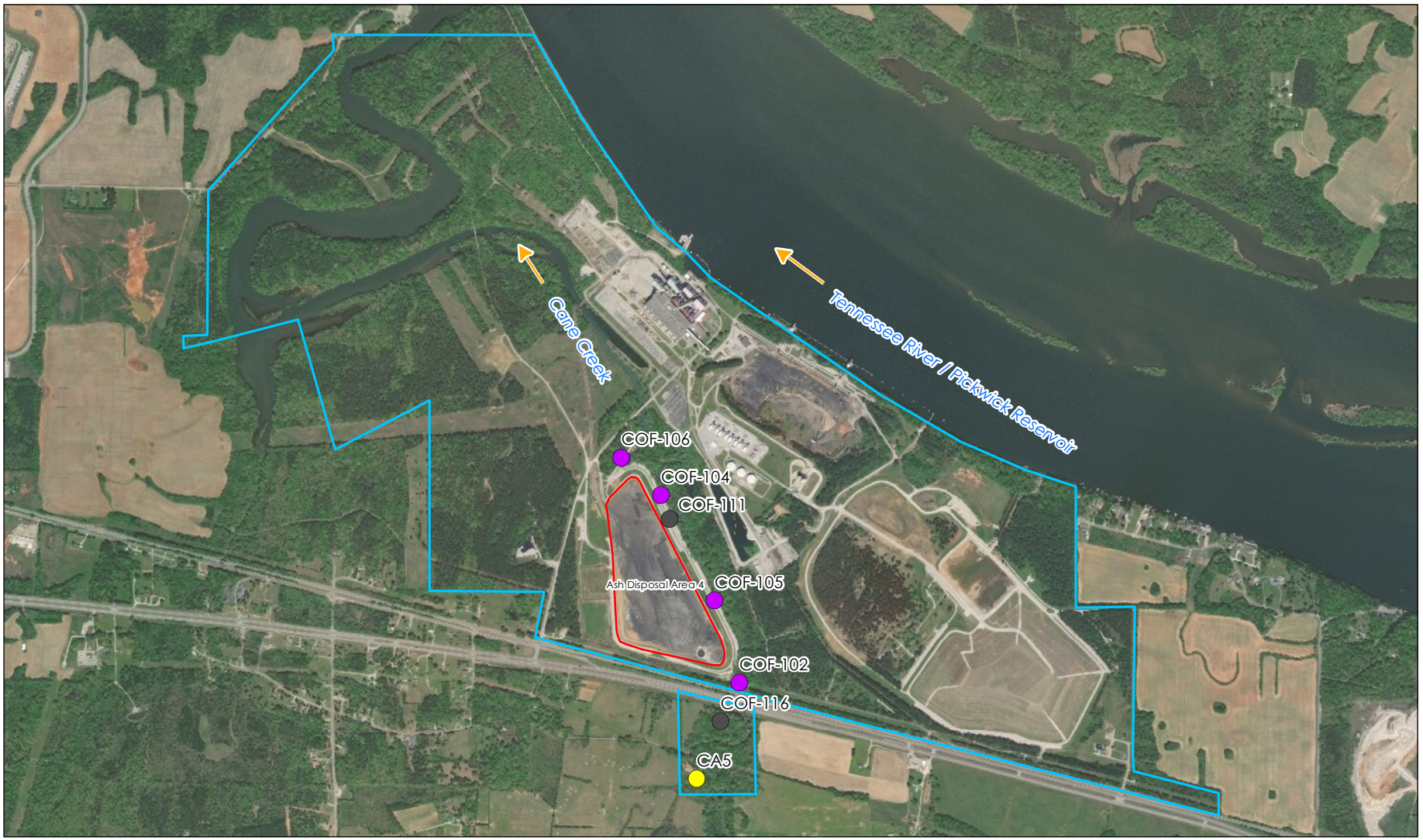
Figures

Figure 1 – CCR Unit with Background and Downgradient Wells

Figure 2 – Geological Cross-Section COF Ash Disposal Area 4

Figure 3 – COF Ash Disposal Area 4 Groundwater Flow Direction in Alluvium

Figure 4 – Monitoring Wells and Limits of COI Impacts



Legend

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

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0 1,000 2,000 Feet

(At original document size of 8.5x11)
1:24,000

Notes

1. Coordinate System: NAD 1983 StatePlane Alabama West FIPS 0102 Feet

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

Project Location
City of Tuscumbia
Colbert County,
Alabama

Client/Project
Tennessee Valley Authority
Colbert Fossil Plant
CCR Rule

Prepared by LMB on 2020-01-10
Technical Review by EP on 2020-01-10
Independent Review by JB on 2020-01-10
182603534

Figure No.

Figure 1

Title

CCR Unit with Background and Downgradient Wells

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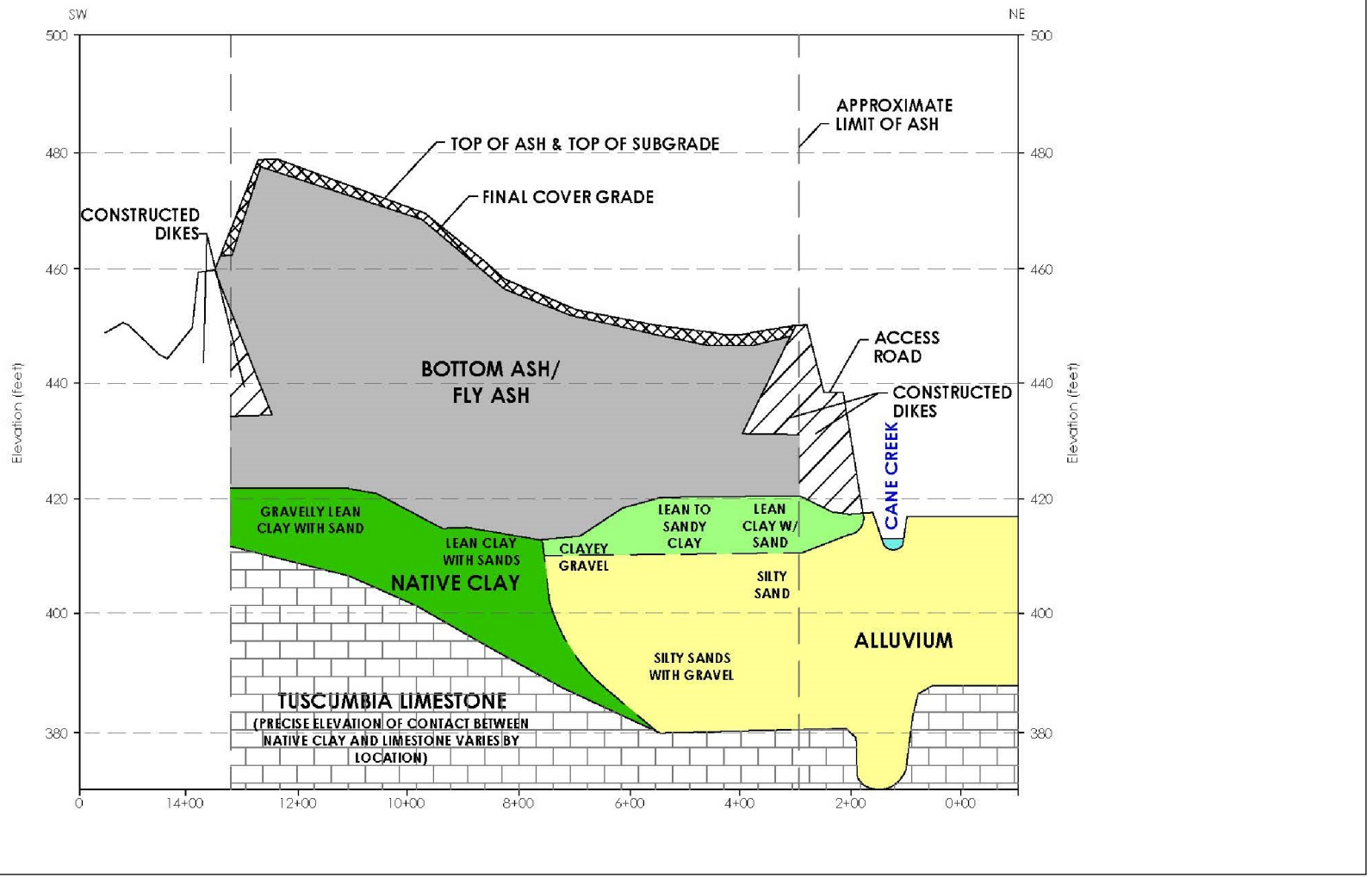

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Figure No.
Figure 2

Title
Geological Cross-Section COF Ash Disposal Area 4

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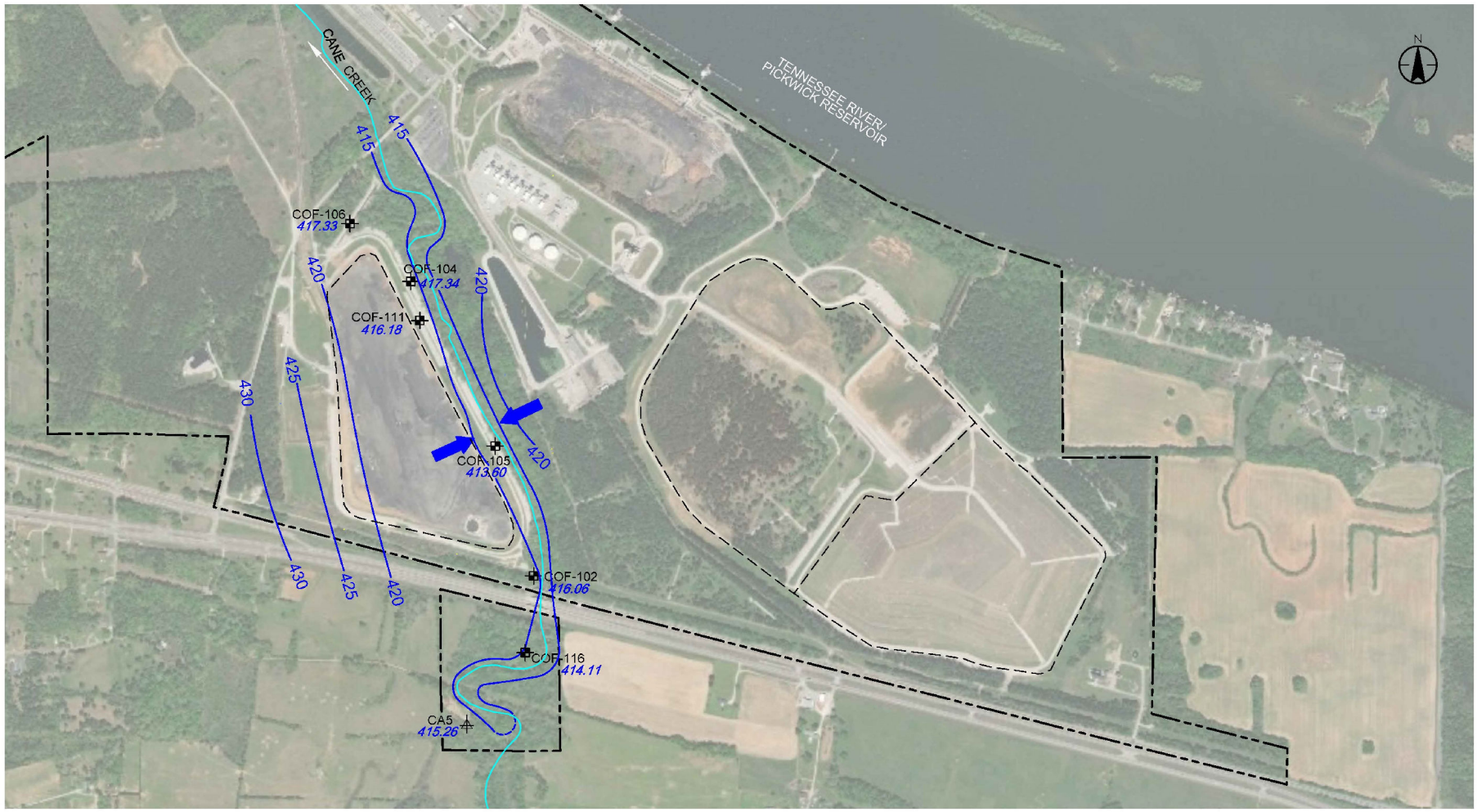

LEGEND

- BEDROCK MONITORING WELL LOCATION
- ALLUVIUM MONITORING WELL LOCATION
- RESIDUUM MONITORING WELL LOCATION
- 415.26 GROUNDWATER ELEVATION (FT NGVD 29) - NOVEMBER 4, 2019
- GROUNDWATER ELEVATION CONTOUR (FT NGVD 29)
- APPROXIMATE GROUNDWATER FLOW DIRECTION
- TVA PROPERTY BOUNDARY

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Figure No.
Figure 3

Title
COF Ash Disposal Area 4 Groundwater Flow Direction in Alluvium

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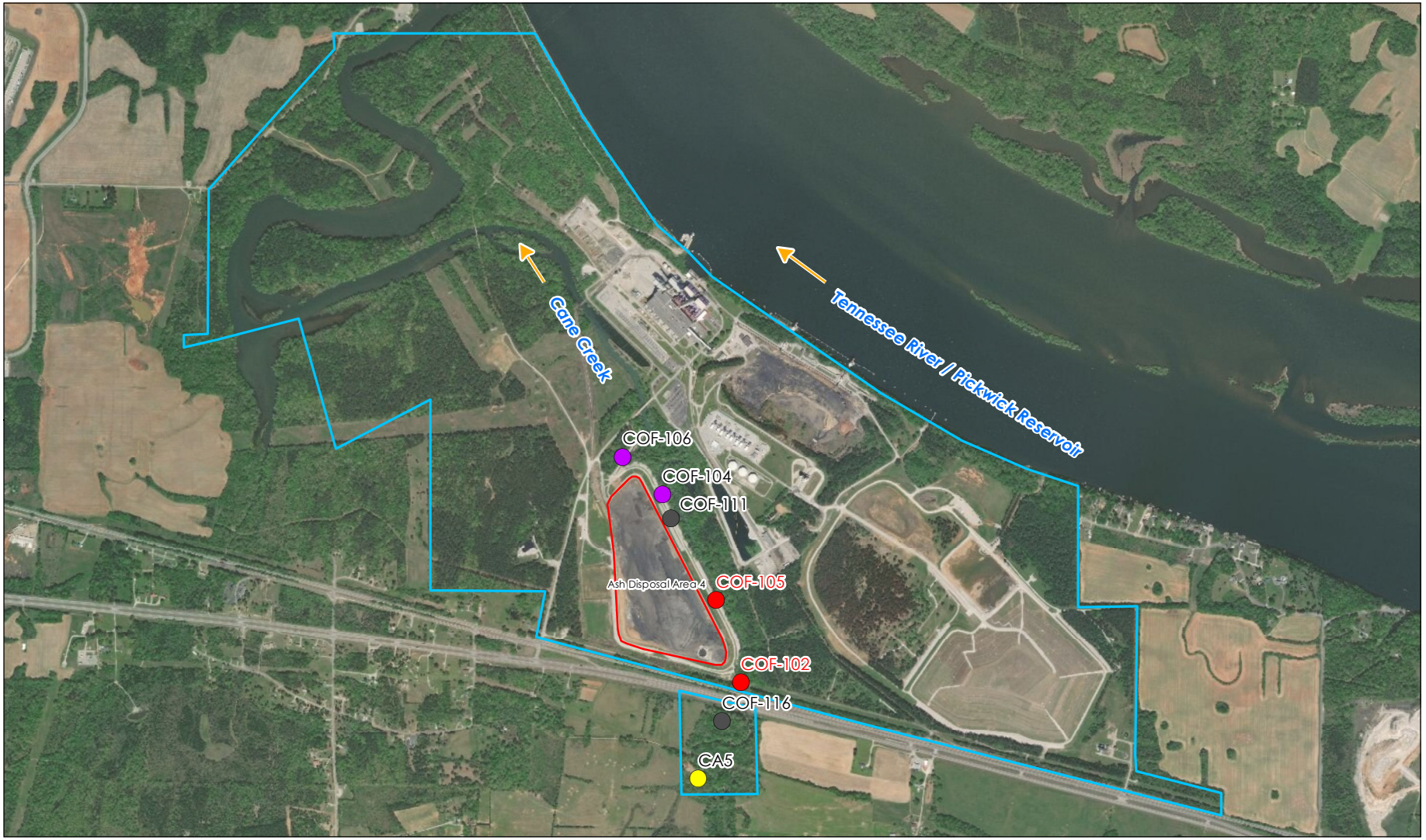

Legend

- GWPS Exceedance Well
- Background Well
- Downgradient Well
- Investigation Well
- CCR Unit Subject to CCR Rule
- TVA Property Boundary

N

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(At original document size of 8.5x11)

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Notes

1. Coordinate System: NAD 1983 StatePlane Alabama West FIPS 0102 Feet

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Figure No.

Figure 4

Title

Monitoring Wells and Limits of COI Impacts

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