TENNESSEE VALLEY AUTHORITY

Seventh Semiannual Report on the Progress of Remedy Selection

Active Ash Pond 2 CCR Unit

TVA Johnsonville Fossil Plant, New Johnsonville, Humphreys County, Tennessee

January 13, 2023

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January 13, 2023

1.0 Introduction

In accordance with Title 40 Code of Federal Regulations (CFR) § 257.97(a), the Tennessee Valley Authority (TVA) has prepared this semiannual report to document progress toward remedy selection and design at the Active Ash Pond 2 (CCR Unit) at the Johnsonville Fossil Plant (JOF) in New Johnsonville, Humphreys County, Tennessee.

1.1 Regulatory Background

On April 17, 2015, the United States Environmental Protection Agency 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, CFR Part 257, Subpart D (CCR Rule). The CCR Rule includes requirements for monitoring groundwater and assessing corrective measures if constituents listed in Appendix IV of the CCR 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 determined that 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 in 2018 detected SSLs greater than the GWPS for cobalt at monitoring wells 10-AP3 and JOF-103. TVA has updated the statistical analysis after each assessment monitoring event and retest event on a semiannual basis from mid-2019 through 2021.

- In mid and late 2022, TVA updated the statistical analysis after incorporating results from the assessment monitoring and retest events conducted in 2022. 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 10-AP3 and JOF-103 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 JOF, 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 corrective measures in accordance with 40 CFR § 257.96(c). Three primary strategies were evaluated to address groundwater exhibiting concentrations of cobalt above the GWPS:

- Hydraulic Containment and Treatment
    - Physical Barriers
    - Pumping Systems
- Enhanced In-Situ Treatment (EIST)
    - Infiltration Galleries

  - Direct Injection
  - Permeable Reactive Barriers (PRB)
- Monitored Natural Attenuation (MNA)

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. TVA placed prior Semiannual Reports on the Progress of Remedy Selection into the facility operating record 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 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 units at JOF, including Active Ash Pond 2, 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 impacts, including groundwater impacts, at JOF to TDEC for approval. Then, as part of the TDEC Order process, TVA will submit a Corrective Action/Risk Assessment (CARA) Plan to TDEC for approval. The CARA Plan will specify actions that TVA plans to take, including corrective measures for groundwater remediation. TDEC must approve the CARA Plan, including the closure methodology for the CCR Unit and corrective measures for groundwater remediation. The TDEC Order process includes a public comment period for the CARA Plan.

1.3 Report Contents

This semiannual progress report provides a summary of JOF 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

JOF is located in New Johnsonville, Humphreys County, Tennessee. The facility lies on the eastern bank of the Tennessee River (Kentucky Lake). **Figure 1** shows an overview map of JOF, including the CCR Unit. Construction of JOF began in 1949, and operations commenced in 1951. Coal-fired power generation ceased in December 2017. The coal combustion process at JOF resulted in the production of fly ash and bottom ash. The plant most recently managed these materials in the CCR Unit.

Active Ash Pond 2 encompasses approximately 90 acres and is surrounded by perimeter dikes with a height that ranges from approximately 25 to 35 feet above the original ground surface. During plant operations, the CCR Unit received sluiced fly and bottom ash, plant effluent, and stormwater runoff pumped from the Coal Yard Drainage Basin. The last JOF coal-fired generating units were shut down in December 2017 and CCR sluicing to the CCR Unit ceased. Process water flows to the CCR Unit ceased in April 2021.

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 JOF have been characterized during implementation of multiple investigations. These investigations provide a detailed understanding of geology and the water-bearing zones.

The CCR Unit has two clay dikes, a hydraulic fill layer, and two foundation layers. The two clay dikes are the upper clay dike and the lower clay dike. The dikes and foundation layers are separated by a hydraulic fill layer. The upper clay dike has textural descriptions of lean clay, lean clay with sand and lean clay with gravel. Underlying the upper clay dike is the lower clay dike with textural descriptions ranging from lean clay to silt with sand and gravel in places. The hydraulic fill material underlies the lower clay dike and consists of clay, silt, sand and gravel. The uppermost foundation layer is encountered below the hydraulic fill material and is comprised of alluvial lean clay, lean clay with sand and gravel, silt, and silt with gravel. Beneath the alluvial clay and silt layer is the lower foundation layer consisting of alluvial sand and gravel.

The natural unconsolidated materials consist primarily of alluvium overlying bedrock. Alluvium refers to native materials that are deposited by moving water. The alluvium can be further differentiated into clays, silts, sands, and gravel interval zones of the unconsolidated materials observed near the top of bedrock. The upper fine-grained alluvium layer varies in thickness from 15 to 25 feet and is primarily comprised of clays and silts. The lower alluvial layer, ranging in thickness from 25 to 30 feet, is primarily sand and gravel. Bedrock underlying the CCR unit is the Camden Chert, which is comprised of bluish gray fine grained argillaceous cherty limestone.

A cross-section location map is provided on **Figure 2** with a cross-section view of the typical subsurface geology shown on **Figure 3**. The groundwater flow direction is primarily west towards the Tennessee River. **Figure 4** presents a potentiometric surface map using groundwater data collected on September 12, 2022.

2.2 Potential Receptor Review

There are two public drinking water providers that use the Tennessee River as the source of drinking water in the vicinity of JOF. The town of New Johnsonville has a surface water intake on the east bank of the Tennessee River approximately 1.8 miles upstream of the JOF facility. The town of Camden also sources its drinking water from the Tennessee River and based on the location of the Camden Water Plant, the intake is on the west bank of the Tennessee River upstream from JOF (approximately 0.45 miles). No downstream water providers using the Tennessee River (Kentucky Lake) as a source of drinking water were identified from immediately north of JOF to the border with Kentucky, approximately 37 miles downstream.

Two identified private well locations are located south of JOF within a 1/2-mile radius from the center of the facility property on the south side of Highway 70. Based on their locations and the understanding of groundwater flow directions in this area, which is primarily west towards the river, these wells are either upgradient or cross-gradient of the facility or are located far enough from the facility that groundwater migration from the facility to the wells would be negligible.

3.0 Groundwater Assessment Monitoring Program

Groundwater assessment monitoring for the CCR Unit is conducted at JOF in accordance with 40 CFR § 257.95.

3.1 Groundwater Monitoring System

In compliance with 40 CFR § 257.91, two background wells (B-9 and JOF-101) were installed upgradient and four monitoring wells (10-AP1, 10-AP3, JOF-103, and JOF-104) were certified for the groundwater monitoring system for the CCR Unit. The locations of these monitoring wells are presented on **Figure 1**.

3.2 Groundwater Characterization

Groundwater assessment monitoring was conducted from 2018 through 2022. The following Appendix IV constituent was detected at SSLs above a GWPS for the assessment monitoring events:

Cobalt

- SSLs for cobalt were identified at monitoring wells 10-AP3 and JOF-103
- The GWPS for cobalt is 6 µg/L.

Data from existing wells have been used to characterize the nature and extent of SSLs as required by 40 CFR § 257.95(g)(1). The monitoring wells with cobalt concentrations above GWPS are illustrated on **Figure 5**. The work being performed under the TDEC Order process will further refine this characterization and inform the evaluation and selection of the remedy(s) under 40 CFR § 257.97 of the CCR Rule.

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 corrective measures in accordance with 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 "Control 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 management of wet CCR has ceased 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. The CCR Unit stopped receiving waste streams in April 2021, andTVA initiated closure of the CCR Unit under the requirements of 40 CFR § 257.101(a)(1). The method of final closure for the CCR Unit will be determined following the outcome of the TDEC Order process and will be in accordance with 40 CFR § 257.102. TVA plans to decant the southern end of the CCR Unit which would be necessary regardless of the method of closure that TDEC approves for this CCR Unit.

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

4.2 Potential Remedial Technologies

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

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

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

  - PRB
- MNA

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 measures are currently considered feasible for remediating the groundwater at the CCR Unit.

5.0 Selection of Remedy: Current Progress

A remedy to address SSLs for cobalt 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(b)(1)-(5). Remedies must:

- Be protective of human health and the environment
- Attain the groundwater protection standard as specified pursuant to §257.95(h)
- Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in appendix IV to this part into the environment
- 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, and
- Comply with standards for management of wastes as specified in §257.98(d).

In support of the remedy selection process, additional investigation is needed and ongoing as described below.

5.1 Data Requirements for Design of Groundwater Corrective Action

Additional data to address potential data gaps to further refine the targeted area for corrective measures and to evaluate and select the groundwater remedy(s) for the CCR Unit will include ongoing TDEC Order work that is reported separately. Pursuant to the TDEC Order, the groundwater remedy for this CCR Unit must be approved by TDEC upon completion of the TDEC Order process, which is currently ongoing.

Activities completed to further evaluate site conditions include:

- Continued to evaluate data obtained from soil boring materials collected in May 2021 extending from the east side of Active Ash Pond 2 to near the eastern boundary of the coal yard. The locations of the soil borings are depicted in **Figure 6**.
- Completed three in-situ field testing events in June and July 2022 using in-well point velocity probes (IWPVPs) at nine existing monitoring wells shown in **Figure 7**.
- Continued to evaluate groundwater monitoring data.

Ongoing and potential future activities to evaluate hydraulic containment and treatment include:

- Groundwater Flow Modeling – The numerical groundwater flow model may be used to evaluate targeted hydraulic containment. A calibrated groundwater flow model may be used to evaluate a variety of hydraulic containment 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 cobalt-impacted groundwater while balancing extracted groundwater treatment requirements.

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

- Supplemental Hydraulic Properties Evaluation – An evaluation was designed to further refine the hydrogeologic conceptual site model, provide calibration data for the groundwater flow model, provide input for geochemical modeling and to guide potential corrective measures at the CCR Unit. This investigation used IWPVPs in nine existing wells to obtain additional site-specific groundwater flow direction, groundwater flux, and flow velocities to supplement understanding of groundwater systems at the CCR Unit. These data may be used to support estimates of groundwater flow velocity and estimated groundwater flux to support remedy selection and design. Well locations are provided on **Figure 7**.

Ongoing activities to evaluate EIST:

- Groundwater Treatability Study – For in-situ treatment of groundwater, bench-scale treatability studies are being conducted using representative groundwater samples prior to selecting a groundwater corrective measure for implementation to address cobalt concentrations. Results of geochemical modeling will be used to guide the treatability testing. The groundwater and soil geochemistry are site-specific and area-specific; therefore, bench-scale treatability testing can be used to evaluate the best method to immobilize or treat cobalt. Initial phases of treatability testing are complete and longer-term evaluation to understand the longevity of potential treatment and mechanisms of attenuation are ongoing.

Ongoing and potential future activities to further evaluate MNA include:

- A geochemical investigation is being conducted to evaluate groundwater and aquifer solids east and northeast of the CCR Unit.

- TVA is conducting geochemical modeling at the CCR Unit to evaluate the influence of native soils on groundwater chemistry. The geochemical modeling will aid in evaluating corrective measures. Geochemical processes operating in groundwater influence migration of Appendix IV constituents through adsorption, ion exchange, and potential mineral precipitation/dissolution. The time frame of effectiveness and capacity of the native soil system to attenuate Appendix IV constituents is being evaluated using geochemical characterization of soils and modeling of soils and groundwater.

- Numerical groundwater flow modeling is being conducted to support geochemical modeling and selection of a final remedy by incorporating the additional groundwater elevation data gained from the ongoing environmental investigation and additional hydrogeologic characterization efforts under the TDEC Order.

- Groundwater fate and transport modeling may be conducted to further evaluate the natural attenuation and migration of constituents. The refined groundwater flow model and geochemical model would be used in conjunction to evaluate fate and transport to inform potential corrective measures.

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 40 CFR § 257.97. 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 § 257.97(e).

Seventh Semiannual Report on the Progress of Remedy Selection
TVA Johnsonville Fossil Plant, New Johnsonville, Humphreys County, Tennessee

January 13, 2023

Attachments:

Figures

Figure 1 – CCR Unit with Background and Downgradient Monitoring Wells

Figure 2 – Cross-Section Location Map

Figure 3 – Geologic Cross-Section Active Ash Pond 2

Figure 4 – Potentiometric Map September 12, 2022

Figure 5 – Monitoring Wells and Appendix IV Constituents Above GWPS

Figure 6 – Investigation Locations

Figure 7 – JOF Plant IWPVP Test Well Location Map

FIGURES